

Final Reports as of February 2005 - #01 Projects

**#01-03 Indian Ricegrass: A Value-Added Perennial Crop for Montana Growers –
David Sands – Montana State University Bozeman
Year 1 - \$122,800; Year 2 - \$82,500
Final Report approved November 2003**

Summary:

The overall goal of this project was to develop Indian Ricegrass (IRG), a native perennial bunchgrass, into a valuable grain crop for Montana producers. This crop has the potential to benefit agricultural growers, producers and their communities, and the worldwide celiac population who are unable to tolerate gliadin (a protein fraction of gluten found in many cereal grain crops including wheat, barley and rye). IRG does not contain gluten and is a highly flavorful grain, which provides an exciting additive, or alternative, to traditional gluten-free flours such as rice, bean, potato, tapioca and cassava. The project has gone very well and is rapidly meeting the commercialization success originally anticipated.

Commercialization Plan:

Product Description: Montana™ is a gluten-free flour product derived from Indian Ricegrass, a dietary staple of Western Native Americans. The benefits of Indian Ricegrass as gluten-free flour have recently been discovered as an alternative agricultural crop for Montana's struggling farmers.

Market Analysis:

Celiac Disease: The market for gluten-free products consists primarily of those who suffer from celiac disease, an autoimmune disorder, which damages and destroys the lining in the intestines when it reacts with a protein called gluten. Recent studies show 1 in 150 to 1 in 200, or 1.5 million, Americans suffer from celiac disease. Awareness of the disease is increasing and diagnosis becoming more prevalent not only in the United States but in Canada and Europe as well.

Market for Gluten Free Flour: Montana has the potential to substitute the rice or brown flour used in most recipes, which would account for 82,800,000 pounds per year, or \$79,129,200. This is a potential of about 10% of the total gluten-free flour market.

Market for Gluten Free Mixes: Gluten-free mixes account for approximately 20% of the gluten-free products sold. Each celiac purchasing one pound of bread mix per week equals \$6,684,000 annually, or 1.5 million pounds. Montana flour can also be used in cake, muffin and cookie mixes, increasing the potential market by an estimated 100,000 pounds. The average price per pound is \$3.89.

Market for Gluten Free Ready Made Breads: If 60% of celiacs buy an average of one loaf of bread a week, the estimated total annual sales are \$199,836,000. If each celiac purchases an additional ready-made bread product, such as bagels or muffins, twice a month, an additional \$666,120,000 would be spent, or an additional 3 million pounds would be sold.

Market for Reclamation Seed: Potential annual sales are around \$4,000 to \$7,000 per dealer. With increasing uses of IRG, sales of \$50,000 annually are estimated. Research shows that IRG is currently only 2-5% of reclamation seed dealers' income.

Competition: There are many producers, manufacturers and distributors of gluten-free products throughout the United States, Canada and Europe. Many sell their products directly through websites and/or distribute through retailers. There do not appear to be any producers or manufacturers of Indian Ricegrass as a gluten-free product. This would give Montana a competitive edge in the gluten-free product market.

Current Commercialization Success: Montana is a successful commercialization product. Montana™ Pure Baking Supplement and Montana™ All-purpose flour are currently in markets across the Northwest and Midwest United States and product is available via the Internet. Negotiations are in progress with corporations in Canada and Great Britain. Demand greatly exceeds supply. Amazing Grains Cooperative is responding to this demand by increasing acreage and recruiting additional gluten-free producers.

Economic Impacts:

Establishment of Statewide Montana cooperative: Amazing Grains Grower Cooperative incorporated in Montana with 38 members and three full-time employees at Mission Mountain Market in Ronan, Montana. Currently, about 2,500 acres of IRG production committed to IRG with an expected yield of ~150,000 pounds in 2003. At \$2.89 per pound, this equates to gross return to producers of \$429,916. Sales of Montana™ products (baking supplement and all-purpose flour) for 2003 are estimated at approximately \$1,316,526.

Extensive news coverage: Montana newspapers, local TV channels, societies of celiac sufferers have informed membership of safety and nutritional merits of the product.

Basis for rejuvenation of Montana agriculture: Enable farmers to control and protect a new technology and derive a sustainable profit stream from continued production. The price paid to cooperative members is orders of magnitude more than for other cereal crops and can be expected to enable growers to make a good income.

Long-Term Objectives:

Increase number of acres in IRG to meet demand: At least double current acreage planted in next two years.

Optimization of gluten-free IRG production including weed control, crop rotation and harvest: A full grower manual for producing IRG will be compiled from studies to determine the effects of seed rate, irrigation, fertilization and herbicide treatments on IRG. Additional plants will be evaluated as potential gluten-free seed crops.

Continued development of Montana products: Identification and development of additional recipes and products using IRG and other gluten-free grains

**#01-4&5 Market Opportunities and Strategic Directions for Specialty Herbs and Essential Oil Crops in Montana – Nancy Callan – Western Agriculture Research Center/Corvallis, MSU Bozeman - \$114,000
*Final Report approved February 2003***

Summary:

The goal of the project was to enable Montana growers of specialty crops to become more competitive by helping them generate a higher-value product with lower production costs.

