Impact Statement Catalogue: 2012 Projects

This catalogue contains all completed Impact Statements for multistate research projects that terminated in 2012.

These Impact Statements were prepared by a professional writer as part of the National MRF Impact Writing Project, an initiative launched by the Experiment Station Committee on Organization and Policy in 2012. By summarizing and sharing the activities and outcomes of each multistate research/coordination project, Impact Statements show stakeholders and leaders why supporting Land Grant Universities and sustaining the Agricultural Experiment Stations and Cooperative Extension is so important.

Support for multistate research projects comes, in part, from USDA's National Institute of Food and Agriculture through the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds are provided by contracts and grants to participating scientists.

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Plant Genetic Resources

This project has coordinated efficient acquisition, preservation, evaluation, and distribution of plant genetic resources, which has enabled research aimed at improving food and energy security.

Who cares and why?

The North Central U.S. is a major producer of crops important to food, animal feed, fiber, biofuels, and biochemical products, making the region crucial to global food security, national energy security, and economic security. The region's ability to sustain production and respond to challenges and changing societal needs relies on genetic diversity. Genetic diversity makes plant populations less vulnerable to widespread damage from pests, diseases and environmental stresses. Diverse plant genetic materials are also essential to help scientists breed new crop varieties; produce biofuels; develop nutritional, pharmaceutical and medical products; and conduct basic plant research. Plant genetic resource collections are vital because they systematically acquire, store, propagate, and distribute plant tissues, seeds, and other gene-containing materials. Conserving genetic material is especially important for plants that can no longer be obtained from their native environments due to changes in land use or policies. Because of the varied environments and needs in the North Central region and the range of research interests and expertise, managing plant genetic resources must be a well-coordinated multistate and multidisciplinary effort, and these resources must be properly classified, well-described, easily accessible, and routinely evaluated for quality.

In the top photo, NCRPIS Seed Storage Manager Lisa Burke fills seed requests. Evaluating and describing samples are key steps in maintaining a plant genetic resource collection and being able to fill specfic requests. NC-007 researchers have thoroughly evaluated NCRPIS soybean germplasm, identifying genetic differences in salt tolerance, disease susceptibility, and resistance to soybean cyst nematode, frog eyespot, and root rot (middle photo by United Soybean Board). In the bottom photo, a plant breeding class discusses Stewart's Wilt evaluations of corn with pathologist Charlie Block.

What has the project done so far?

Since 1947, NC-007 has supported the North Central Regional Plant Introduction Station (NCRPIS), which provides plant genetic resources, information, and technical expertise in the North Central U.S. Over the past five years, NC-007 has facilitated the conservation of seed and vegetative stock of more than 1,700 plant species and has steadily increased the number of samples available to researchers, including species at risk of extinction (such as U.S. ash tree populations). Monitoring the health of the collection's stock has been a major focus. NC-007 scientists have developed new analytical and diagnostic methods to detect pathogens and have recommended better propagation practices to avoid spreading diseases. As part of these efforts, thousands of samples have been screened for diseases. Another focus for NC-007 has been evaluating and describing the samples in the collection, which has identified traits for disease and pest resistance, growth characteristics, environmental adaptation, and enhanced nutritional and aesthetic qualities. For example, researchers have discovered 24 canola samples that are resistant to turnip aphid and 24 corn inbreds resistant to Asian leaf borers. NC-007 researchers have also coordinated field studies to evaluate the regional adaptability of plants. In particular, they have determined the winter hardiness of oilseed plants, noting poor winter survival in safflower and canola

and high winter survival in field pennycress and camelina. Researchers have also conducted risk assessments to determine whether a species is likely to become invasive in specific environments. NC-007 members have experimented with creating new varieties, crosses, and inbreds including disease-resistant sweet corn populations; spring barley resistant to the Russian wheat aphid; chickpea with improved resistance to Ascochyta blight; new varieties of hard red winter wheat with superior performance under irrigation and rain-fed conditions; and superior sour cherry germplasm. Scientists have also screened plant materials to determine potential biomass energy crops. Other researchers have used historical documents and art to illuminate the movement of plant genetic resources among peoples and nations and the events and practices that led to successful cultivation and uses. To make information about plant genetic resources easier to share and use, NC-007 has developed software, databases, and websites and encouraged standardized descriptions. NC-007 members have also educated students, scientists, and the public about plant genetic issues and solutions through college courses, Extension presentations, conferences, and field days.

Impact Statements

Boosted farm productivity and profits and increased food security by developing improved crop varieties

Improved public health and well-being by enhancing nutritional qualities of plants and discovering new medical and pharmaceutical uses for plant materials

Developed biofuel opportunities, strengthening national energy independence and security

Predicted potential invasiveness of species, influencing decisions about introducing new plants

Increased the number and diversity of genetic resources available

Helped researchers select appropriate plant genetic materials for studies

Ensured the health of plant genetic resources, facilitating the success of research and development that uses these materials

Helped organic farmers by making suitable seedstock more consistently available

NC-007 scientists have strategically sampled U.S. ash trees (top photo by Sarah Gadd, Flickr) in anticipation of what may be a complete loss of the species due to devastation by emerald ash borer, an insect pest that feeds on tree tissue beneath the bark (bottom photo by Wisconsin Department of Natural Resources).

What research is still needed?

Sustainable agricultural production depends on continued development of comprehensive plant genetic resource collections. Specific research and information management needs include: understanding the mechanisms that control viability and dormancy of seeds; developing protocols to assess the viability of certain species; associating genetic information with traits, performance attributes, and geographical context; improving databases and interfaces to facilitate information sharing; and developing and releasing new crops and crop varieties with enhanced agronomic, horticultural, nutritional, industrial, and aesthetic traits.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://ncra.info/*.

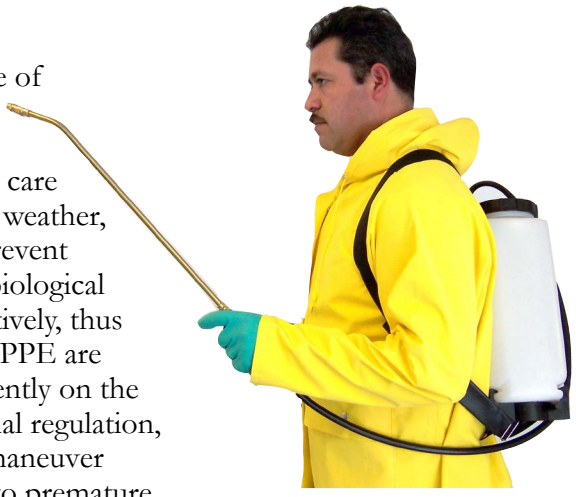
Compiled and designed by Sara Delheimer

Personal Protective Technologies

This project has evaluated and improved textiles and personal protective garments for workers in hazardous occupations, leading to better safety and job performance.

Who cares and why?

Personal protective equipment (PPE) protects individuals from a wide range of occupational hazards. In agricultural settings, pesticide applicators need special protection from the chemicals they use. "First responders" on the scene of a terrorist attack or natural disaster and "first receivers" in medical care facilities often need special garments to protect against fire, debris, extreme weather, chemicals and pathogens, and other hazards. Well-designed PPE can also prevent injuries among soldiers who encounter IEDs, small arms, and chemical or biological warfare agents. These workers rely on PPE to do their jobs safely and effectively, thus saving lives and preventing widespread damage; however, improvements to PPE are much-needed. User feedback and performance tests indicate that PPE currently on the market has many outstanding issues related to fit, comfort, durability, thermal regulation, and moisture control. For example, poor fit makes it difficult to use tools, maneuver through small spaces, and move quickly, and poor thermal regulation leads to premature exhaustion. Moreover, many workers do not receive proper guidance on how to select, use, and maintain PPE. Good communication with PPE users and multidisciplinary collaboration among researchers is needed to make sure that practical, top-of-the-line PPE is available for a wide variety of hazardous occupations.



Agricultural workers require special protective garments when spraying chemical pesticides to avoid getting the chemicals on their skin or breathing in vapors. Photo courtesy of Pacific Northwest Safety and Health Center.

What has the project done so far?

NC-170 members have trained firefighters to use PPE (above). In addition, researchers in Iowa, Missouri, New York, and Hawaii have held 12 focus group meetings with over 100 firefighters from 11 fire departments, leading to better conceptual designs for garments. For example, researchers at Oklahoma State University have worked on smart clothing that can monitor temperature, heart rate, and blood oxygen content of firefighters. Photo by Lynn Boorady, Buffalo State.

Over the past five years, NC-170 scientists and designers have made major achievements in materials research, garment design, and user education. Researchers across the U.S. have identified and developed textiles with attractive properties, such as UV ray protection, moisture, heat, and bacteria control, and the ability to detoxify pathogens and pesticides. For example, researchers at Oklahoma State University have completed a project on smart textiles for chemical detection that was funded through the Approaches to Combat Terrorism program of the U.S. Intelligence Community. Other NC-170 researchers have used advanced tools (including 3D scans) and user feedback to evaluate existing PPE and have collaborated with laboratories, designers, and manufacturers worldwide to develop new PPE. Researchers at many institutions have focused on improved PPE for firefighters and military personnel (see photos). With regard to agricultural workers, scientists from New York, California, Minnesota, Missouri, and Iowa have used data from over 60 interviews and surveys and 250 photographs of body positions to address fit issues for protective coveralls. Design sessions and consultations with manufacturers have led to multiple prototypes of disposable protective coveralls with reduced catching and tearing and improved fit and comfort. Hospital patients and workers have also been target audiences. Researchers at Colorado State University have initiated a hospital patient apparel redesign project, and researchers at the University of Hawaii have used funding by the Christopher & Dana Reeve Foundation and University of Hawaii Women's Center to evaluate immobile patient gowns. Addressing NASA's needs, studies at the University of Minnesota have led to better fit and sizing of a full-body space suit, a hood, and hand-warming glove liner for astronauts.

Impact Statements

Increased user satisfaction by designing more practical PPE based on nuanced performance testing and user feedback.

Ensured a baseline level of protection for workers by setting standard performance specifications for PPE sold in the U.S.

Improved tools and methods for testing PPE performance.

Improved infection and odor control by developing antibacterial textiles that have been used in healthcare apparel, military clothing, and civilian products.

Improved protection from dangerous chemicals and pathogens by developing self-decontaminating materials for industrial workers, first responders, public health workers, and military personnel.

Designed body armor that has been adopted by the U.S. Marine Corps.

Made it possible for PPE users to work safely under adverse environmental conditions by improving moisture and heat control of textiles.

Helped PPE users perform their jobs quickly and comfortably even in highly active situations by refining PPE fit and sizing systems.

Kept first responders out of dangerous situations by integrating reliable wireless sensors into PPE to monitor vital signs, track location, and detect potential hazards.

Established an easy-access database that helps users, manufacturers, researchers, and purchasing agents select and use appropriate PPE.

Educated thousands of workers through training courses, outreach programs, interactive websites, and articles. Expanding audiences include young students interested in designing new materials, Amish farmers interested in low-tech ways to reduce pesticide exposure, and orchard and vineyard workers concerned about thermal comfort while performing winter tasks.

NC-170 researchers have made many improvements to PPE for combat or defense scenarios. For example, prototype design work at Oklahoma State University (supported by funding through the Naval Research Laboratory) has resulted in QuadGard® arm and leg armor that has been tested and approved for combat. More than 600 units have been used by the U.S. Marines to protect against shrapnel from IEDs and small arms. Researchers have also developed a quick-release ballistic vest with a cooling pad that has increased comfort and mobility and decreased the risk of injuries from the impact of the body armor. Other studies and design sessions have resulted in: a prototype for infrared camouflage; rechargeable odor-free underwear garments tested by the U.S. Air Force; and nanofiber membranes and coated fabrics that provide chemical and biological protection (supported by Defense Threat Reduction Agency and U.S. Army Natick Soldier Center). Photos by Semra Peksoz, Oklahoma State University.

What research is needed?

More work is needed to continue to improve PPE design and function. For example, firefighter footwear and gloves with improved fit, protection, and function need to be developed based on new data (such as measurements of active hands) and antimicrobial performance and user acceptance of redesigned hospital apparel need to be evaluated in real hospital environments. Researchers also need to focus on developing decontaminating materials to industrial scale, and further work is needed to develop PPE and address fit and sizing issues for women's figures.

Want to know more?

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Written and designed by Sara Delheimer

Omega-3 Fatty Acids & Human Health

This project has fostered research that has determined what forms and amounts of omega-3 fatty acids are beneficial to human health, thereby improving quality of life and reducing health care costs.

Who cares and why?

Chronic diseases like cancer, cardiovascular disease, type 2 diabetes, degenerative diseases, and others often lead to poor quality of life and high health care costs. Adequate amounts of omega-3 fatty acids—found in plant, algal, fungal, and fish oils—as part of a nutritious diet could help prevent or treat these diseases and reduce their economic impacts. However, the different forms of omega-3 fatty acids have distinct effects on human health, and some health benefits—and the recommended daily intake to achieve these benefits—are controversial. Current recommendations made by medical professionals and public health authorities are not always consistent or up-to-date, leading many consumers to be confused about how much or what kinds of omega-3 fatty acids to include in their diets. Furthermore, concerns regarding the sustainability of fish stocks and the contamination of fish by mercury and pesticides are rising, making consumers unsure whether fish is a healthy source for omega-3 fatty acids. Appropriate dietary recommendations for omega-3 fatty acids are also needed to reduce the potential for negative health and economic consequences of excessive and unsafe omega-3 fatty acid supplementation practices.

What has the project done so far?