Important factors, which determine the yield and quality of dill oil, have been identified and cultural practices to address these factors have been evaluated.

Commercialization Plan:

Product Description: Information available for use by Montana growers and potential growers of specialty crops.

Marketing Strategy: Presentation at annual meeting of Montana Mint Growers Association, WARC and NASRC websites; one-on-one discussions with growers and potential growers

Economic Impacts:

Essential Oils: Potential for formation of Montana cooperative marketing associations to market specialty oils to the \$79 million export/import peppermint, lavender, and anise oil markets.

Herbal Teas: Potential for Montana herbal tea industry to capture a fraction of the \$66.8 million export/import herbal tea market and could result in significant revenue for Montana producers. Big Sky Teas of Thompson Falls is developing locally grown herbal tea products and is expanding into a market that could involve many growers, or a grower cooperative.

#01-07 Research, Education and Technology Transfer in Plant Sciences – Luther Talbert – Montana State University Bozeman

Year 1 - \$75,000; Year 2 - \$75,000

Final report approved November 2003

Summary:

New molecular marker technology to identify a gene controlling stem solidness in wheat will allow more rapid development of solid-stemmed, sawfly-resistant wheat varieties. Additionally, the project assisted with the development of a new solid-stemmed spring wheat variety named Choteau, which is being grown by the Foundation Seed program in 2003, and will be released to Montana seed growers in 2004, with first commercial production in 2005. The second area of focus involved successful research in identifying the genetic basis of regulation of stem elongation in a model plant, including the cloning of three critical genes. The potential of this work for agricultural benefit was recognized by the USDA to fund project continuation. Additionally, activities to forge connections between various parties involved in agricultural research were conducted and provided a foundation for continued collaboration to improve agricultural productivity in Montana.

Commercialization Plan:

Product Description: New solid-stemmed wheat, released and named Choteau, with excellent yield potential and sawfly resistance, will occupy significant acreage in Montana.

Marketing Strategy: Commercialization procedure has commenced with the growing of breeder's seed by the Montana Foundation Seed Program. Approximately 600 bushels have been produced with allocation to approximately 30 Montana farmers. These farmers will produce Certified Seed to be sold to commercial wheat growers in the state with first commercial production in 2005.

Economic Impacts:

Anticipated acreage is at least 500,000 acres per year. Assuming a conservative two-bushel per acre yield advantage over current varieties and a \$3.00 per bushel selling price, minimal value to Choteau is \$ 3.0 million per year.

Update 2/17/05:

Dr. Luther Talbert reports: that information from Bill Grey, MSU Foundation Seed Manager, indicates the following regarding *Choteau*:

2004 – 650 bushels sold; 655 acres enrolled in Montana Seed Growers Assn. certified seed production.

2005 Estimates – 26,000 acres enrolled in MSGA certified seed production; 520,000 bushels certified seed (18% of spring wheat coverage). It is reasonable to assume that *Choteau* will be a minimum of 18% of spring wheat coverage in 2006 and will replace Ernst, Lew, Fortuna entirely and then start to capture part of McNeal each year afterwards. Estimated production value of 520,000 acres at the end of 2006 @ \$83 per acre equals \$42 million.

#01-08 Novel Tools for Wheat Stem Sawfly Management – Wendell Morrill – Montana State University Bozeman Year 1 - \$121,931; Year 2 - \$121,931 *Final report approved November 2003*

Summary:

Innovative pest management strategies with potential for commercial development were investigated for the wheat stem sawfly. This insect cannot be controlled with insecticides and annual losses to wheat production are estimated to be about \$30 million. The objective, to develop traps that use volatile chemicals from plants and insects as attractants, was achieved. The objective to investigate biological control using parasitoids that attack and kill sawfly larvae that feed in stems was achieved, but additional research is underway and needs to be scaled up. The objective to test strains of *Bacillus thuringiensis* that could be engineered into wheat and kill sawfly larvae was achieved and further research is not being planned due to the political situation associated with genetic modification. Additional research is being conducted and scaled up to determine the potential of using naturally occurring fungi to kill sawflies.

Commercialization Plan:

Potential Products:

- (1) Volatile chemicals produced by insects and/or plants could be used as attractants in traps utilized by consultants to monitor sawfly populations.
- (2) A new trap that can be used in conjunction with the attractant to capture adult sawflies
- (3) Biological controls, or parasitoids, for sawfly control could be marketed in two ways – wheat stems containing over-wintering parasitoids and/or adult parasitoids could be sold.
- (4) Fungal endophytes for sawfly control could be marketed as seed treatment or soil additive at planting time.

Marketing Strategy:

Potential products would be marketed through various companies specializing in the particular type of product. Customers include agricultural consultants, county agents and wheat producers

located in the United States and Canada where sawflies are problematic. Potential sales revenues for all products are undetermined at this time.

Economic Impacts:

Products that reduce the amount of damage caused by sawflies would enhance wheat production profitability in Montana and the northern Great Plains. Development and sales of the products would support several modest companies based in Montana. Patents could be requested for the traps, pheromone blends, and fungi formulations.

#01-09 Discovering Important Genes and Deploying New Feed Barley Varieties – Thomas Blake – Montana State University Bozeman

Year 1 - \$55,000; Year 2 - \$55,000

Final report approved November 2003

Summary:

This project has been successful in advancing the understanding of genetic systems controlling barley quality for cattle feed. Specific objectives to develop a system for genotype identification by multiplexed microarray and to utilize this and other information in the development of improved feed barley varieties for Montana have been achieved. Progress toward commercialization of genotype identification by multiplexed microarray has also been achieved.

Commercialization Plan for commercialization of Genotype Identification utilizing multiplexed microarray technology

A Provisional Patent - was filed and the university is deliberating on whether to pursue a patent.

A Market survey – was performed by TechRanch.

Potential venture capital firms – discussion is ongoing.

Collaborative efforts – between the PI, ICARDA and TIGR may facilitate commercialization efforts.

Commercialization Plan for commercialization of new Feed Barley Varieties

Product: A high test weight, high yielding improved feed barley, Haxby, was released effective 2002 and Foundation Seed was available for the 2003 growing season with approximately 200,000 acres being grown.

High yielding feed barley, MT960228, was released in 2003.

Improved hay barley, Hays, with high grain yield was released in 2003 and limited amounts of Foundation Seed were made available for the 2003-growing season.

Plant variety protection (PVP) is being sought for Hays and Haxby.

Economic Impacts:

Sales generated: Sales of barley accounted for \$115 million in 2002 and increasing acreage of Haxby, MT960228 and Hays is anticipated as the lines move through the Foundation and Certified Seed production.

Acquisition of investment capital: Improvements on the multiplex microarray technology will continue and these advancements will facilitate marketing to interested venture capital representatives.

Other: The yield and agronomic performance of the new lines of barley will rival the leading feed and hay barleys currently in production in Montana.

**#01-10 Analysis of Mouse and Human Tramdorin Genes – John Bermingham –
McLaughlin Research Institute – Great Falls
Year 1 - \$84,262; Year 2 - \$92,539
Final Report approved February 2004**

Summary:

The research has provided essential information for filing a patent that describes tramdorin genes and their uses. This is the first step in the commercialization of these genes. Results from the analysis of expression patterns of tramdorin 1-4 suggest that tramdorin1 is an important candidate gene for 5q-myelodysplastic syndrome. Based on data generated from this project, a provisional patent was converted to a formal patent application in August 2003. Successful commercialization depends on approval of the patent application and whether tramdorin1 proves to be an important regulator of NMDA glutamate receptor function in the peripheral nervous system and in on-neuronal tissues.

Commercialization Plan:

Product: Tramdorin-related products

Target Market and Revenue Projections:

The target market is undetermined at this time. It is critically dependent on tramdorin activity.

Estimated sales revenues for five-year period:

No sales of tramdorin-related products are anticipated within the next five years. Anticipated revenue stream will be derived from patent licensing.

Economic Impacts:

Patents applied for: A formal patent application was made August 21, 2003. International patent rights were also filed under the Patent Cooperation Treaty.

Other:

- The grant funding directly supported a technician salary. Salaries of other personnel who performed work essential to the completion of the project were paid by funds from elsewhere.
- Research experiments from this project provided indirect support for a \$132,000 grant from the Muscular Dystrophy Association for work on the myelination mutation law paw.

**#01-12 Microbiological Process Research for the Commercialization of Subsurface
Biofilm Barrier Technology – Alfred Cunningham – Montana State University
Bozeman
Year 1 - \$65,765; Year 2 - \$65,765
Final report approved November 2003**

Summary:

Research results from this project are intended to facilitate commercialization of the subsurface biofilm barrier by proving the basis for designing barriers, which contain the movement of contaminated ground water and provide for the *in-situ* bioremediation of target organic contaminants. Significant results from the research indicate that it is possible to construct subsurface barriers composed of two microbial species: one, which provides the polymer structure for the biofilm and another species, which actively biodegrades the target contaminant. This research contributed to the subsequent awarding of a Phase 2 SBIR to MSE/CBE, which provides the opportunity for construction and evaluation of a denitrifying biofilm barrier at a site in New Mexico. It was also instrumental in writing a successful SBIR proposal to the USDA

Commercialization Plan:

Product: Providing subsurface biological barrier technology for the containment and bioremediation of contaminated soil and groundwater to MSE customers.

Target Market and Revenue projections:

There are at least 6000 contaminated groundwater plumes in the United States, some of which would benefit from use of barrier technologies. Once the technology is successfully commercialization, an estimated projection is that MSE will have at least one project per year.

Customers are both the private and government sector and any industry that has contaminated groundwater plumes. For example, saltwater intrusion mitigation has the potential to be a \$50 to \$100 million annual business.