Over the past five years, the NC-1039 project has coordinated research among multiple institutions and scientists from diverse disciplines. Participating scientists have advanced research methods and confirmed that experiments using cell cultures and rodents can be used to accurately determine the dose of omega-3 fatty acids needed to achieve health benefits in humans. Using these methods, scientists have provided evidence supporting the health benefits and disease prevention effects of omega-3 fatty acids, including newly identified effects that advance the potential to prevent or treat problems with reproductive performance, inflammation, type 2 diabetes, cancer, and obesity. In particular, NC-1039 scientists have studied health benefits and proper doses for special populations, such as Hispanic women and pregnant women and Women, Infants, and Children (WIC) program participants. NC-1039 studies have shown that there is increased need for the omega-3 fatty acid DHA in pregnant and lactating women

Salmon, walnuts, and flax seeds are high in omega-3 fatty acids. NC-1039 researchers have evaluated these and other sources of omega-3 fatty acids to determine how much of these foods people should consume in order to get the associated health benefits. Top photo by Dennis Sylvester Hurd. Middle photo by Eliza Adam. Bottom photo by veganbaking.net.

to promote healthy cognitive development in infants. Another study has provided evidence that pregnant women receiving WIC support in Larimer County, Colorado, do not consume enough DHA from food sources to meet the daily recommended intake. This has highlighted an important economic disparity between lower income individuals and omega-3 fatty acid intake. The collective data gathered from NC-1039 studies have been used to modify daily recommended intakes for omega-3 fatty acids. Scientists have also explored ways to share data and recommendations. For example, NC-1039 researchers have initiated an omega-3 Community of Practice eXtension website through the USDA. Scientists have also worked with the National Healthy Mothers Healthy Babies coalition to educate the public of the benefits of seafood consumption and help them make informed, healthy food choices. Research findings have also been disseminated to research communities and the general public via seminars, publications, and websites.

Impact Statements

Raised awareness among the medical community and nutrition professionals of the specific benefits of omega-3 fatty acids, leading to improved nutritional counseling and increased consumption of food-based sources of omega-3 fatty acids.

Determined specific benefits of certain forms and amounts of omega-3 fatty acids, advancing the potential to prevent or treat many diseases and reduce health care costs.

Made suggestions for setting daily recommended intakes of omega-3 fatty acids, including special advice that helps minority groups like Hispanic women increase omega-3 fatty acid consumption.

Educated House Representatives and Senators on the issue of fish intake and omega-3 benefits to pregnant and breastfeeding women and their infants, helping Congress make more informed policy decisions.

Provided valuable data for WIC to revise their current pregnancy package to include fish, thus addressing economic disparities in omega-3 fatty acid intake and promoting healthy mothers and infants.

Fish oil capsules are often taken as dietary supplements. NC-1039 research has provided information on the health benefits of consuming different sources of omega-3 fatty acids and provided recommendations for safe amounts to consume. Photo by Stephen Cummings.

What research is needed?

Scientists are continuing to evaluate the minimum daily amount of the omega-3 fatty acid DHA to promote health and investigate sustainable algae, fungi and plant sources. More research is needed to address the hypothesis that omega-3 fatty acids can help prevent inflammation and enhance immune response. Scientists are taking steps toward identifying genes that mediate the effects of omega-3 fatty acids, opening the door for individualized dietary recommendations.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://ncra.info/*.

Compiled and designed by Sara Delheimer

Intestinal Diseases of Pigs and Cattle

This project has enhanced animal welfare and public health while maintaining efficient pork, beef, and dairy production through interventions that reduce the incidence of intestinal diseases in animals and transmission to humans.

Who cares and why?

Intensive farming practices, the movement of livestock between farms, and the overuse of antimicrobials may facilitate the emergence of drug-resistant diseases. Photo by Scott Bauer/USDA.

Intestinal diseases are major causes of sickness and death among livestock, racking up huge costs for the livestock industry. Furthermore, many of the bacteria, viruses, and parasites that cause these diseases in livestock can be transmitted easily to humans when animal feces contaminate foods or water supplies. Foodborne illness is a serious public health concern in the U.S. Each year, roughly 48 million Americans get sick, 128,000 are hospitalized, and 3,000 die from foodborne diseases. Costs associated with medical treatment, productivity losses, and premature deaths total billions of dollars each year. Interventions including vaccines, antibiotic treatments, farming practices, and producer and consumer education have spurred a decline in foodborne illness incidence; however, some diseases still have no effective treatments, some strains have developed drug-resistance, and new strains continue to emerge. As livestock production systems grow larger and more complex, disease control is becoming more necessary. On the other hand, special disease control and food safety techniques may be needed for natural, grass-fed, and organic livestock production due to constraints on acceptable drug use and farming practices. To develop precise detection methods and effective treatments, scientists need to fully understand the causes, effects, and patterns of intestinal diseases. Given the wide range of intestinal pathogens and types of livestock production systems in which they occur, scientists from across the U.S. and multiple disciplines must share expertise and resources to pursue solutions that protect and optimize animal welfare and food safety.

What has the project done so far?

NC-1041 has encouraged collaborative, innovative research. Participating scientists have shed light on the biology and virulence of existing and emerging diseases, offering a better understanding of the origins of intestinal diseases in livestock. For example, studies have indicated that *Salmonella* are more prevalent during warm months. NC-1041 scientists have also identified hosts—like birds, flies, and wild animals—that can transmit pathogens to livestock. Studies have also identified and monitored ways that these pathogens are transmitted from livestock to humans. Using this information, scientists have designed more specific and reliable pathogen detection methods and have developed new and improved vaccines, antimicrobials, and other therapies that prevent and treat intestinal infections. In particular, scientists have shown that feeding beneficial microbes to feedlot cattle is a good option for controlling the amount of *E. coli* that is shed in feces. Other studies have found that multiple doses of a vaccine containing certain secreted proteins of *E. coli* can also significantly reduce the amount of *E. coli* that is shed in cattle feces. Researchers have even identified natural products that could be utilized as nutritious feed additives to inhibit or reduce parasite infections. Research has also demonstrated that beneficial bacteria—probiotics—can be used to stimulate the immune system of newborn pigs, helping them ward off intestinal diseases. Probiotics can also have profound impacts on vaccine

efficacy when administered to mothers late in gestation or to infants upon initial breastfeeding. In addition, scientists have shed light on genetic susceptibility of animals to certain diseases, providing a basis for breeding disease-resistant livestock. Other work has determined that vegetative filter strips (or buffer strips) can be used to block the overland run-off of pathogens. Project members have shared this research with and provided training to researchers, veterinarians, producers, and consumers.

Impact Statements

Improved ability to diagnose, monitor, and treat diseases in a timely manner.

Reduced potential food and water contamination and foodborne illness risk.

Protected animal health and food safety through new and improved vaccines, antibiotics, and other treatments that are effective worldwide.

Reduced livestock producer costs associated with sick animals.

Raised awareness and increased adoption of effective disease prevention and treatment strategies among livestock producers, veterinarians, and health care professionals.

Enhanced options for disease control for organic and natural farmers.

Researchers and food inspectors are on the lookout for *Salmonella Newport*. Researchers have found that this strain is increasingly resistant to multiple antimicrobial drugs, and illness due to this pathogen tends to be more severe. Photo by Michael J. Ermarth/FDA.

What research is needed?

Complex issues, such as resistance to antimicrobials, require an integrated approach to figuring out how to use drugs judiciously on different types of farms and how to communicate these best practices to livestock producers. Another challenge is the development of effective vaccines that provide broad protection against pathogens. Additionally, the ecology and pathogenesis of various pathogens need to be better understood.

Fruits and vegetables can pick up pathogens if they come into contact with animal feces or contaminated water run-off from livestock facilities. NC-1041 has tested ways to keep plants from coming into contact with pathogens. Rigorous inspection is also needed to catch contaminated food before it reaches consumers. Photo by Michael J. Ermarth/FDA.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://ncra.info/*.

Compiled and designed by Sara Delheimer

Regulating Photosynthesis

This project has improved our understanding of photosynthesis, thus providing new strategies for boosting plant productivity and resistance to stressful conditions.

Who cares and why?

During photosynthesis, plants use light energy to synthesize food (carbohydrates) for growth from carbon dioxide and water. As the key process in plant productivity, photosynthesis plays a vital role in every aspect of agricultural production. However, researchers and farmers do not fully understand how photosynthesis is affected by environmental, molecular, and genetic constraints. Alleviating some or all of these constraints could lead to substantial increases in plant productivity. Understanding photosynthetic processes could also help researchers develop new crop varieties with improved grain or oil yield or better resistance to water, heat, and salt stress. In these ways, exploiting the photosynthetic processes underlying plant productivity could help agriculture meet increasing demands for food, fiber, and biofuels. Because photosynthesis captures carbon dioxide from the atmosphere, a better understanding of photosynthesis could also illuminate new opportunities for reducing atmospheric carbon dioxide levels—a major factor in global warming.

What has the project done so far?

The NC-1168 project has brought together outstanding researchers from across the U.S. to investigate critically important areas of photosynthesis research. Over the past five years of the project, researchers have examined how photosynthetic processes are regulated, especially the genetic and environmental factors that influence photosynthetic productivity. These studies have found enzymes that could be engineered to increase plant production of starch and biomass as well as ways to alter photosynthesis so that plants are more efficient at converting sunlight into grain. Researchers have also gained better understanding of the genetic mechanisms that regulate which photosynthates—sugars like starch and sucrose—are produced by photosynthesis and where they end up in the plant (e.g. leaf cells, tissues, fruits, seeds). For example, one study revealed that day length affects the proportion of photosynthates stored in leaves as either starch or sucrose. This line of research gives scientists the potential to alter photosynthesis so that the substances produced are stored in the optimum chemical form and cellular location depending on the desired end use of the plant. Indeed, one NC-1168 study demonstrated a 10% to 20% increase in rice yields through these kinds of alterations. Additionally, NC-1168 has advanced research on the conversion of photosynthetic sugars into vegetable oils—work that is essential for engineering novel biofuel crops. NC-1168 studies on the expression of genes involved in photosynthesis have advanced the potential to breed plants that perform better under stressful conditions. For example, researchers have engineered more heat tolerant enzymes involved in photosynthesis. Other studies which measured photosynthesis in

By studying the genetic mechanisms that regulate which sugars are produced by photosynthesis and where they end up in the plant, NC-1168 researchers have been able to engineer plants that convert sunlight into grain more efficiently. Top photo by Kay Ledbetter/Texas A&M AgriLife Research, Flickr. NC-1168 researchers have also found ways to alter photosynthesis so that plants are more resilient to stress from heat and frost, which can damage plant leaves and impair photosynthetic processes and plant productivity. Middle photo by International Maize and Wheat Improvement Center, Flickr. Bottom photo by Alameda County Community Food Bank, Flickr.

cotton plants have revealed useful details about the onset of heat and drought stress. Researchers have also discovered a new mechanism for plants to cope with freezing stress and have genetically engineered improved salt tolerance in small flowering plants related to cabbage. Other studies have shed light on regulatory patterns that could help researchers develop water-saving plants. Another focus of NC-1168 research has been determining and modifying the biochemical and regulatory factors that impact the capture and release of carbon dioxide by plants.

Impact Statements

Addressed rising demand for food and fiber for increasing populations with decreasing arable land by designing strategies for manipulating photosynthetic processes so that plants produce more usable biomass.

Opened doors to new starch types for industrial, medical, and food-processing applications by providing new knowledge about starch formation.

Identified genetic mechanisms that increase resistance to salt, heat and water stress, reducing crop loss and costs and advancing strategies to maintain plant yields under climate change.

Discovered ways to regulate gene expression during photosynthesis, enabling scientists to modify crop genetics without introducing foreign genes, thus relieving many consumer concerns about genetically engineered plants.

Determined proper timing for applying agrochemicals without disrupting photosynthesis, reducing farmers' costs.

Found ways to manipulate photosynthesis so that plants produce more oil, helping satisfy increased demand for renewable biomass fuels.

Advanced opportunities to regulate global warming by modifying the capture and release of carbon dioxide during photosynthesis.

During photosynthesis, algae produce significant amounts of oil, which can be extracted and processed into biofuels. NC-1168 researchers are exploring how to manipulate photosynthesis in algae to produce more oil without impacting algae growth. Top photo by Andrea Pokrzywinsk, Flickr. Bottom photo by Texas A&M AgriLife, Flickr.

What research is needed?

Future research must focus on improving the response of photosynthesis to developmental and environmental factors that limit productivity so that sufficient food and fuels can be produced in a rapidly changing climate. Researchers must also continue to improve the capture and release of carbon during photosynthesis with emphasis on reducing greenhouse gas production. A more detailed understanding of the chloroplast—the part of plant cells that harbors the photosynthetic apparatus—is also needed.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://ncra.info/*.

Compiled and designed by Sara Delheimer

Management of Small Grain Diseases

This project has improved monitoring and management of diseases of small grains, thus preventing millions of dollars in losses due to poor grain yield and quality and assuring an ample supply of grain for consumption and other uses.

Who cares and why?

Small grain crops, such as wheat, barley, oats, and rye, are used for human consumption, in malting and brewing, as livestock feed, as hay and straw, and in biofuel production. Despite many uses, small grains are often less economical for farmers than crops such as corn and soybeans, and production of small grains in the U.S. has declined significantly over the past 20 years. Profitability has declined partly because diseases have impacted grain yield and quality. Various blights and rust diseases have devastated small grain crops across the U.S., resulting in lost bushels of grain, economic hardship on farms, and disruption of entire rural communities. These diseases have wide geographic ranges and often require complicated management strategies. To manage these diseases, strategies must be comprehensive, cost-effective, and well-coordinated. Furthermore, scientists need to collaborate across states and disciplines so that they can provide up-to-date, pertinent information to farmers. Better disease management will help small grains farmers remain competitive in international markets and assure an ample supply of high-quality grain for people around the world.

Protecting small grains from diseases helps assure a steady supply of high-quality grain for products like whole grain breads (above, photo courtesy of National Cancer Institute.

What has the project done so far?