Marketing Strategy:

Target the seawater intrusion market and industries with contaminant plume problems. In addition, representatives will attend trade shows and give papers at environmental conferences. Note: Speaking at an International Business Communication conference in Washington D.C. resulted in Chevron initiating a biobarrier project.

Business Risk Assessment:

Principal competition consists of conventional physical barrier technologies, i.e. sheet piling and grout curtains. Also, more novel barrier technologies are cropping up, including slurry walls, jet grouting, and cryogenic walls. There are technical, acceptance and regulatory risks.

Economic Impact:

MSE will retain exclusive license to the technology and will become a full service provider.

**#01-13 Enhancement of Biomedical Research in Montana – Richard Bridges –
University of Montana Missoula
Year 1 - \$100,000; Year 2 - \$100,000
Final report approved July 2004****Summary:**

Significant progress has been made to extend the COBRE funding and enhance applied biomedical research efforts in the state. Specifically, considerable success has been achieved in relationship to the original goals in the areas of recruiting translational researchers, supporting shared instrumentation, training students, increasing opportunities and training in research commercialization.

Commercialization Plan:

Product: Although the emphasis of the project is a long-term effort to enhance the infrastructure needed to enhance translational and applied biomedical research, the commercialization of technology is an overall goal which has been achieved through strategic collaboration with private sector companies, i.e. MedIntel and Neurocrine Biosciences. These efforts have primarily been targeted at development and submission of SBIR grants, typically at the Phase 1 level.

Economic Impact:

The project has made significant impact in terms of leveraging additional federal grants, creating research-based jobs, and increasing the expertise and resources available to regional biomedical/biotech companies.

- Annual federal research contract funding with the CSFN is currently \$4.5 million (not including the original COBRE award).
- Total funding awarded to CSFN researchers over the next five years amounts to approximately \$13.6 million.
- These federal research contract dollars contribute to the salaries of more than 63 employees, including 24 undergraduate students.
- These federal research funds represent new dollars coming into Montana.

#01-14 Non-Structural Adhesives Requiring No Volatile Organic Compounds – Gill Geesey – Montana State University Bozeman

Year 1 - \$40,000; Year 2 - \$60,000

Final report approved November 2003

Update received May 2004

One-year Update 5/04:

Dr. Gill Geesey reports: SBC [Specialty Biopolymers Corp.] is developing very nicely. We landed an SBIR through the USDA entitled "Biological Polymer-Based green Adhesives from Renewable Resources" that starts May 15th for \$80K. The funding rate was 17%, so we feel quite fortunate that we scored on our first attempt. We just hired our 4th Ph.D. scientist and our first MSU undergraduate to work for the company. We also received a \$15K PFI seed grant from Tech-Link to conduct an exhaustive market survey for our products. This will be completed on May 21st and a report will be available on the findings at that time. We are currently updating a provisional patent filed last June by MSU. We have an option agreement in place with MSU that expires soon and will be renegotiated. We plan to file for a patent next December once we have all our results from the Phase 1 SBIR. We then plan to apply for a Phase II award at that time.

Final Report Summary:

The Principal Investigator reports that this project has advanced bacterial polymers as wood adhesives far beyond the state of commercialization originally anticipated for this point in time. Continued efforts to secure additional funding through local private investments and federal government programs demonstrate a long-term commitment to develop the bacterial polymers into successful commercial products. These efforts are intended to strengthen the link between Montana State University and local industry in Montana.

Commercialization Plan:

Product: Environmentally compatible adhesive product based on biological polymer-based technologies

Target markets: Cabinet making and furniture manufacturing industries

Marketing strategy:

Target local cabinet-makers and furniture manufacturing companies interested in using “green” adhesives for bonding cabinet components. When the adhesive is demonstrated as reliable without exposing workers to toxic chemicals, an adhesive company interested in developing a line of “green” adhesives will be sought. A path by which the end users create the momentum for replacement of current products with this new adhesive will be pursued. The move by the Federal Government to replace toxic materials with environmentally acceptable products will also be exploited.

The virtues of the product will be advertised through presentations at adhesives conferences and conferences, publication of information in appropriate trade and scientific journals, and presenting seminars and workshops for potential licensees. Marketing theme is “New Uses of Natural Products from Renewal Sources”.

Economic Impact:

New businesses created or expanded:

Specialty Biopolymers Corporation (SBC) is a new, Montana-based biotechnology research and development company specializing in microbial biotechnology with a commitment to development of products and processes derived from microorganisms that have commercial value.

Patents applied for or granted:

A patent application is currently in preparation for SP adhesive.

Acquisition of investment capital:

Work is underway for financial commitments from the private sector within Montana to execute a license agreement with a company with international exposure in the green adhesives market with the goal of introducing the first VOC-free adhesive derived from renewal resources to the European market.