Over the last five years, the NCERA-184 project has promoted the exchange of information, techniques, and study results among small grains researchers, leading to improved disease management strategies. More specifically, scientists have determined how different varieties of small grains react to various diseases and have guided efforts to breed disease-resistant varieties of small grains. They have also conducted trials to test fungicides, seed treatments, and biological control agents. From these studies, scientists have determined the most effective time to apply fungicides and minimize disease-related yield losses. NCERA-184 researchers have also created an informative table comparing the efficacy of the most widely used fungicides based on data from studies and test trials. Other researchers have focused on how soil and water conservation practices and crop rotation affect disease development. Across the region, NCERA-184 researchers have been surveying for diseases, screening plants for resistance to threatening pathogens, and determining the potential harmfulness of new disease strains. For example, NCERA-184 participants helped set in motion a surveillance plan for stem rust prior to the arrival of threatening strains in the U.S. Additionally, NCERA-184 researchers have helped design tools for predicting disease risk and reporting disease observations. The web-based risk prediction system for FHB, which provides daily information and commentary to farmers in 30 states, was

Bleached seed spikelets (above, photo by Erick De Wolf, Kansas State University) are early signs of fusarium head blight (FHB). FHB is caused by a fungus and leads to discolored, shrunken, and wrinkled grain kernels. The fungus also produces a mold toxin that can be dangerous to animal and human health. NCERA-184 FHB projects are supported by the U.S. Wheat and Barley Scab Initiative through the USDA-ARS.

visited over 10,000 times during the 2012 growing season. Committee members from several states have coordinated trainings on how to use these tools for disease management. To share study results and recommendations, NCERA-184 members have co-authored reports in numerous journals and delivered 200,000 extension outreach materials across the region.

Impact Statements

Fostered communication among scientists, providing real-time information about diseases, driving efficient, useful research, and harmonizing disease management across the region.

Provided daily information about FHB risk to thousands of farmers in 30 states, helping prevent serious outbreaks. The estimated net value of the disease prediction system to U.S. wheat growers exceeds $47 million per year.

Reduced the impact of diseases on small grains, assuring ample supplies of high-quality small grains.

Reduced unnecessary fungicide use and cut disease management costs by informing farmers which fungicides are most effective and how to use them properly.

Educated the public on important diseases, thus increasing the adoption of integrated management practices among farmers.

Prompted more farmers to use small grains as profitable part of their crop production. More diverse crop production reduces the impacts of pests and diseases on all crops.

Want to know more?

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This project was supported by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. For more information, visit *http://ncra.info/*.

Compiled and designed by Sara Delheimer

What research is needed?

Because disease-causing fungi are always adapting, continued research is needed to guide the development of new disease-resistant crop varieties. Scientists also need to continue to test new fungicides and evaluate optimum timing for applying them. Monitoring programs are necessary in order to detect populations of fungi that are resistant to fungicides before these fungi become widespread. Furthermore, additional research is needed to develop the next generation of disease prediction models and communication tools. For example, in order to address wheat blast, a new disease of wheat that recently emerged in South America and could make its way into the U.S., researchers need to screen current wheat varieties for possible sources of genetic resistance, develop disease prediction models, and provide educational materials that will help farmers identify and manage this disease.

Ug99 is a type of wheat stem rust that can cause severe crop damage (above, photo by Erick De Wolf, Kansas State University), sometimes resulting in total crop loss. Though this strain has not been detected in the U.S., NCERA-184 researchers are working on ways to prevent and manage the spread of this strain, including identifying resistant wheat varieties. The NCERA-184 Ug99 stem rust projects are supported by USDA-NIFA.

Nursery & Landscape IPM

This project has developed integrated pest management strategies for insect pests and diseases of ornamental plants in nurseries, landscapes, and urban forests.

Who cares and why?

Nursery and landscape industries are fast growing segments of U.S. agriculture, contributing around $147 billion each year to the U.S. economy and supporting over 600,000 workers. Over the last 20 years, public demand for high quality ornamental plants has more than tripled, with more than $20 billion spent each year at retail and mail order stores on plants and associated products for lawns, parks, urban forests, golf courses, etc. Beyond their economic value, these plants are integral to human health, recreation, and community pride. Properly placed and maintained plants—especially urban trees—absorb noise and air pollutants, purify water, reduce soil erosion, and provide wildlife habitat. However, ornamental plants are threatened insect pests and diseases. Widespread shipping and planting of ornamental plants has facilitated the rapid spread of these pests and diseases, and current suppression and eradication efforts are complicated and costly. Concerns about environmental and human health risks have led to restrictions on many available insecticides and fungicides. For example, there are critical concerns about the impacts of insecticides on honey bees and native pollinators. Heavy use of pesticides also increases the potential that pests and pathogens will develop resistance. Nurseries, landscapers, homeowners, and governments are now embracing integrated pest management (IPM)—an environmentally sensitive and economical approach that combines natural plant resistance with available control techniques, including prevention, monitoring, pheromones, trapping, weeding, and judicious chemical pesticide use. To implement IPM, more detailed information about pest biology is needed in addition to new tools for predicting and monitoring outbreaks.

Recent research has shown that urban trees reduce air pollution and improve human health. NCERA-193's IPM recommendations have helped ensure that nurseries have healthy trees and other ornamental plants available for landscaping urban public spaces as well as residential areas. Top photo by Mark Heard. Bottom photo by Phillip Merritt.

What has the project done so far?

With such a diversity of plants—each with their own complement of pest problems—no individual researcher or state can hope to address them all. For almost 20 years, NCERA-193 has fostered highly efficient and successful coordination among plant pathologists and entomologists working on IPM programs for ornamental plants. Over the past five years, studies conducted by NCERA-193 members have shed light on the biology and behavior of invasive insect pests such as emerald ash borer, pink hibiscus mealybug, chili thrips, grand fir twig borer, viburnum leaf beetle, and banded elm bark beetle. NCERA-193 members have also studied important tree diseases including Dutch elm disease, sudden oak death, pine tip blight, and bacterial scorch and have conducted surveys of pests in firewood. These studies have led to a better understanding of the life cycles of pests and pathogens and have revealed potential hosts. Other studies have assessed how plants, pests, and pathogens are affected by various environmental stressors—such as drought—and practices like mulching, fertilizing, composting, and pruning. NCERA-193 researchers have also improved visual and remote sensing approaches and molecular methods for detecting pests and diseases. Additionally, they have developed new tools to determine the rate and direction of pest and pathogen spread. Using this information, the team has been able to initiate successful rapid responses to outbreaks of emerald ash borer and sudden oak death. Another major focus of NCERA-193 scientists has been evaluating reduced-risk chemical pesticides, biopesticides (formulated from bacterial, fungal, or viral agents), and new application technologies. Researchers have also developed and evaluated pest and pathogen resistance in major landscape plants including ash, hemlock, maple, fir, pine, rhododendron, and viburnum. For example, researchers have developed a variety of chokecherry that is more tolerant of X-disease. Researchers have also set up study sites across the U.S. to determine how resistant varieties of Dutch elm perform under environmental and biotic stress. NCERA-193 has developed IPM guidelines based on this research

and members have served as liaisons with federal and state regulatory and management agencies. NCERA-193 Extension professionals have also reached out to nursery and landscaping industries, gardeners, and communities. They have distributed science-based materials including fact sheets, newsletters, bulletins, and an award-winning video about invasive pests and have designed and maintained listservs and websites to quickly and easily disseminate information. The group has also hosted conferences, field days, and Master Gardener trainings.

Impact Statements

Brought together scientists across disciplines and states, accelerating advanced research and IPM solutions

Made it possible to respond earlier and more successfully to outbreaks with new tools that increase the speed and accuracy of pest detection and disease diagnosis

Encouraged adoption of good horticultural practices that minimize pest and disease control costs and environmental harm

Reduced health risks to workers, non-target organisms, and the environment by developing new, safer chemical insecticides and natural alternatives

Raised profitability of ornamental plant producers by raising awareness of ways to improve plant yields and quality using IPM

Guided new regulations on the movement of firewood, thus limiting the spread of pests and diseases

Protected valuable resources like water and soil from erosion by saving landscape plants from pests and diseases

Renewed acceptance of elms as valuable trees among urban foresters, nurseries, landscape planners, and the public

What research is needed?

This project has received renewed federal support and will continue (as NCERA-224) through 2017. Development and evaluation of IPM strategies that conserve pollinators and protect the health of honey bees are high priorities. Researchers also need to assess the true potential of natural host resistance to pests and pathogens. Further research also needs to assess the economic impact of recently discovered invasive exotic insects and diseases, especially those with expanding ranges due to climate change.

	National Parks	Colorado State Parks
% firewood bought outside park	25	28
% firewood cut or collected at home	17	15
% firewood with signs of bark beetles/wood borers	45/40	67/57
% firewood with stain or decay fungi	39	79

NCERA-193 studies have shed light on the emerald ash borer, an invasive insect that bores into trees to lay eggs. When the eggs hatch, larvae feed on the bark, carving tunnels that disrupt the tree's ability to transport water and nutrients (left photo by Bill Jacobi). Study findings have led to improved EAB detection and trapping methods (right photo by Mike Gifford). Other research has revealed that moving infected firewood is a major way that EAB and other pests and diseases spread to new areas (see table above). To curtail the spread of pests and diseases, NCERA-193 has worked with state and federal agencies to formulate new regulations and design education programs on firewood transport (bottom photo by Bill Jacobi).

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://ncra.info/*.

Compiled and designed by Sara Delheimer

Beef Cattle Genetic Evaluations

NCERA-199 leadership, coordination, research, and outreach have helped maximize adoption and minimize costs of innovative tools and strategies for beef cattle genetic evaluations and breeding.

Who cares and why?

The production of high quality, healthy, and affordable beef begins by identifying the best animals for breeding. Improving cattle genetics through selective breeding can lead to animals that gain weight faster, produce more desirable meat, and are more tolerant of pests, diseases, and stressful environmental conditions. Breeders and producers need ways to evaluate the genetic merits of cattle and predict the traits and performance of their offspring. In the U.S., National Cattle Evaluation (NCE) programs are the main avenue for collecting, analyzing, and distributing genetic information. However, many breed associations find it difficult to fund NCE programs. Furthermore, when genetic evaluations are done through specific breed associations and independent breeders, it is difficult to establish broadly accepted breeding goals or adopt new approaches and technologies industry-wide. The research supporting these programs also tends to be disjointed, leading to overlapping studies and research gaps. All of these limitations make it difficult to adapt breeding practices to changes in beef production and marketing practices. Uncoordinated, inefficient NCE programs could reduce the economic viability, international competitiveness, and sustainability of U.S. beef cattle producers, leaving consumers without the affordable beef products they desire.

NCERA-199 has provided the beef industry with predictions of the heritability of certain traits and diseases in cattle. This information has influenced the selection of bulls for breeding and increased the competitiveness and marketing opportunities for bulls, semen, and embryos with certain genetic traits. Top photo by Scott Bauer/USDA. Bottom photo by Steph Smith Photography, Flickr.

What has the project done so far?

NCERA-199 has facilitated research and exchange of information about National Cattle Evaluation programs. A major focus of NCERA-199 research has been improving methods for evaluating beef cattle genetics and selecting animals for breeding. Scientists have identified economically important traits and have developed tools for predicting whether the offspring of a certain animal will be below or above average for a certain trait. In addition, researchers have designed and distributed software that enables producers to compare bulls from different breeds and crossbred bulls to each other. NCERA-199 scientists have also developed new statistical methods and computing techniques and have helped standardize how results from genetic evaluations are presented to the beef cattle industry. Moreover, they have found new ways to quickly and easily disseminate this information, including a free web-based platform for analyzing genomic data. NCERA-199 researchers and Extension professionals have served as leaders and speakers at workshops and symposiums for breed

associations, beef cattle producers, and groups such as the National Cattlemen's Beef Association and Beef Improvement Federation. Other outreach efforts such as the "Brown Bagger Series: Beef Genetics from Molecular to Management" have been delivered online and via teleconferences. NCERA-199 has also contributed to online curriculum for graduate programs, offering students at universities across the U.S. the opportunity to engage in cattle genetics and breeding coursework.

Impact Statements

By enabling beef cattle genetics research and coordinating the spread of and access to new data, tools, and techniques, NCERA-199 has:

Given breeders a wider portfolio of evaluated traits to consider, providing more ways to improve herd genetics.

Made it possible to do genetic evaluations more often, helping ensure that breeding selections are informed and successful.

Increased adoption of breeding strategies that produce cattle that are hardier in certain environments and production systems and more valuable in certain marketing systems.

Increased global competitiveness and marketing opportunities for producers of cattle, cattle semen, and embryos.

Improved training and education in the area of beef cattle genetics across the U.S.

Advanced statistical methods that can be used in genetics research avenues outside the beef cattle industry.

What research is still needed?

Researchers must continue to develop genetic predictions for a wide portfolio of economically important traits. In particular, research efforts must include methods for combining genomic information, pedigree, and performance data for multiple trait, multiple breed evaluations. Future research must also attempt to expand NCE methods to incorporate data from a greater variety of breeds, production systems, and marketing strategies.

New product tracking technology and inspection protocols make it easier to identify the traits that consumers seek out in the beef products they purchase and easier to trace the source of contaminated beef products back to the original herd. This information influences breeding and marketing decisions. Top photo courtesy of the Borlaug Institute. Bottom photo by Scott Sheperd, USDA.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://ncra.info/*.

Compiled and designed by Sara Delheimer

Embryonic Survival in Cows and Sheep

This project developed and enhanced preventive and therapeutic approaches that address fertility problems and embryonic loss in cattle and sheep, thus supporting better animal care and sustaining efficient, profitable, and competitive agricultural production.

Who cares and why?

Impaired reproductive performance is an increasing problem and a major cause of reduced profitability for dairy and meat producers. Farmers dealing with low fertility or infertility are faced with reduced milk production, fewer calves for raising or selling, as well as expensive fertility enhancement strategies. Various genetic, physical, nutritional, and environmental factors impact ovarian function, fertilization success, and embryo survival; however, further research is needed to understand the underlying mechanisms that affect fertility in cattle and sheep. With enhanced knowledge of the biology of ovarian function, animal producers, veterinarians, nutritionists, and scientists can work together to develop and implement new preventive and therapeutic reproductive management strategies, especially ones that are not drug-based. These kinds of innovative strategies are critically needed so that farmers can efficiently and safely produce high-quality meat and dairy products that meet rising consumer demands. Improved animal reproductive performance is a key part of sustaining an agricultural production system that is highly competitive in the global economy.

Minutes after giving birth, a two-year-old beef cow attends to her newborn calf. Calves are an important source of income for cattle farmers, and farmers and scientists are working together to ensure that reproduction is successful. Photo courtesy of USDA-ARS.

What has the project done so far?

NE-1027 has brought together molecular biologists, physiologists, geneticists, and other animal scientists from multiple states. These scientists have studied the characteristics and processes necessary for an egg to complete maturation, undergo successful fertilization, and survive as an embryo during early pregnancy. By collaborating, these scientists have been able to standardize protocols and exchange samples, and thereby quickly produce reliable findings. NE-1027 studies have identified markers of low fertility in females and in bulls. In addition, scientists have identified the molecules that trigger the development of an egg into an embryo and have determined cell signaling and hormone regulation patterns during early pregnancy. Participating scientists have also started defining genes that are important for establishing a high-quality egg and genes that can be targeted in order to reverse the effects of abnormal ovarian function. Furthermore, researchers have examined how high feed intake and high metabolism during peak lactation are related to conception rates. Using these findings, NE-1027 members have improved fertility tests, treatments, and management strategies. Findings and recommendations have been shared in over 100 published articles.

Impact Statements

Improved the reproductive performance of cattle and sheep and the efficiency of meat and dairy production systems in ways that protect animal health as well as profits for farmers.

Identified novel strategies to control and possibly enhance ovarian function in dairy and beef cattle. For example, researchers are exploring ways to enhance female reproductive longevity based on new knowledge about ovarian follicles.

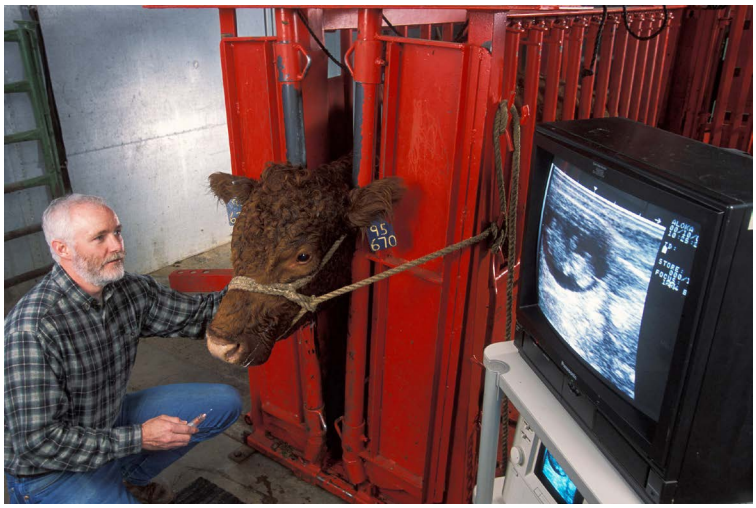
Made discoveries about gene expression and regulation of egg and embryo development in dairy and beef cows that could provide insights for human fertility.

Made molecular discoveries that advanced Assisted Reproductive Technologies (e.g., cloning and sperm injections) and improved conception rates among artificially inseminated animals.

Discovered ways to detect infertility/subfertility in sires, helping farmers make more productive breeding choices.

Helped develop methods for increasing the success of out-of-season breeding in sheep. These methods are being increasingly used by producers and are resulting in greater income.

Advanced and standardized research methods, so that culture samples are more reliable and comparable and a wider variety of tests can be performed.



Reproductive physiologist Tom Geary prepares to take a blood sample from a cow to measure her hormones. An ultrasound monitor on the right indicates this cow is 45 days pregnant. New testing technology has helped scientists and farmers better understand fertility problems and come up with strategies to improve reproductive performance. Photo courtesy of USDA-ARS.

What research is needed?

The team will continue to conduct studies to identify novel genes that predict egg quality. Specifically, researchers will focus on how these genes regulate gene expression in the embryo and during luteal development and function. Additional studies will focus on environmental and metabolic stress that negatively impacts embryo and fetus survival in cattle and sheep. Project scientists will continue to distribute findings to producers to assist them with management strategies and decisions that minimize the detrimental effects of genetic, nutritional, and environmental stress on herd fertility.

Want to know more?

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Compiled and designed by Sara Delheimer

Rural Change & Quality of Life

This project's research has informed policies that enhance the amenities and opportunities offered in rural communities, helping these areas adapt and thrive.

Who cares and why?

The quality of life in rural communities both affects and is affected by the evolution of agriculture and industry, local social organization, public policy, and the movement of people into and out of these areas. For much of the past century, many rural communities have struggled with population and employment loss, high rates of poverty, poor education and training opportunities, and insufficient financial resources to provide basic services to residents. On the other hand, some rural communities, especially those with abundant natural amenities, are experiencing high rates of population, employment, and income growth. Rather than extracting or developing their natural resources, these communities are building economies based on environmental quality and a high quality of life. However, a major concern is that rural population growth may generate congestion and overexploitation that degrade the very amenities that are attracting people to the area. The citizens, businesses, and policymakers who will decide the future of rural America are in need of comprehensive research and outreach to help them understand the forces shaping their communities. If decisions are based on an up-to-date, precise understanding of how jobs, market goods, opportunities, and social life are woven together, rural communities will be better able to adapt and thrive.

Insights from NE-1029 studies have encouraged rural areas to take advantage of ecotourism opportunities and helped them make the best use of available Internet and telecommunications technologies. Top photo by Rennett Stowe, Flickr. Middle photo by Laura Elizabeth Pohl/Bread for the World, Flickr. Bottom photo by Chester County Planning Commission, Flickr.

What has the project done so far?

Over the past five years, NE-1029 researchers have learned how various amenities shape rural development and how social and economic changes affect the quality of rural life. In particular, NE-1029 researchers have analyzed ongoing and potential changes in rural labor markets and the impacts of migration, commuting, and workforce development programs. Researchers have also studied the potential for entrepreneurship, industrial clustering, and nontraditional agricultural businesses in many rural areas. Many researchers have focused on strategies to increase worker productivity and wages and on strengthening important links between urban and rural communities. Applying the findings from these studies, NE-1029 researchers have presented revenue forecasts, ecotourism assessments, and economic impact projections for proposed policies, businesses, and other programs and have guided state and local government reforms. NE-1029 researchers at USDA's Economic Research Service have focused significant efforts on analyzing the

economic relationship between the Internet and rural economies, especially in farm management. Researchers have also examined the use of telecommunications and information technologies to provide clinical health care at a distance. These researchers have produced fact sheets on electronic health records that have been adopted and made mandatory for many rural hospitals and health care providers. NE-1029 members have successfully engaged citizens and policymakers through conferences, hands-on trainings, media interviews, and numerous publications in refereed journals and popular press outlets. For example, in the wake of the devastating tsunami in Japan, Michigan State scientists co-authored research on natural disasters that was cited by well-known U.S. news media as well as prominent outlets around the world.

Impact Statements

Informed voters about the economic impacts of propositions appearing on local and state ballots

Helped identify problems and opportunities in local economies in a timely manner

Influenced policy changes that support better land use planning, stronger links between urban and rural areas, and more efficient rural government service provision

Attracted businesses to rural counties in the Western U.S. by enacting better recruiting strategies that target new industries

Increased visibility of local food enterprises in economic development planning

Helped developers, homebuyers, and local officials prepare for changes in the real estate market

Informed policy and advocacy discussions by providing analyses of farm labor market trends and immigration policies

Promoted better rural health care by increasing use of electronic health records.

Presented revenue forecasts that led legislators to limit spending and tax cuts

Developed databases that made detailed local government data available to citizens, local officials, state lawmakers, policy analysts, and researchers

Researchers in Maine have studied the impacts of hosting cruise ships in two amenity-rich coastal communities and have provided guidance to local businesses and entrepreneurs on the best ways to benefit from this growing segment of the tourism industry. Photo courtesy of James McConnon.

What research is needed?

More research is needed to learn about the factors affecting rural communities and how they can become more resilient. In particular, researchers are also seeking a better understanding of how restructured food systems that increase emphasis on local procurement may influence food sector performance, including links between adjacent rural farm sectors and urban food manufacturing. Researchers also need to assess how government policies may influence rural areas with high shares of immigrant workers (for example, housing, community, and education investments by immigrant families). Furthermore, new measures of regional competitive advantage need to be developed.

Want to know more?

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Compiled and designed by Sara Delheimer

Plant Responses to Ozone

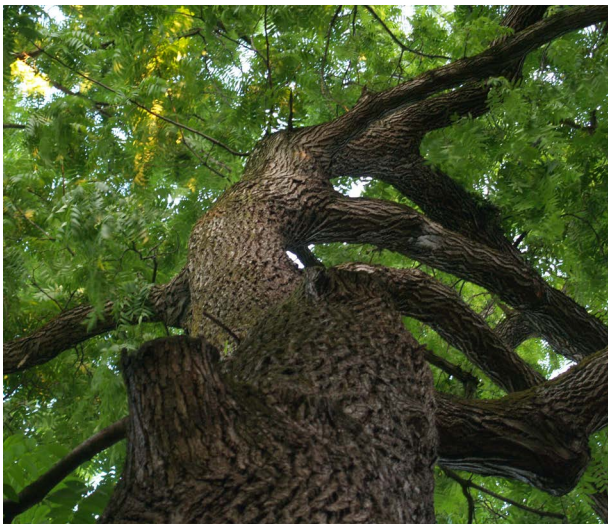
This project has collected data about ozone damage to plants that have been used to describe ozone impacts on agricultural and natural ecosystems, screen plants for ozone tolerance, and to set national ozone standards, ultimately protecting U.S. crops, forests, and other vegetation.

Who cares and why?

In this field plot, ozone-sensitive snap beans in the middle row show signs of premature deterioration and stem and leaf loss compared to ozone-tolerant snap beans in the far right row. Photo by Kent Burkey.

In the layer of the atmosphere closest to the Earth's surface, ozone is a gaseous air pollutant created when sunlight reacts with chemical compounds in vehicle exhausts, industrial emissions, and chemical solvents. Ozone can severely damage plants and is a serious concern for farmers, forest and plant nursery managers, park managers and visitors, landscapers and gardeners, and consumers across the U.S. Ozone-sensitive plants include major crops (e.g., barley, bean, cotton, grape, oat, peanut, potato, soybean, tomato, and wheat) and many important tree species (e.g., aspen, birch, cottonwood, Ponderosa pine, black cherry, white ash, sycamore, and yellow poplar). Chronic exposure to ozone injures the leaves of sensitive plants and can reduce plant growth, quality, seed production, and tolerance to insects, pathogens, weather, and other stress factors. Current estimates suggest that ozone causes three to five billion dollars in crop loss annually. Considerable visible damage has also been noted among native plants in wilderness areas and recreational areas. Damage to plants in both managed and natural settings can lead to poor soil and water quality and can affect organisms that rely on plants for food, shelter, and other uses. By collaborating across multiple disciplines and states, researchers can get a more complete picture of the factors involved in ozone damage. Scientific data will help estimate economic costs, project future impacts, set air quality regulations, and protect U.S. crops, forests, and other plants.

What has the project done so far?



With funding from the USDA Plant Genome Program, NE-1030 researchers have analyzed genes in black cherry, green ash, and black walnut trees (above, photo courtesy of Minh Kiet Callies, Flickr) to understand how different hardwood tree species respond to ozone.

Since the project started in 1995, NE-1030 researchers have become international leaders of cooperative work on ozone damage to plants. By bringing together scientists with diverse knowledge and experience, this project has led to unique approaches to studying—and preventing—ozone damage. Over the past five years, NE-1030 scientists have described many different molecular and environmental characteristics that influence ozone levels in the air. For example, NE-1030 studies have shown that warmer soils can accelerate ozone damage to beans. Reliable data collected through NE-1030 studies have helped scientists develop models that accurately predict and assess ozone damage. These models have been adopted by regulatory agencies around the world and used to set appropriate ozone level standards. NE-1030 research has also led to more accurate calculations of the economic cost of ozone damage

to plants by providing information about changes in ozone levels based on time of day and season. Furthermore, scientists have shown that economic damage estimates should include reduced nutritional value in addition to reduced crop yield. Taking a major step towards breeding ozone-tolerant plants, NE-1030 scientists have examined the molecular basis of ozone toxicity in a variety of plants. To share results and recommendations from these studies, NE-1030 members have developed handouts, websites, and digital media and have led classroom instruction, interactive presentations, and training sessions for many groups, including teachers and Master Gardeners.

Impact Statements

Measured ozone levels and damage, providing early detection of ecosystems under ozone stress, thereby helping to tackle problems quickly and successfully.

Collected reliable scientific data used to set State and National Ambient Air Quality Standards for ozone to protect crops, forests, and other plants and sustain the goods and services they provide.

Developed more accurate estimates of the economic impact of ozone damage to plants, helping agencies like the U.S. EPA compare the costs and benefits of various ozone control strategies.

Gained acceptance of ozone regulations by showing the severity of damage to plants.

Shared locally relevant information on ozone air pollution and control strategies, leading to informed communities and voters and encouraging behaviors that promote better air quality.

Demonstrated potential ways to improve the ozone tolerance of cultivated plants through genetics and to improve the sustainability of U.S. agriculture.

To study the impacts of ozone on the nutritional qualities of plants, rabbits were fed forage grown under elevated ozone levels. Researchers found that high ozone levels decreased digestible dry matter intake, suggesting that ozone air pollution can have negative impacts on animals that eat plants. Photo courtesy of Carl Mueller, Flickr.

What research is needed?

Researchers need to quantify the effects of ozone in terms of interactions with climate change factors (e.g., temperature), plant pathogens, and biodiversity. More work is also needed to quantify the effects of ozone on the nutritional qualities of forage consumed by animals. In national parks and other natural ecosystems, researchers need to assess how ozone impacts aesthetics and visitors' enjoyment. For cultivated plants, continued genetic research is needed to improve the ozone tolerance—and thus yield and quality.

Want to know more?