**#01-15 Research Support for the Manufacturing and Marketing of the Suspended Coupon Biofilm Reactor – Martin Hamilton – Montana State University Bozeman
Year 1 – \$71,050; Year 2 - \$71,050**

Final report approved November 2003

Summary:

This project enabled development of the CDC Biofilm Reactor into a commercial product that BioSurface Technologies, Inc. (BST) manufactures and sells.

Commercialization Plan:

Collaboration/Business Overview:

BST, established in 1994, sells biofilm related products worldwide into the drinking water industry, power industry, chemical industry and academia.

Product:

A laboratory reactor system, the CDC Biofilm Reactor, is suitable for growing a repeatable biofilm.

Target markets:

EPA Certified Evaluation Laboratories/Certified Biofilm Evaluation process – depends on certification of the reactor as an established biofilm grown and evaluation method by a standard method certifying agency, such as AOAC or ASTM – includes 100-180 worldwide-certified laboratories. Also included in this market are companies, which submit their products for evaluation in the aforementioned labs.

Expansion of the biofilm education market and academic/government research markets. Another market includes all chemical and material manufacturing concerned with biocide development and testing. The industrial biofouling market includes all industrial users that operate their own biofouling evaluation laboratories, and non-certified testing laboratories, which evaluate site applications and biofilm control removal strategies.

Promotional efforts:

Promotional efforts at internally attended meetings, such as the American Society for Microbiology and the American Water Works Association

Certification of the CBR and operational protocols as an ASTM or AOAC method – this would establish the CBR as the baseline biofilm growth and evaluation system against which all other systems would be compared.

Journal publications describing the system and its availability through BST will provide free advertising and the exposure to end-users should steadily increase demand.

Manufacturing plan:

Components are currently custom manufactured at local machine shops in the Bozeman area. The design and fabrication drawings of the CBR reactor will aid in the machining and standardization of the components between suppliers. Final assembly and testing takes place at BST laboratory.

Business risk:

There is no business risk anticipated in the production and sale of this reactor system as it is already in production and does not require any additional start-up capital.

Economic impacts:

Use of local companies for parts fabrication translates into indirect economic impact on the local economy.

The more than \$200,000 in salaries funded also benefited the local economy through taxes paid on the money, and reinvestment of the money into the local economy for living expenses.

Qualitative impact:

By funding this proposal, the State of Montana, demonstrated support for the CBE, a recognized leader in biofilm research, which is dependent on funding to keep the research moving forward.

Funding this proposal capitalized on the expertise found at Montana State University, helped to secure a global market for a local company, created manufacturing jobs in Montana and contributed to the education of five undergraduate students.

#01-16 Vaccines for Livestock *E. coli* Diseases: Scours and O157:H7

David Pascual, Montana State University, \$400,000

Final Report approved September 2004

Summary:

The proposed work was intended to develop vaccines to reduce newborn calf and piglet mortalities due to *E. coli* scouring disease. It was also intended to develop a vaccine to eliminate *E. coli* O157:H7 from Montana beef and dairy herds using MSU's recently developed "smart vaccine" technology for the purpose of mucosal vaccine delivery. The objectives were to develop an intranasal scours vaccine and to later modify this vaccine to incorporate the protective epitope to *E. coli* O157:H7.

Results:

Development of the soluble fusion vaccine did not prove possible. Efforts then focused on developing the *E. coli* O157:H7 vaccine, which were successful in producing a fusion vaccine in an attenuated *Salmonella* vaccine and which were able to elicit antibodies to the original inducing peptide. Studies are continuing to test the feasibility of purifying the vaccine from *Salmonella* and testing its ability to protect. Once the studies have been completed, commercialization of such a vaccine has potential.

Commercialization Plan:

Product description: Efforts of the grant effort continue to obtain a suitable vaccine for bovine scours and *E. coli* O157:H7. Studies remain ongoing and it is anticipated to take another five years before a suitable vaccine is developed.

Target market: The worldwide animal health market is over \$10 billion, two-thirds of which relates to farm animals. Vaccines account for approximately 20% of that market.

Economic Impacts:

Development of a vaccine would benefit livestock producers, as it would help protect newborn calves and piglets against diarrheal disease. An effective combination vaccine would provide a means to eradicate *E. coli* O157:H7 carriage from cattle. *Salmonella* vaccine vectors are currently used to vaccinate newborn chicks, a procedure which establishes a precedent for the approach used in this study.

#01-17 Development of a Novel Cancer Bio-Imaging and Therapeutic Delivery System

Mark Young, Montana State University, \$300,000

Final Report approved July 2004

Summary:

The overall goal of the project was to make significant forward progress in the development of a novel combined cell targeted, MRI bioimaging, and drug delivery system for commercial biomedical applications. Nearly all the objectives of the grant were successfully completed. As a result of the research, the biomedical

commercialization of this technology has moved forward in the development of a highly sensitive, non-invasive bioimaging and drug delivery system.