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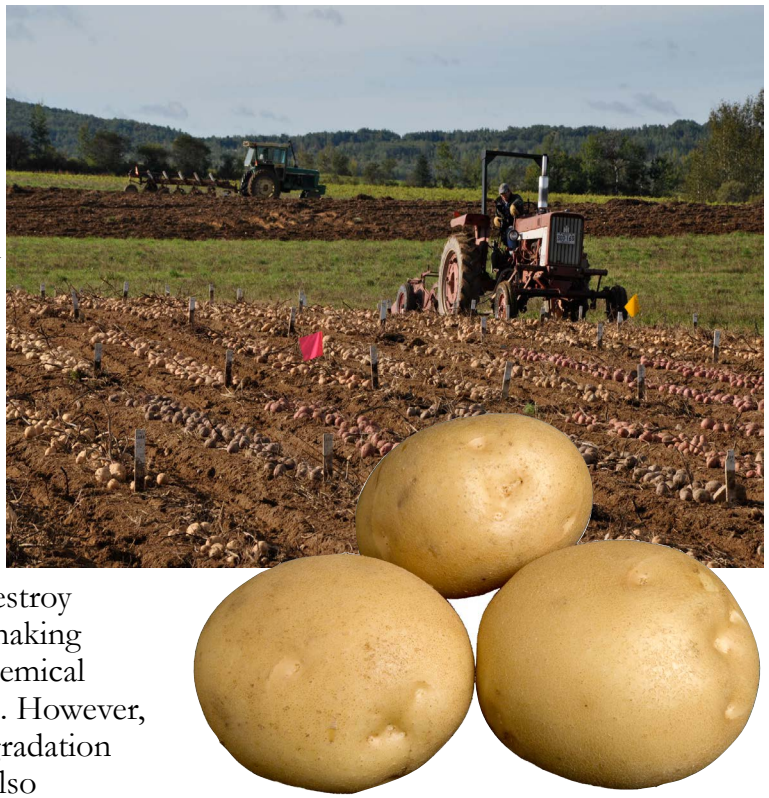
This project was supported by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. For more information, visit *http://www.nera.umd.edu/*.

Compiled and designed by Sara Delheimer

Eastern Potato Varieties & Farm Sustainability

This project has developed improved potato varieties, helping farmers provide safe, nutritious potatoes to the potato processing industry and consumers in an environmentally and economically sustainable way.

Who cares and why?



Potato ranks in the top three vegetable crops produced in the eastern U.S., generating hundreds of millions of dollars and supporting thousands of jobs. Growing conditions, consumer demands, and marketing opportunities vary widely across the region, creating need for tremendous diversity in potato varieties. Many traditional varieties available to eastern farmers are not well adapted to their specific growing conditions or markets. This makes it difficult for farmers to supply high quality products to consumers while maintaining economically and environmentally sustainable farming practices. For example, many traditional varieties are susceptible to pests (e.g., Colorado potato beetle, aphids, and leaf hoppers), diseases (e.g., scab, and silver and black scurf), and other stressors, which can destroy crops or cause defects in appearance, taste, or texture, making them unmarketable. Currently, farmers rely on costly chemical pesticides to prevent crop loss due to pests and diseases. However, these chemicals can result in chronic environmental degradation and health problems for agricultural workers. Farmers also need to know the best growing practices for specific varieties, including how far apart seed pieces should be planted and how much water and fertilizer will be needed. Furthermore, farmers must make sure that in-demand red-skinned and purple potatoes maintain their bright color while in storage after harvest. While demand for fresh potatoes is high in the region, potatoes with uniform shape, consistent color, and few defects must also be produced to fill contracts with large, international chip and French fry processing companies.

NE-1031 research has helped farmers know how to successfully grow different varieties of potatoes in different climates and for different uses (top photo by Lincoln Zotarelli, University of Florida). The group's potato breeding efforts have resulted in varieties like Lamoka potatoes, which have good qualities for making chips (photo by Kent Loeffler, Cornell University).

What has the project done so far?

Over the past five years, NE-1031 has fostered collaboration and communication among researchers, growers, and industry members so that new potato varieties can be adopted in a timely manner. This project has facilitated experimental- and commercial-scale trials that have evaluated yield, quality, and pest resistance of potato breeding lines at multiple locations across the eastern U.S. NE-1031 scientists have improved regional potato breeding and selection strategies so that the appropriate varieties are grown in various geographic areas. Researchers have also mapped the genetics of several important potato varieties. As a result, breeders have released new potato varieties with improved shape, color, and nutritional traits for fresh market and chip and fry processing. For example, NE-1031 scientists helped develop the Waneta and Lamoka potato varieties, which have good qualities for making chips. Other studies have focused on disease resistance in the field and in storage.

This research has led to the development and adoption of Red Maria, a high yielding, red-skinned potato variety that is resistant to the golden cyst nematode and common scab, as well as the Pike variety, which is highly resistant to pink rot. Scientists have shared their research results and insights with other researchers and stakeholders through a project website, a web-based potato variety performance database, scientific journals, and Extension presentations and field days.

Impact Statements

Strengthened communication and interactions among potato scientists located in the eastern U.S. and elsewhere.

Provided growers with better marketing opportunities and profits by releasing and aiding the adoption of new potato varieties with more desirable characteristics. Recent eastern releases have potential to be planted across tens of thousands of acres and have an estimated end value of $35 million.

Enabled a steady supply of high quality potatoes for consumers.

Improved the sustainability and profitability of the chip and French fry industries by developing potato varieties with desirable characteristics like uniform shape and appealing color.

Reduced crop loss, improved worker safety, and reduced pesticide load in the environment and human diet by releasing disease and pest resistant potato varieties.

Stabilized communities dependent on potato production by making potato production more sustainable.

What research is needed?

The needs and expectations of the potato industry and consumers are constantly changing, keeping up demand for new potato varieties. For example, potato chip processors in the northern U.S. would like varieties that can be stored for at least nine months to ensure a stable supply throughout the year, while potato processors in the South seek varieties that better tolerate heat stress. More research is also needed to provide potatoes with excellent boiling and baking qualities, uniform size and shape, and better pest resistance.

During field trials at multiple locations across the U.S., NE-1031 researchers have evaluated the yield, quality, and pest resistance of different potato breeding lines (top photo by Walter De Jong, Cornell University). This research has led to the development of potatoes like Red Maria, a high yielding, red-skinned potato variety that is resistant to the golden cyst nematode and common scab (photo by Kent Loeffler, Cornell University.

Want to know more?

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Project website:
http://potatoes.ncsu.edu/NE.html

This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *www.nera.umd.edu.*

Compiled and designed by Sara Delheimer

Conserving Plant Genetic Resources

S-009 has coordinated efficient acquisition, preservation, evaluation, and distribution of plant genetic resources, thus enabling a wide variety of current and future research projects and improving food security.

Who cares and why?

Different peanut samples show the genetic diversity in the Griffin peanut collection. Images courtesy of USDA-ARS.

Plant genetic resources (living plant materials that include genes) are essential parts of the agricultural production system that sustains the world's population. Seeds, plant tissues, and other genetic resources collected from throughout the world provide the raw materials that farmers and plant breeders use to improve crop quality and productivity. Furthermore, genetic diversity makes crops less vulnerable to widespread damage from pests, diseases, and stresses. Preserving genetic resources is vital for the homeland security of American food and fiber, especially in the Southern Region where agriculture is based primarily on crops such as peanuts and sorghum that were imported centuries ago from other parts of the world. Moreover, many samples can no longer be obtained from their native environments due to changes in land use or policies. Conserving genetic resources in "gene banks" ensures that these materials are available to farmers for years to come. It also ensures that these materials are available for current and future research projects. Researchers use plant genetic resources to breed new crop varieties with specific characteristics like disease resistance, drought tolerance, or color; develop pharmaceutical or medical products; and determine the origins of a particular species. This research provides the public with a more abundant, stable, and environmentally sustainable food supply with improved nutritional or pharmaceutical qualities. In order for plant breeders, pathologists, anthropologists, ecologists, and other scientists to be able to make the best and most efficient use of plant genetic resources, they must be properly classified, well-described, routinely evaluated for quality, and easily accessible. Proper conservation of plant genetic resources enables valuable research and provides security from devastating crop disasters, agroterrorist attacks, and other possible blows to crop production.

What has the project done so far?

Dr. Gary Pederson weighs sorghum seed, preparing samples for storage. Proper classification, evaluation, and storage of plant seeds makes it easier to scientists to identify and use the right samples for their projects. Photo courtesy of USDA-ARS.

For over 60 years, the S-009 project has helped coordinate the acquisition, preservation, evaluation, and distribution of plant genetic material for key Southern Region crops. Over the last five years, this collection (maintained at the Griffin Campus of the University of Georgia) has provided over 163,000 samples to users in all 50 states and 70 foreign countries. In addition, the S-009 team has acquired substantial new materials that have filled taxonomic gaps in the collection. S-009 studies have also identified and categorized samples that were previously unknown, misidentified, or mis-categorized. The S-009 team has pioneered the use of portable data logging devices and barcodes to increase the speed and accuracy of data handling. S-009 has also applied new or improved procedures for assessing the diversity of genetic resources. The team has taken digital images of flowers, fruits, and seeds and has described and categorized the characteristics (such as color, biomass, seed oil content, fatty acid composition, glucose content, etc.) of a variety of species in the collection. These detailed descriptions have helped researchers select

Impact Statements

Increased availability of and access to genetic resources, distributing over 35,000 seed, tissue culture, and clonal resources to users in 47 states and 45 foreign countries in 2011—a dramatic increase in demand from the average of 13,000 accessions distributed per year in the 1990s.

Enabled a widening array of studies across the world, including plant pathology, anthropology, medical, pharmaceutical, and food security projects.

Provided genetic resources that have been used in new ways beyond research, such as in classroom activities, charity/aid project demonstrations, wildlife management, biofuels, gourmet foods, and art.

Enabled plant breeding and crop improvement. For example, a single peanut sample (collected from a Brazilian market in 1952) with resistance to a major peanut disease (tomato spotted wilt virus) has been bred into 24 cultivated peanut varieties, including the five varieties currently dominating Southeastern U.S. peanut acreage. The economic return for this sample is estimated at $200 million per year.

Helped researchers use the collection more efficiently and select the most appropriate samples for their research objectives by thoroughly describing, classifying, and evaluating genetic resources.

Completed disease screening on many collections, assuring safe genetic resources for research and other uses—a big step toward controlling the introduction and spread of pathogens in U.S. agriculture.

Ensured high seed quality and encouraged user confidence by conducting germination tests and by putting samples into -18° C storage.

the right materials to use in their studies. S-009 has also tested the viability of seeds in the collection through germination tests on new and backlogged seed samples. Since 2002, germination tests have been conducted on over 80% of the Griffin collection. With this data, S-009 members have been able to better determine which seeds need to be regenerated. In addition, S-009 has taken steps to increase seed longevity. Currently, almost 75% of the entire Griffin collection has at least one sample in -18° C storage, an increase from only 58% in 2004. Collaborating with state and federal agencies, S-009 has made significant quarantine and inspection efforts that have minimized the threat of introducing or spreading pathogens and pests. Furthermore, S-009 has stored a duplicate of Griffin's genetic resource collection at another site to protect it from natural or other destructive disasters.

Watermelons are being grown in cages in order to increase the number of samples in the Griffin collection. Photo courtesy of USDA-ARS.

What research is needed?

Evaluating and adapting molecular biology breakthroughs will help researchers understand the genetic make-up of the collection samples and improve the efficiency of the collection's conservation.

Want to know more?

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http://www.ars-grin.gov/ars/SoAtlantic/Griffin/pgrcu/s9.html

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Compiled and designed by Sara Delheimer

S-1025 (2006-2012)

Emissions from Dairy, Swine & Poultry Facilities

This project has provided extensive, high-quality emissions data and robust, low-cost strategies for mitigating particulate matter, gas, and odor emissions from animal housing, thus reducing indoor and downwind concentrations and protecting animal and human health, producer profits, and a stable, safe food supply.

Photo by Ken Casey, Texas A&M AgriLife Research

Who cares and why?

Dairy, swine, and poultry production are major industries in the U.S. Total production has continued to increase over the past two decades; however, the number of production operations has rapidly decreased. Although there are fewer facilities, they are larger and more productive and have concentrated air pollution in both the indoor environments and their surroundings. These operations emit odorous and hazardous dusts, gases (like methane and nitrous oxide), and microbiological pollutants (such as bacteria and viruses). Airborne pollutants affect the productivity and well-being of the animals, comfort and health of workers, quality of life for neighboring communities, and energy and resource use on the farm. Although some promising technologies for controlling emissions have been developed, cost and practicality are still concerns for producers. Technologies must be tailored for use in indoor facilities and engineered to deal with the targeted pollutant. A multidisciplinary approach involving scientists and engineers is needed in order to design feasible solutions that help producers meet demands for improved air quality, reduced emissions, improved animal welfare, and safe, low-cost food.

What has the project done so far?

Over the past six years, S-1025 scientists, engineers, and extension professionals from 20 universities across the U.S., USDA-ARS stations, and foreign universities have worked with producers, agricultural equipment suppliers, regulators, public health workers, veterinary experts, and other groups to solve air quality issues associated with poultry and livestock production. Researchers have completed comprehensive measurements of gas, particulate matter, and odor concentrations and emissions from swine, poultry, and dairy buildings and manure storages. As part of the National Air Emissions Monitoring Study (NAEMS), S-1025 scientists have provided benchmark emissions rates, which the U.S. EPA is using to develop "Emissions Estimating Methodologies." S-1025 scientists have also refined sensor systems and air sampling tools for monitoring air pollutant concentrations and airflow rates. S-1025 scientists and engineers have conducted many studies and side-by-side comparisons to determine the effectiveness of various emissions mitigation strategies, including dietary changes, manure treatments, filters, sprinkler systems, shelterbelts, vegetative buffers, and new facility designs and bedding types. Moreover, project members have played a key role in training students and researchers and have shared information through workshops, outreach programs, peer-reviewed journals, popular press articles, an online decision aid, and a video series. To address barriers to adopting mitigation technologies, S-1025 extension professionals have engaged with stakeholders to assess perceptions, concerns, and knowledge about agricultural air quality and emissions.

Impact Statements

Fostered collaboration that resulted in robust, practical, well-tested solutions.

Offered solutions that help livestock producers maintain profits and provide a safe, affordable food supply. For example, shelterbelts and diet changes have been readily adopted by producers because they are relatively low-cost, easy-to-implement solutions with immediate mitigation effects.

Reduced threats to public health and improved neighbor relations by mitigating emissions from livestock facilities. For example, better manure management (such as covering manure lagoons, injecting manure below the soil surface, and treating manure with chemicals) have reduced odor complaints in many areas.

Improved the well-being, performance, and economic value of livestock by informing producers about equipment, management practices, and facility designs that provide healthier indoor environments for animals.

Created better models that track the dispersal of emissions and identify sources of pollutants—information needed to optimize the design and siting of indoor livestock facilities.

Developed monitoring and measurement tools that have been used in 13 states for more than 30 laboratory and long-term field studies in the U.S. and China.

Helped farmers target problems and adjust strategies to seasonal climatic changes and animal growth cycles by providing precise emissions measurements.

Helped regulators set new regulations and make sure that producers meet environmental protection requirements with detailed emissions data from the NAEMS.

Developed and tested various bedding materials that reduce ammonia emissions from poultry facilities—a major concern for producers. These are timely findings since traditionally-used materials are in short supply.

Researchers at the University of Minnesota have tested a vertical biofilter that treats exhaust air from a commercial-type pig nursery barn. Exhaust air flows from the barn through ducts and then into a tall, packed bed of living material that biologically degrades the pollutants in the exhaust air. Photo by Larry Jacobson, University of Minnesota.

Researchers have positioned a sampling port and instruments in front of the primary exhaust fan in this building to measure exhaust gases, particulates, temperature, and relative humidity. Photo by Ken Casey.

What research is needed?

More research and testing are needed to develop technologies for improving the air quality of and reducing emissions from animal production facilities. Increased focus should be given to environmental design standards for reducing the water footprint and fossil fuel and feed energy use in indoor livestock facilities. Animal wellbeing and animal care should also be incorporated into livestock facility design standards. In particular, more work is needed to develop non-evaporative cooling options for lowering heat stress and improving animal performance in response to higher nighttime temperatures and humidity levels. Due to shortages of pine shavings and sawdust, evaluating bedding material alternatives is also a high priority.

Want to know more?

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S-1026 (2007-2012)

Textiles & National Security

This project has developed cost-effective, environmentally friendly textile materials that protect people and property from biological and chemical hazards, fire, and other catastrophic events, thus addressing homeland security issues.

Who cares and why?

Textile materials and technologies play an important role in homeland security. Protective clothing is essential for the safety and performance of first responders, firefighters, healthcare personnel, and others who work to protect and rescue people and infrastructure from catastrophic events, biological and chemical hazards, and acts of terrorism. However, currently available protective gear is often bulky and heavy and does not adequately protect wearers from toxic chemicals and biological hazards, thus endangering the lives of those workers and jeopardizing the success of disaster response efforts. Textiles that address fire safety issues and provide barriers against biological and chemical threats are also needed for automobile interiors, furniture, bedding, and bandages. Rigorous research and testing is needed to determine the best ways to treat textile surfaces so that they repel or deactivate microbes, fungi, and chemicals and do not accelerate fires. There is also demand for textiles that can be created without using chemical solvents or resins that may be toxic to humans and the environment or petroleum-based materials that are economically and environmentally unsustainable. To make improved protective textiles widely available, reasonably priced, and sustainable, scientists must explore textiles that can be made from bio-based materials and processes as well as textiles that can be made uniquely in the U.S.

S-1026 research has produced firefighter gear that not only protects firefighters from fire, heat, and possible biological and chemical agents, but also improves comfort and mobility, allowing firefighters to perform tasks efficiently. Photo by Heather Paul, Flickr.

S-1026 researchers have also developed new textiles and fabric treatments that shield healthcare workers from biological pathogens and chemical toxins they may encounter when treating patients. Photo by Sergeant Paz Quillé, Canadian Forces Combat Camera, Flickr.

What has the project done so far?

Over the past five years, the S-1026 project has brought together expert scientists to conduct innovative research and develop new textile products. S-1026 researchers have made significant efforts to create bio-based textiles with limited chemical inputs, especially petrochemicals. As part of this effort, they have generated textile fibers from sugar cane bagasse—the fibrous matter that remains after sugar cane stalks are crushed to extract their juice—using a reusable solvent. Other S-1026 researchers have produced textile fibers from zein—a soft, yellow powder of simple proteins obtained from corn. Scientists have even identified usable fabric-like materials made by insects. Other researchers have formed biocomposites—fabric-like materials made out from plant resins reinforced by natural fibers—that have a wide range of uses including car interior carpeting and medical implants for bone and tissue repair. They have been able to form biocomposites using agricultural wastes such as soybean straws, wheat straws, hop bines, milkweed floss, switchgrass stems, and poultry feathers as reinforcement fibers and resins from soy proteins and wheat gluten. Test trials have shown that biocomposites for automobiles made out of cotton, kenaf, and hemp fibers offer higher noise absorption and moldability. Exploring new methods for making nontraditional textiles, researchers have experimented with an electrospinning apparatus, which uses an electrical charge to extract very fine fibers from a liquid. Another major focus of S-1026 in recent years has been creating fabrics with antimicrobial and antifungal finishes. Experimenting with ways to add these protective barriers to fabrics, S-1026 researchers have discovered how to use plasma to create non-toxic fabrics that kill bacteria on contact and to modify the cellular structure of fabric surfaces, resulting in better flame resistance, adhesiveness, hardness, and

other properties. Other researchers have shown that containing protective treatments in microcapsules allows control of the release and activation of protective treatments so that they are not worn out by constant exposure to heat and light, regular wear and tear, and repeated washing. Other research has focused on textiles used in medical settings. In a preclinical study with pigs, scientists have evaluated the healing properties of different textiles used to dress wounds. S-1026 researchers have also developed a new decontamination wipe that is useful in healthcare and military settings. Addressing fire safety issues in the U.S., S-1026 researchers have designed new fire retardant bedding and vehicle interior fabrics. S-1026 studies have also concentrated on developing and evaluating textiles with enhanced resistance to environmental degradation. For example, scientists have examined discoloration and loss of strength in quilting materials. S-1026 members have pursued patents, licenses, and cooperative agreements with specific industries in order to make these textile materials and technologies commercially available. They have also shared research results and insights through presentations to various industry associations, journal articles, flyers, and outreach activities.

Impact Statements

Created new protective textiles, improving the safety of workers in healthcare and homeland security positions.

Expanded new, higher value markets for fiber crops, creating new opportunities for farmers and improving the profitability and sustainability of these industries.

Decreased dependence on petroleum-based products and increased use of environmentally friendly, renewable resources, making textile production less likely to harm the environment and more sustainable.

Provided the auto industry with materials that offer better noise absorption, moldability, and fire resistance, offering comfort and safety to passengers.

Reduced the cost of and provided easier access to demanded textiles.

Helped quilters make informed decisions.

What research is needed?

To assure that the products and processes already developed by S-1026 are environmentally responsible, researchers need to perform full life cycle analyses. Researchers also need to collaborate with industry to move these products into industrial applications. Additional studies are needed to explore new, highly demanded fiber materials, including nanofiber, regenerated cellulose and protein fiber, antimicrobial fiber, thermal regulating fiber, conductive fiber, and biosensor fiber. Future research will focus on developing fiber materials using agricultural resources and advancing materials that are renewable, sustainable, carbon neutral, and functional. Continued work on these new fiber materials will facilitate lifestyle changes and living quality improvements that will impact a wide variety of industries from fashion to healthcare.

S-1026 researchers have designed new fabrics for vehicle seats and carpeting that are more fire resistant, thus improving occupant safety. Test trials have also shown that biocomposites made out of cotton, kenaf, and hemp fibers offer higher noise absorption and moldability, improving passenger comfort. Photo by GARNET, Flickr.

Want to know more?

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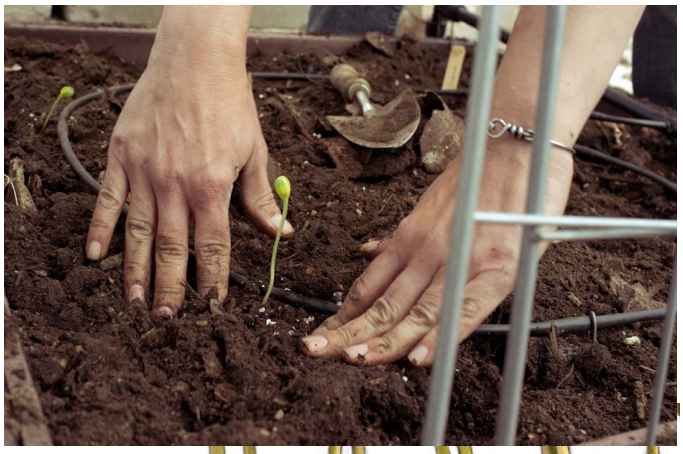
Compiled and designed by Sara Delheimer

Soilborne Pathogens

This project has advanced our understanding of soilborne plant pathogens and identified effective treatments and practices that prevent and/or control the diseases they cause, thus improving crop yield and quality and reducing grower costs.

Who cares and why?



Soilborne pathogens are tiny organisms like bacteria, viruses, or fungi that infect plant roots, stems, and leaves, leading to reduced plant growth, increased costs to the growers, and potential damage to the environment. Cotton seedling diseases caused by soilborne pathogens can kill or weaken seeds and seedlings, delay crop growth, or require costly replanting. Though U.S. cotton seed is universally treated with fungicides prior to sale, growers must decide whether to use additional fungicides to ward off disease. Growers need to know which treatments are most effective for their specific problems and growing conditions in order to prevent needless expenses, ineffective treatments, and crop losses. Soilborne pathogens are also problematic for bedding plants and vegetable transplants, both of which are key commodities in the Southeast. Although production of these plants typically takes place in greenhouses where environmental conditions can be controlled and sanitation is practiced, many greenhouses inadvertently provide conditions favorable for pathogen survival. Even one diseased plant can result in the loss of the entire flat of plants. In 2009, soilborne pathogens were responsible for an estimated 10% of losses in vegetable crops. Though these soilborne pathogens and others are common throughout the southeastern U.S., we know little about their genetics, making it difficult to develop control methods. Because fungicide use is not consistently effective, economical, ecologically desirable (due to environmental and worker exposure concerns), or commercially desirable (production of pesticide-free or organic crops can increase crop value by 30%), biological control and plant growth promoting agents should be considered key management components. Research is needed to make sure that these control methods are safe, effective, and economical for greenhouse, field, and landscaping use. In turn, this research will help reduce our reliance on chemical fungicides and increase the sustainability of U.S. agriculture.

Bedding plants and vegetable transplants (top, photo by Owen Lin) are especially susceptible to soilborne pathogens, which can kill plants and result in serious economic losses for growers and customer dissatisfaction. *Rhizoctonia solani* is a destructive plant fungus that attacks a variety of host plants and can cause many different types of damage, including seed decay, foliage diseases, and root rot (early symptoms shown on bean seedlings above, photo by Howard Schwartz/CSU, Bugwood.org).

What has the project done so far?

This project has created opportunities for multistate, multidisciplinary collaboration. The S-1028 team has conducted many trials and field tests. More specifically, project scientists have examined biological control agents for use as seed treatments, in-furrow treatments, or as potting soil mix-ins for plants like broccoli, tomatoes, impatiens, cotton, and soybeans. The group has also examined the effect of cultural practices (such as crop rotation and tillage) on soilborne pathogens and plant growth. Members have also examined the genetic diversity of soil pathogens. S-1028 scientists have shared their findings at annual meetings and in various publications and outreach materials, including a peer-reviewed video about soil fungi (available through the American Society of Microbiology's MicrobeLibrary, *http://www.microbelibrary.org/library/fungi/3178-soil-fungi*) and an educational website about important soil organisms (*http://www.agron.iastate.edu/~loynachan/mov/*).

Impact Statements

Advanced knowledge of soilborne pathogen diversity, helping scientists pinpoint ways to increase plants' resistance or tolerance to specific pathogens and support longer-term disease prevention.

Helped growers make science-based fungicide choices by developing a database of fungicide recommendations for wheat, corn, and soybeans.

Helped growers increase plant quality and yield, reduce fungicide use, and cut costs by identifying new alternatives to fungicides, including biological agents that control pests, farming practices that reduce disease symptoms, seed treatments that can be safely combined for greater control, fertilizer that reduces seedling disease, and microorganisms that boost plants' resistance to pathogens or promote plant growth. For example, the group identified a formulation of beneficial fungi, Tenet™ WP, which significantly suppresses root and collar rot, enhancing vegetable crop quality, yield, and profits for both conventional and organic vegetable producers.

Changed farmer practices by showing them how certain plants can protect crops when they are incorporated into soils or used as off-season field cover. For example, using hairy vetch as a winter cover crop suppressed disease (by releasing pathogen-deterring ammonia into the soil) in a South Carolina watermelon field and increased that year's watermelon acreage three-fold.

Want to know more?

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Compiled and designed by Sara Delheimer

Researchers tested mustard (*Brassica* species) as a cover crop because the plants produce a large amount of biomass in a short time, thus providing benefits like increased soil organic matter, erosion control, and weed control. Most *Brassica* species also release chemicals that may be toxic to soilborne pathogens and may help suppress diseases. Field trials have shown that *Brassica* cover crops have potential to change soil microbial populations and reduce damage from soilborne pathogens in strawberry, bell pepper, and cotton fields. Photo by Michael Stephens, USDA-NRCS South Dakota.

What research is needed?