Commercialization Plan:

Commercialization depends on licensing and partnering with companies that have product needs and established markets. In 2003 the stage was set for implementing the commercialization model that will have direct benefit to Montana companies while positioning MSU's nanotechnology for commercialization through networking with larger companies. In addition to efforts currently underway with MPS and American Chemet, discussions are in progress to implement this commercialization model with a biotechnology company in Bozeman for medical field applications.

Product:

Development of a unique naturally derived nanotechnology architecture based on the use, manipulation and manufacture of proteins that have the potential for application in a broad range of current and proposed nanoproducts

Economic Impacts:

Patents applied for or granted:

MSU has a seminal patent for the application of protein cages in nanotechnology and several pending patents including new technology for using different types of proteins and for applying proteins in nanomedical applications.

Collaborations:

Collaborative research and licensing opportunities established with Montana companies that have significant connections to nanoproduct markets.

- Micropowder Solutions (MPS), Missoula, has been awarded a \$100,000 NSF SBIR Phase I to develop MSU's nanotechnology for additives in passive electronics components and involves the licensing of MSU technology and collaboration with MSU researchers to demonstrate the use of a protein derived material for use in passive electronics.
- MPS is writing other SBIR's in the areas of nanophase catalysts to improve efficiency of fuels and reduce emissions.
- MPS is collaborating with Catlyx, Vancouver, B.C., for testing proof-of-concept catalysts and commercialization of the catalysts.
- MSP is discussing collaboration with Battelle for scale-up and development of MSU's nanotechnology.
- American Chemet Corporation, Helena, was awarded a Phase 0 SBIR grant to develop a proposal for enhancing performance and materials characteristics of Chemet's copper-based products through introduction of nanophase additives.
- American Chemet is collaborating with MPS in developing the SBIR Phase 1 application.

Publications:

The report lists 12 published articles.

Funded grants based on this research:

The PI indicates nine additional grants based on this research have been funded, totaling \$5,037,155.

**#01-21 A Real-Time Coal Content/Ore Grade (C2OG) Sensor
Tom Moon, Montana Tech, \$226,569**

Final Report approved May 2004

Summary:

An objective of this project was to develop an instrument that could be used in a variety of applications and would be compact, inexpensive, easy to use, give results in real-time and present results in easy to interpret manner. Most of these requirements have been met and the C²OG Sensor is ready for deployment in the core room at the Stillwater Mine near Nye, Montana. Real-time analysis, a key requirement, is still under development. Resonon, Inc. has sold an imaging system to an agricultural research laboratory at the University of Montana for an airborne remote sensing application. The Center for Biofilm Engineering (CBE) at Montana State University has purchased an imaging system for laboratory work.

Commercialization Plan:

Product: An imaging spectrometer with multiple current and potential uses in the agricultural, mining, biomedical, and environmental monitoring sectors

Target market: Potential user groups include state and federal governments, university and commercial laboratories, and various users in the mining, biomedical, agricultural, and environmental monitoring industries. Specific uses include automated assaying in the mining industry, crop assessment for pesticide control in commercial and experimental agriculture, proteomics, and environmental monitoring.

Marketing strategy: Plans to add additional sales staff in 2005 to promote the products using direct marketing.

Production or manufacturing plan: Partnerships with various research groups in the Montana University system to tailor the hyperspectral imaging device to users in specific application areas. (1) Partnership with Montana Tech with funding from DOE to adapt the instrument for “look-ahead” mining; (2) Partnership with Dr. Edward Dratz at Montana State University to develop an instrument for hyperspectral identification of proteins in a 2-dimensional gel electrophoresis system; (3) Partnership with Dr. Lisa Rew at Montana State University for the development of an instrument that distinguishes weeds from other objects in crop fields.

Business risk assessment: Primarily associated with a potentially weak market demand and strong competition, neither of which are likely.

Economic Impacts:

New business expanded: The hyperspectral imaging technology supported by this project is the central technology of Resonon, Inc., a start-up company in Bozeman.

Increase in employment levels: Resonon currently has 3.35 FTE employees.

Sales generated: Largely due to this project, Resonon has released a commercial imaging spectrometer system and has sold an imaging spectrometer based system to the University of Minnesota.

Other: One DOE SBIR award in the amount of \$112,000 is a direct result of this project and selected for funding with a start date of July 2003.

#01-23 A Programmable Frequency Chirped External Cavity Diode Laser-Based on KTP Waveguides

Kevin Repasky, MSU Bozeman - \$119,056

Final Report approved January 2004

Summary:

The major goal of this research project was development of a rapidly tunable external cavity diode laser based on integrated waveguide technology in collaboration with AdvR, a Bozeman based photonic company. Various applications of the tunable laser were studied and a commercialization plan developed. Commercialization began with a market survey completed by AdvR. A prototype waveguide based laser was presented at a Trade Show during the Conference on Lasers and Electrooptics and Quantum Electronics and Laser Science Conference in Baltimore June 1-7, 2003. The first sales of a waveguide based external cavity laser, for use in a gravitational detection instrument, are underway with Stanford.