Although scientists have been investigating soil microbial communities for several decades, knowledge of how these tiny organisms affect crop yield, disease severity, and ecosystem function is still incomplete. However, with the advent of next-generation sequencing technology, scientists are now able to look at the genomes of all organisms present in a soil (metagenomics) as well as all the genes they are expressing (metatranscriptomics). These technologies will shed light on the basic mechanisms by which control strategies such as crop rotation, cover crops, plant variety mixture, biocontrol organisms, and organic soil additives impact both pathogenic and beneficial soil organisms contributing to disease suppression. Researchers also need to continue thoroughly testing control options to make sure that recommended strategies are effective in a variety of settings and when plants are infected by more than one pathogen.

S-1030 (2007-2012)

Flies, Livestock & Food Safety

This project has developed tools and strategies to manage house and stable flies, reducing loss to producers as well as nuisance and health risks they pose to livestock and humans.

Who cares and why?

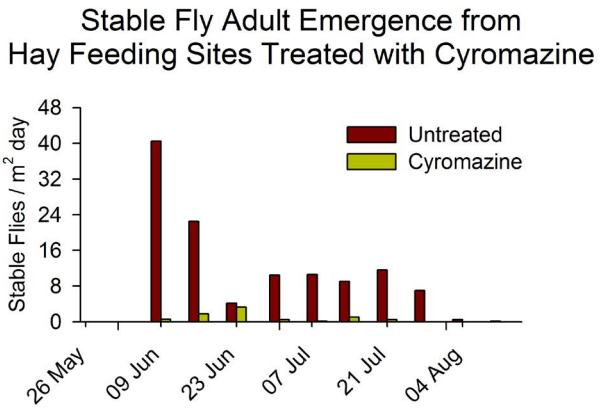
House flies, stable flies, horn flies, and face flies are serious pests of livestock, especially in confined animal operations. These fly species are responsible for damage and control costs that reach billions of dollars each year in the U.S. Stable flies and horn flies inflict painful bites to animals, resulting in direct losses to producers as a result of reduced weight gain and milk production. In addition, these flies can carry more than 65 disease organisms—such as *E. coli* and *Salmonella*—that can cause illnesses in livestock and humans. Flies can transmit pathogens to humans via direct contact and bites, as well as through water and food that they have contaminated. Concerns about flies have led to law suits, zoning limitations, and animosity between farmers and nearby residents and businesses. Available control technologies have been inadequate, largely because scientific knowledge of the biology of these flies has been seriously lacking and because control options have not been well suited for certain agricultural practices, facilities, processing plants, or climatic conditions.

House flies are the most serious nuisance pest associated with dairy and other confined animal operations. S-1030 researchers have determined that insecticide-treated fabric targets (see inset photo) can effectively trap and kill these pest flies when placed around animal facilities and feeding areas.

What has the project done so far?

Over the past five years, innovative studies coordinated by the S-1030 project have propelled the development of successful fly management technologies. Focusing on fly ecology, researchers have characterized the origins, dispersal, population dynamics, and behavior of stable flies and house flies. Studies have shown that local stable fly populations emerge from animal feeding sites from May to July, and migrating stable flies typically arrive after southerly wind events. Other studies have shown that stable fly densities rise quickly and remain high with favorable spring and summer weather. S-1030 researchers have also designed and used new methods for tracking fly abundance and movement. For example, researchers in Washington used digital photography to count face flies and horn flies in six cow-calf herds to determine if commercially available ear tags were effective at keeping flies away. Researchers noted that all tested ear tags achieved up to three months of control for horns flies; however, the same ear tags did not keep away face flies. In another study, researchers lured flies into traps using pheromones, marked the flies, and then tracked how they moved among dairy cattle, swine, and beef cattle facilities. S-1030 scientists at University of California at Riverside have also copyrighted the FlySpotter software, which counts, graphs, and reports fly abundance. Another focus of S-1030 has been determining flies' role in dispersing pathogens. Researchers have examined the digestive tracts of house flies under microscopes and confirmed that they can carry many pathogens, such as *E. coli* and *Salmonella*. Related studies have analyzed how flies spread these pathogens from livestock production areas into residential areas. Drinking water and feed were both found to be contaminated with bacteria spread by flies. Researchers have also assessed how the risk of fly-borne illnesses varies when different production techniques and types of facilities are used. Using this information, scientists have improved tactics for managing flies. For example, S-1030 researchers

have determined that insecticide treated fabrics can help manage stable flies and house flies, working best when two targets per acre are placed at ground level. Participating scientists at the University of Florida have developed a novel trapping technology, Florida-Fly Baiter, that attracts and kills house flies. S-1030 scientists have also started designing and evaluating a leg patch that controls stable flies on pastured cattle. Initial studies have focused on patch size, shape, and adherence properties. To ensure that these strategies control flies for years to come, researchers have conducted a nationwide survey of insecticide resistance in flies. S-1030 researchers have also discovered new alternatives to insecticides, such as exotic parasites and viruses that kill house flies. Researchers have provided an economic impact analysis tool to animal producers so that they can compare the costs and benefits of various control options. Throughout the last five years, research results and insights have been shared via Extension education programs and fact sheets, University and industry publications, and meetings with livestock producers.



Fly larvae often live in hay in livestock feeding areas (see inset photo below). S-1030 researches have applied the insecticide cyromazine to hay feeding sites to evaluate how well it controls fly populations. Study results indicated that cyromazine significantly reduced the number of stable flies per meter on the feeding sites for many months (see graph above).

Impact Statements

By improving our understanding of pest flies and developing economically and environmentally sustainable monitoring and control strategies, S-1030 has:

Helped livestock producers make informed, cost-saving choices about which fly control strategies to use.

Improved livestock welfare and quality, thus increasing productivity and profits.

Lowered the risk of pathogens in animal products and food crops, limiting the spread of diseases to animals and humans.

Reduced the use of expensive — and sometimes ineffective — chemicals, saving livestock producers money and reducing harm to the environment.

Improved quality of life in residential and recreational areas near animal facilities.

What research is needed?

Continued research is needed to evaluate the accuracy and efficiency of monitoring strategies and the effectiveness of newly available insecticides. Researchers also need to take advantage of new information about fly genomes to improve control strategies. In particular, further research is needed to develop technologies for reducing biting fly activity on cattle and to assess the impact of antimicrobials on pathogen survival in flies' digestive systems. Additional studies are needed to determine the role of microbes in pathogen transmission from flies to food plants.

Want to know more?

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Compiled and designed by Sara Delheimer

Managing Soybean Insect Pests

This project advanced knowledge of current and emerging soybean insect pests and improved tactics for managing them, thus promoting a stable, high-quality supply of soybeans for consumers while reducing farmers' costs and making soybean production more sustainable.

Who cares and why?

Soybeans are a major crop in the U.S., where they are grown in 31 states and account for 35% of the world's production. Specialty soybean production is also a growing, profitable market. Specialty soybeans are sought for traits such as high protein or improved flavor and texture in the case of tofu and edamame. Furthermore, soybeans are the most-produced legume in the U.S. organic industry, which has grown 20% or more annually since 2002. Given the large acreage and wide distribution of soybeans, insect pests are an increasing problem. Insect pests hinder soybean growth, quality, and yield and elevate risks to human health and the environment. This damage is costly. In just Mississippi alone, insect pests caused estimated losses of $20.33 million per year from 2004 to 2010. Pest infestations also raise the cost of soybean production by dramatically increasing chemical insecticide use. The distributions and impacts of many soybean pests (such as soybean aphids, bean leaf beetle, and stink bugs) are increasing as a result of expanding soybean production, changes in cropping practices, and/or global climate change. Farmers are also encountering new insect pest problems that they have never seen or managed before. As pest problems evolve, richer, more up-to-date knowledge of these pests is needed in addition to new or modified thresholds, scouting practices, and control methods. Although insecticides are often the go-to tools for dealing with insect pest problems, sustainable long-term solutions must include pest-resistant soybean plants and biological control. Furthermore, these solutions must be effective for soybeans in many different growth stages and planting systems.

Educating growers on detecting damage is key for S-1039 members. Kudzu bug is a new invasive pest devastating soybeans in the Southeast (top photos by M. Mian). Stink bugs (middle right, photo by D. Shetlar) damage soybean seeds, causing them to wrinkle and shrink (middle, photo by A. Michel). Bean leaf beetles feed on soybean leaves and pods. Pod damage (bottom, photo by R. Hammond) enables infections in the soybean seeds, leading to moldy beans.

What has the project done so far?

Over the past five years, S-1039 members (who represent many disciplines and almost all soybean production acres in the U.S.) have shared expertise. S-1039 researchers have characterized many soybean pests and their impacts on the growth, quality, and yield of different soybean varieties. Project members have also researched when to plant soybeans, when to apply seed treatments and/or insecticides, and which agricultural practices are the most effective and cost-efficient. Building on these findings, the group has developed tactics for managing key soybean pests, including new or refined thresholds that are appropriate for specific regions, cropping systems, and growth stages; cost-effective insecticides and spray technologies; organic-compliant insecticides; modified agricultural practices; biological control; and pest-resistant soybean varieties. S-1039 members have also set up a multistate trapping network that has provided critical information for predicting pest outbreaks, keeping track of insecticide resistance, and making pest advisories and alerts. Project

Impact Statements

Educated thousands of farmers, consultants, educators, and other agriculture professionals about soybean pest management. For example, North Carolina Cooperative Extension County Agent knowledge on soybean insect identification increased 28% and confidence in the ability to train others increased 21%.

Helped farmers head off pest problems while keeping their costs and losses low by providing pest alerts that encouraged farmers to scout fields, use appropriate economic thresholds, and limit insecticide treatment to at-risk fields. For example, timely information about lower-than-expected soybean aphid numbers saved Ohio farmers an estimated $12,000,000 on insecticide applications.

Recommended soybean aphids thresholds that have prevented losses of at least $40.00 per acre. Using this threshold, U.S. soybean producers are expected to save $13.3 billion over the next 15 years.

Provided evidence for registration and labeling of several new insecticides that have longer-lasting performance but limited impacts on non-target species, thus providing farmers with safer, more sustainable control options for soybean pests.

Identified effective seed treatments that have increased soybean yields. For instance, researchers found a seed treatment that gave 45% to 100% control of Dectes stem borer and resulted in a 10% yield increase in the test location. In the mid-South, farmers who used recommended treatments increased yields by three bushels per acre.

Gave farmers alternatives to chemical pesticides, including pest resistant soybean varieties and biological control options, thus promoting environmentally and economically sustainable soybean production.

Increased acceptance and release of seed-applied insecticides and pest-resistant soybean varieties among farmers and regulators in areas where they provide the most benefit.

members have shared news and findings in many media, including over 200,000 copies of a pocket-sized, full-color field guide for identifying soybean aphids and look-alikes and the Pest Information Platform for Extension and Education (*http://www.ipmpipe.org/*).

In the northern U.S., heavy pressure from soybean aphids (SBA) results in soybean crop losses (sometimes as high as 50%). Many different insecticides are used to control SBA on millions of acres, adding $10 to $20 per acre to production costs. S-1039 researchers are evaluating new soybean varieties for resistance to SBA and other soybean insect pests. Photo by R. Bansal.

What research is needed?

Continued cooperation among states and across disciplines will improve soybean insect pest management and insecticide resistance monitoring. Additional emphasis will be placed on pest-resistant soybeans (especially finding molecular markers of pest resistance) and natural control. Scientists will continue to adjust thresholds as needed and will develop precision technologies to help farmers properly apply insecticides. Seed treatments for SBA control are becoming more popular, and seemingly more affordable, but additional research is required to make sure that this tactic is not overused to the point that it becomes ineffective. Management recommendations must also be adapted for electronic delivery.

Want to know more?

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This project was supported by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. For more information, visit *http://saaesd.ncsu.edu/*.

Compiled and designed by Sara Delheimer

Nutrient Analyses

This project has promoted accurate, unbiased procedures for nutrient analyses, facilitating better nutrient management that ensures the sustainability of agricultural production and natural resource stewardship in the southern U.S.

Who cares and why?

Farmers use manure, fertilizer, and other nutrients to maximize crop and forage yields; however, nutrients must be applied at the appropriate time and in the proper form, amount, and location to minimize human and environmental health risks (such as hazardous byproducts, contaminated runoff, and erosion). Accurate and timely analyses of soil, water, and plants help determine which nutrients are needed as well as the appropriate amounts and best application methods for optimal results. To perform these analyses, laboratories need safe, precise, and cost-effective testing procedures and tools. Coordination across regions and among local, state, and federal agencies is important to make sure that all laboratories have access to updated procedures, new technologies, and standardized reasoning methods for interpreting results. Otherwise, it is difficult to compare results and harder to use the results to develop comprehensive, effective nutrient management guidelines, which are essential for the economic and environmental sustainability of agricultural production and the quality of life in rural and urban areas.

Animal wastes are used widely in agriculture to fertilize crops. Methods for analyzing the nutrients in wastes and predicting their potential availability to plants helps avoid over application and minimize risk to the environment.

Although originally developed to assess nutrient needs, soil testing methods are now being used to predict and diagnose environmental issues. For example, excess nitrogen and phosphorous in soils can pollute surface waters, causing algal blooms that threaten water quality and aquatic organisms.

What has the project done so far?

Over the last five years, SERA-006 researchers have continued to review, update, and publish procedures used by state soil testing labs in the southern U.S. The group has also developed and implemented new, less hazardous methods, including ones for determining lime requirements for soils. A soil testing methods manual covering all lab procedures used in southern U.S. is currently being developed. SERA-006 has also focused on fostering quality assurance and quality control among labs in the Southern Region. SERA-006 scientists have evaluated new instrumentation and promoted uniform calibration for soil testing tools and analyses. This work has facilitated the development of resource management guidelines across areas that share similar soils, crops, climate, and environmental concerns. For example, SERA-006 researchers have published soil testing recommendations for cotton in coastal plains soils and have promoted regional fertilizer recommendations for many states. SERA-006 researchers and Extension professionals have provided easy access to research data and educational materials for labs, agencies, and the public through an up-to-date project website. Project members have also disseminated information during regional meetings of soil test work groups and national meetings of the American Society of Agronomy and Soil Science Society of America. Extension specialists have also hosted conferences, laboratory tours, and training programs and have developed outreach materials including a soil test video.