Commercialization Plan:

Product: Narrow bandwidth diode laser, which is narrowly tunable with tight wavelength control

Target applications: High power laser and low power laser markets

Competitive products: Lightwave offers a YAG seed laser used by Spectra Physics, which is rather expensive. For sensing applications, the primary competition is New Focus with its family of widely tunable spectroscopy lasers, which are relatively inexpensive, produced in volume but can take several months to get a device at a wavelength not readily available.

Summary: The proposed product offers the ability to provide a source at any wavelength for which a laser diode is commercially available, and offers rapid EO tuning without any moving parts. The inherent flexibility of the design makes targeting a wide range of applications and corresponding wavelengths financially practical. Capture of 5% to 10% of the existing market could result in annual revenue of ~\$500K.

Economic Impacts:

Sales: Successful development of the waveguide based external cavity diode laser led to a commercial product for AdvR, a Bozeman based photonic company. AdvR has sold its first waveguide-based laser to Stanford.

High-Tech Employment for Montana State University Graduate Students:

- Elizabeth Noonan was the graduate student working on the development of the waveguide based external cavity diode laser. She completed her M.S. degree in physics and is currently employed by AdvR where she continues her work with the development and commercialization of the KTP waveguide laser. This project provided her with valuable experience and enabled her to move into a position at AdvR and make immediate contributions.
- Jed Huseby worked on the development of the waveguide based external cavity diode laser as a graduate student. He gained valuable opto-mechanical design experience through this work and is currently employed by Scientific Materials in Bozeman as an opto-

mechanical engineer. Through his work on this project, he has been able to make immediate contributions to Scientific Materials.

#01-24 Design and Synthesis of Near-Infrared Optical Power Limiters

Charles W. Spangler, MSU Bozeman - \$106,000

Final Report approved February 2003

Summary:

This project is an excellent example of university-based research and development that has resulted in two spin-off companies. The project successfully synthesized a series of new potential near-infrared optical limiting materials for protection against intense laser irradiation in the region of 1.06-1.60 μ . SBIR Phase I and II applications, in collaboration with the Air Force Research Laboratories, are expected beginning in 2003. If, after the completion of Phase II, Air Force specifications are met, a contract with MPA Technologies (a new spin-off company) is anticipated. Scientific Materials of Bozeman is expected to be the subcontractor for supplying the final product in the commercialization phase.

Commercialization Plan:

Product: Eye and sensor protection

Prime target customer: Department of Defense

SBIR Phase I & II: To be written by Air Force research project directors for further development of the new materials

Anticipated market: Greater than \$10 million per year

Distribution: Trinity Corporation (major manufacturer and distributor of laser protection eyewear) is a possible distributor of the materials

Subcontractor: Scientific Materials, Bozeman, will be first choice

Economic Impacts:

New R&D Company: MPA Technologies (MPAT), Bozeman, was incorporated September 2001.

New patent: Has been applied for

Second spin-off: A second R&D company, SensoPath Technologies, Bozeman, spun off from MPAT. Its primary focus is to develop new diagnostic bioterror pathogen materials and protocols.

SBIR Phase II: SensoPath received a NIH-NAIAID SBIR Phase I grant and anticipates receiving a 3-year Phase II award beginning April 2003, for more than \$1 million per year.

Venture capital seed funding: MPAT is in final due diligence phase of a venture capital seed funding round for the development of a therapy and imaging approach to a noninvasive treatment of breast cancer using this project's two-photon technology.

#01-25 Commercialization of Instruments for Autonomous Measurements of Carbon Dioxide and pH for Research and Industrial Applications
Michael DeDegrandpre – University of Montana - \$60,000
Final Report approved March 2003

Summary:

The objective of this grant was to simplify the design and operation of the Submersible Autonomous Moored Instrument for CO₂ to make the instrument more reliable and user friendly. A bulky, expensive grating spectrograph was redesigned and is now more compact and less expensive, in addition to providing improved wavelength accuracy. Another objective was the successful redesign and fabrication of an optical cell, dramatically changing the calibration procedure and making it possible for customers to calibrate their own instruments. Although not part of the R&C funded proposal, a software interface that outputs CO₂ concentration in real-time and can readily be understood by outsider users was developed.

Commercialization Plan:

Collaboration: The SAMI has been commercialized in collaboration with Sunburst Sensors, a Missoula company.

Market: The instruments are being sold to oceanographic and freshwater researchers throughout the world, including aquatic scientists from Germany, Spain, Australia, Norway, U.S. and Canada. Future markets will expand international business.

Present and Future Applications: Quantification of global sources and sinks of carbon dioxide; biomedical applications such as a large potential market for blood gas monitors; industrial applications such as process monitoring of carbon dioxide and pH associated with industrial fermentation

Advantages over Competition: (1) The device is significantly less expensive (\$15,000) than the competition (CARIOCA buoy - \$25,000 - \$30,000); (2) has a design that allows for various deployment strategies; (3) renewable reagent-based system has been deployed worldwide for over five years and has a proven record of reliability and versatility; (4) accurately records temperature; (5) has an accessory port so that other instruments can be tied to it and linked to the data logger and microprocessor.

Marketing Plan:

- Website – www.sunburstsensors.com
- Professional contacts through PI
- Promotional literature
- Trade shows and conferences
- Classified and display ads in targeted journals and trade magazines
- Sales outlets in Europe to avoid duty fees

Economic Impacts:

Local Subcontracts: Extensive use of local talent for subcontracts includes Big Sky Machining, Alberton; MetalWorks of Montana, Missoula; M&J Machine, Columbia Falls; and McIntosh and Goffe, Missoula.

High-tech Employment: PI employs one full-time technician and Sunburst Sensors employs two people full-time.

Growth Potential: Future growth of Sunburst and other high-tech companies has the potential to become an important industry for Montana.

#01-28 Optical Control Transient Processing of RF Signals

William Randall Babbitt – MSU Bozeman - \$7,810

Final Report approved February 2003

Summary:

This grant supplied the state matching funds for phase 2 of a 5-year MURI (Multi-University Research Initiative) Grant involving the University of Colorado-Boulder, Montana State University, George Mason University and the University of California-Davis. The MSU effort concentrated on designing and demonstrating rf photonic processing based on optical coherent transient processing units. Once developed, these units would be produced by a Bozeman company and integrated into civilian and military phased-array antenna systems by a major aerospace contractor.

Commercialization:

Commercialization of the technologies is a long-term process and the funding of this grant was intended to help obtain further grants to increase Montana's expertise and ensure development and commercialization of the technology.

The S²-CHIP project (R&C project #03-08), an off-spring technology, is being prepared for commercialization under a new R&C grant and will be developed under a SBIR Phase II award to Scientific Materials Corporation, Bozeman, with MSU as a sub-contractor. The commercialization goal is shorter than this project – a prototype to program test bed within four years.

Economic Impacts:

Total Resultant Follow-on Funding: The MSU Grants and Contracts office reports the project has resulted, directly or indirectly, in new funding of over \$10.3 million, broken down as follows:

\$	4,582,641	NASA
\$	4,925,560	Dept. of Defense
\$	632,195	University of Colorado
\$	171,602	National Science Foundation

#01-29 Investigation of Non-Linear Optical Properties and Performance of Organometallic Chromophores with Applications to Optical Limiting for Protection Against Lasers – Lee Spangler - Montana State University Bozeman

Year 1 - \$82,500; Year 2 - \$82,500

Final report approved December 2004

Summary:

The purpose of the project was to investigate a group of related compounds for multiple potential optical properties. The project resulted in the synthesis and screening of 10 new compounds and establishment of some molecular structure-optical property relationships in those compounds, but

none of the optical properties performed well enough to warrant commercialization. While the study did not result in a compound with strong commercial potential, the entire class of compounds should not be considered unviable based on this single study.

Commercialization:

While the optical properties developed were strong, they could not beat existing systems and only moderate improvements in performance could be generated. Since the materials do not provide distinct advantages over other materials on the market, there is no opportunity to commercialize.

Economic Impacts:

While direct commercialization was not viable, the project generated, or contributed to, several potential economic impacts.

- Match for an Army Research Grant for \$320,000
- Purchase of a Bruker Fourier Transform spectrometer used for characterization that has been used to assist several Montana companies – Butler Creek, Scientific Materials, MPA Technologies, Little Belt Consulting
- Collaboration with MSU’s Engineering Dept. to develop a new control system to extend the performance of Bruker Fourier Transform spectrometers has resulted in a non-disclosure agreement with Bruker and the award of a NSF Major Research Instrument Grant to pursue this development.

#01-30 High Performance Spectral Data Storage System – Alan Craig – Montana State University Bozeman

Year 1 - \$209,866; Year 2 - \$216,706

Final report approved November 2003

Summary:

The project produced a “multiplicity” of results, which establish the efficacy of the memory technology, set some limits on its performance using presently available materials, and suggest means for improving performance as well as alternative memory functions possibly more appropriate for this spectroscopic memory approach. The technology is in a position to pursue select high-end applications in supercomputing but this effort would require substantial additional investment over a longer period of time in order to carry out the engineering aspect of a commercialized high technology device technology. This is unlikely due to the decision by DoD to change directions in its pursuit of research and development of the technology and adopt commercially available computing hardware instead.

Commercialization plan:

No foreseeable commercialization opportunities are apparent at this time. The government has shifted its interest in research and development of new computing capabilities to adoption of company hardware commercially available. Consequently, original plans to launch commercialization of the memory program depended on DoD support have been shelves. Some remote prospects for incorporating the memory technology into other commercial platforms exist, but would require substantial re-design and anecdotal evidence does not favor this effort.

Economic impacts:

New businesses created or expanded:

Encouraged by DoD for future funding of a much-expanded effort, a C corporation, ChronoChrome, Inc., was established and successfully performed on a STTR-SBIR award from the U.S. Air Force, bringing \$70,000 to Montana.