Grain sorghum is an emerging crop in the southeastern U.S., often replacing corn on drought-ridden soils. Farmers need to know the critical levels of micronutrients required for optimum plant growth. Soil tests for sorghum must be calibrated appropriately; however, accurate calibration for a specific crop requires detailed research over many years. Furthermore, as crop varieties change, calibrations must be verified and updated.

Impact Statements

Through research, coordination, and outreach efforts, SERA-006 has:

Developed and documented a scientific basis for more effective nutrient management plans

Improved public knowledge and acceptance of science-based nutrient management plans

Widened the scope of standard agronomic tests and interpretations

Improved laboratory worker safety and efficiency

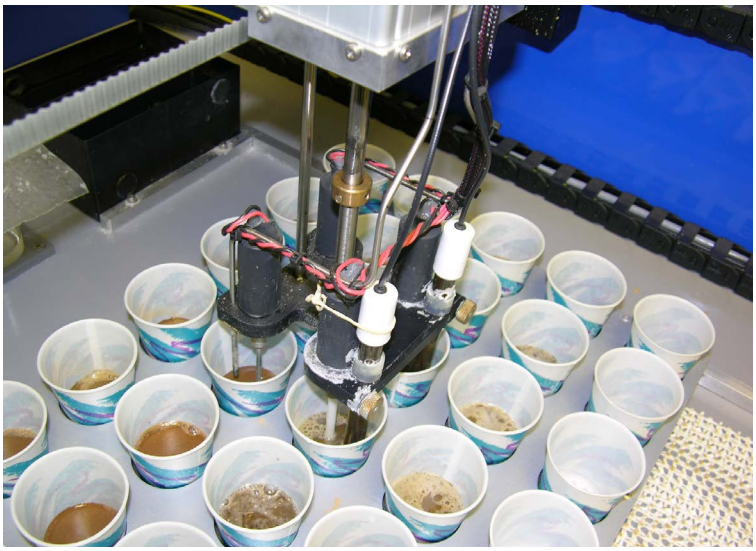
Enabled faster and more accurate data transfer, making it possible to implement nutrient management plans in a timely manner

Reduced over application of nutrients, saving producers tens of millions of dollars and protecting surface waters and groundwater from potential contamination

Provided a more highly trained workforce to address the nutrient management needs of both farmers and urban areas

Above: Master Gardener programs need access to nutrient analysis data so that volunteers can advise and educate the public about gardening.

Right: The Young Scholar Program at UGA teaches students how to extract soil samples for testing.



In many labs today, soil and water pH measurements are made using robots instead of by a chemist at a lab bench. In recent years, SERA-006 researchers have developed new methods to measure pH that minimize hazardous chemicals in labs, thus lessening exposure of workers.

What research is needed?

To provide proper nutrient management recommendations, more research is needed on the micronutrients required for optimum crop production and animal nutrition. Researchers especially need soil test calibrations for modern high-yielding plant varieties. Researchers must also work on widening the current scope of soil testing to determine the environmental fate of unused nutrients in agricultural systems and to examine the potential toxicity of copper and zinc to crops. Future research will also focus on remote sensing methods for nutrient assessments at the regional or watershed scale and nanotechnology that will allow precise targeting and placement of nutrients in soils and plants.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *saaesd.ncsu.edu/*.

Compiled and designed by Sara Delheimer

SERA-027 (2007-2012)

Landscape & Nursery Plants

SERA-027 has provided unbiased information on the performance and adaptation of ornamental plants across a wide geographic range, helping nurseries, landscapers, and gardeners make sustainable selections.

Who cares and why?

New plant material is regularly created through traditional breeding programs and discoveries during exploration expeditions. Demand for new ornamental plant material is high among the horticultural industry and consumers. Some nurseries are investing in the discovery and development of new plant releases and are using this technique to gain market share. Unfortunately, some new plant releases are not widely tested and most have not been independently tested in unbiased trials. In particular, plant evaluations do not often assess the adaptability of these plants to different growing conditions. Nurseries, landscapers, and gardeners need impartial information about new plant materials in order to choose plants that are economically and environmentally sustainable. Otherwise, the U.S. ornamental plant industry could lose its competitiveness and customers may not be satisfied.

What has the project done so far?

Over the past five years, SERA-027 has provided leadership that has facilitated well-coordinated plant evaluations. SERA-027 members have selected and distributed plants from 43 taxa for evaluation, including many lesser-known or less commonly used ornamental plants. Working with multistate cooperators, SERA-027 scientists have assessed the performance and adaptation of these selected plants at multiple trial locations over a five-year period. To facilitate data entry and tabulation of evaluation results, SERA-027 members have developed a web-based data entry form. Summarizing qualitative and quantitative results from these evaluations, the SERA-027 group has provided an overall rating for each plant. Using these ratings, the group has been able to identify underutilized ornamental plants that have superior qualities, especially plants that are more environmentally sustainable. Information about the cold hardiness, heat tolerance, growth rate, environmental adaptation limits, and other qualities of new plants has been shared with a wide variety of audiences. For example, SERA-027 researchers and Extension specialists have shared information via a project webpage, conferences, poster presentations, and collaborative papers. In addition, the

Many of the plants that SERA-027 has selected for evaluation, like the 'Jon Jon' magnolia, have become popular staples in the gardening community. 'Jon Jon' magnolia is a late-flowering magnolia that has been recommended for its cold hardiness.

SERA-027 group has launched a Plant Symposium, during which group members can share their expertise with the general public. The inaugural Plant Symposium was well-attended and well-received.

Impact Statements

Made up-to-date, unbiased evaluation information about ornamental plants more easily accessible for nursery workers, landscapers, gardeners, and others

Enhanced the profitability and sustainability of the ornamental plant industry by providing new staples and promoting lesser-known and underutilized plants that are worthy alternatives to traditional nursery and landscape plants

Identified ornamental plants that are more environmentally sustainable

Improved customer satisfaction by encouraging nurseries to stock higher quality ornamental plants

Shared plant recommendations and trial results with a broader audience by holding a public symposium

What research is needed?

SERA-027 researchers will continue to search for high impact plants to evaluate for potential introduction. Overall, the group's continued work must address the impact of climate change on landscape plant selection. Specific needs include sustainable landscape plants for the southeastern U.S., particularly those that are tolerant of low water and high salinity conditions, and plants that can be used in coastal developments and restoration projects to abate or remediate hurricane and tropical storm damage. In addition, evaluations are needed for ornamental plants that show promise in resisting pests and diseases as well as for plants that could potentially be invasive. More studies and evaluations are also needed to expand the range of ornamental plants that are suitable for the edible landscape.

SERA-027 researchers regularly meet with each other to discuss issues, share expertise, and brainstorm ideas. In the top photo, SERA-027 members Allen Owings and Regina Bracy listen to Bobby Green talk about plants at his nursery. The bottom photo shows the SERA-027 group at Martin's nursery during the 2012 annual meeting in Semmes, Alabama.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://saaesd.ncsu.edu/*.

Compiled and designed by Sara Delheimer

Preventing Obesity in High Risk Families

This project has identified factors that contribute to obesity in young children and have developed innovative strategies and initiatives to help prevent and decrease obesity, especially in low-income and minority families with children.

Who cares and why?

W-1005 studied key behaviors related to weight gain in children, including high intakes of sweetened beverages and high-calorie/low-nutrient foods, low intakes of fruits and vegetables, large portion sizes, few family meals, sedentary behaviors, and excessive TV/media viewing. Photo to the left courtesy of UA Cooperative Extension.

The proportion of the U.S. population that is overweight and the proportion that is obese have reached epidemic levels. By 2002, 65% of U.S. adults were overweight and 31% were obese. Obesity has also become the most prevalent nutritional disease of children and adolescents. These rising rates are cause for concern because excessive body weight is connected to increased risk of chronic disease. Since obesity was first declared a public health concern in 1952, billions of dollars have been spent on prevention and intervention efforts; however, most campaigns and programs have had little discernible effect. A variety of genetic, environmental, and cultural factors (such as race/ethnicity, gender, socioeconomic status, eating habits, and physical activity) have been linked to body weight; however, data on many of these factors are limited or weak. Furthermore, there have been relatively few studies on how the family shapes behaviors that lead to obesity. Appropriate tools and measures are needed in order to gather useful data on the factors that contribute to excessive weight gain in children. Otherwise, prevention and intervention programs may be misdirected, funds misused, and groups of people overlooked. By shedding light on the complex connections between physical, behavioral, social, and environmental variables, multidisciplinary research can help parents, educators, and governments understand how to address obesity risks.

What has the project done so far?

This project has brought together scientists from multiple disciplines and parts of the U.S. to study key behaviors associated with obesity in children ages three to 10. The team has also conducted almost 300 surveys of young children and their mothers that showed how parenting styles and feeding practices are related to perceived and actual weights. Several W-1005 researchers have helped federal agencies conduct 200 interviews that examined resilience to obesity among families exposed to factors that typically promote obesity. W-1005 researchers have also investigated what parents think about currently-used programs and messages. This research has stimulated new approaches for prevention programs and intervention strategies. For example, a W-1005 member now chairs a national expert panel convened to develop ways to integrate the "dynamic energy balance" approach into training programs for practitioners and into nutrition and physical activity educational programs for the public. Furthermore, surveys have pointed out what changes individuals and families are willing and able to make and which methods and tools will be needed for successful interventions. Over 75 interviews with low-income parents have demonstrated how obesity prevention programs can be more successful in limited-resource communities. W-1005 researchers have shared their findings and recommendations in numerous journal articles, conferences, and seminars.

Impact Statements

Advanced the science of child obesity prevention, particularly about parenting, energy dynamics, and lifestyle factors. By focusing on these factors, child obesity prevention programs can be more effective in family and community settings.

Shed light on parenting styles, feeding practices, and other key behaviors that protect children from becoming obese. This information can help determine which aspects of nutrition education and assistance programs help individuals and families acquire the skills, knowledge, attitudes, and means to prevent obesity.

Advanced obesity research methods by identifying accurate ways to assess behaviors that contribute to obesity in children and by improving field methods for measuring body size and weight, fitness, physical activity, and metabolism. Improved methods allow more refined studies and help identify risk factors for obesity and chronic disease in children and families in school and community settings.

Determined how to appropriately and effectively measure differences in parent-child interactions among low-income families. Improved understanding of these differences can lead to programs that are better tailored for families with limited resources.

Provided insights about how obesity prevention messages are interpreted by parents, suggesting ways to design more effective educational campaigns and enhance participation in prevention programs.

Helped schools, families, and communities increase physical activity, choose healthy foods, and meet their wellness goals through a wide variety of programs launched or supported by W-1005 members and their institutions.

Children with low levels of physical activity face increased risk of childhood obesity. W-1005 members have been working with schools, communities, and state and federal agencies to design programs that encourage physical activity, curiosity about food, and healthy lifestyles. For example, All 4 Kids©, which features the work of several W-1005 members, is a nationally-acclaimed, award-winning preschool obesity prevention program.

What research is needed?

Additional research should focus on identifying potential training, programming, and policy needs that will help educators and parents follow established national guidelines. This research is needed in order to help parents provide the environment, support, and examples that will promote a healthier lifestyle for their children. Researchers need to continue evaluating the factors that influence excessive gains in body weight by young children, especially factors related to parenting practices and styles and energy balance, so that sustainable behavior changes can be made.

Want to know more?

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This project was supported by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. For more information, visit *http://www.waaesd.org/*.

Compiled and designed by Sara Delheimer

W-1008 (2007-2012)

Iris Yellow Spot Virus and Thrips in Onions

This multidisciplinary group developed onion varieties and management strategies that have been successfully adopted by growers, resulting in more effective control of Iris yellow spot virus and its insect vector (*Thrips tabaci*), reduced onion crop losses, and economic savings for the industry.

Who cares and why?

Onion is an important crop in the U.S., generating over $900 million annually in farm receipts from 2005 to 2010. Western states cultivate 54,000 hectares (nearly 80% of all U.S. summer production) and produce a large portion of the world supply of onion seed. Onion thrips, an insect that feeds on onion plant leaves, is the most serious pest of onion worldwide. It has become an even greater threat as a vector of Iris yellow spot virus (IYSV), a devastating new onion disease. The projected economic impacts of IYSV and its insect vector in the U.S. total $60 to 90 million; increased pesticide use adds $7.5 to 12.5 million to pest control costs as well as environmental costs that are difficult to measure. Integrated Pest Management (IPM) strategies are needed to deal with these immediate and serious threats; however, much is still unknown about IYSV and thrips. Lacking knowledge and resources, growers in the western U.S. currently rely on insecticides for thrips management even though insecticide resistance problems have been reported for over 15 years. As pest populations and disease outbreaks spread rapidly around the world, scientists must develop IPM strategies that include pest-tolerant and disease-resistant onion varieties, biological control options, and modified farming practices in order to ensure economically and environmentally sustainable onion production.

Lesions on onion plant stalks and leaves are signs of IYSV infection (above, photo by Howard F. Schwartz/CSU, Bugwood.org). Onion thrips that are infected with the virus transmit it to onion plants when they feed on the plants (below, photo by Whitney Cranshaw/CSU, Bugwood.org). IYSV weakens onion plants and reduces bulb size and seed yield.

What has the project done so far?

W-1008 scientists and Extension specialists have partnered with industry representatives to identify onion varieties that are genetically improved to better tolerate damage from thrips and to successfully resist IYSV. Project scientists have investigated the biology and epidemiology of IYSV and thrips and have evaluated how well chemical, cultural, and biological tactics reduce their negative effects on onion crops. To share information on IYSV and thrips biology and IPM strategies, the group has held field days and meetings for growers, managed web sites (*http://www.alliumnet.com/index.htm*), and shared findings and recommendations in *Onion World* magazine and Extension publications, including brochures on how to identify pests and diseases and how to minimize IYSV through irrigation management.

Impact Statements

Helped growers, breeders, and IPM specialists select effective management strategies including using pest-tolerant and disease-resistant onion varieties.

Identified new, selective insecticides and application methods that were adopted by growers. These methods control onion thrips, decrease the frequency of sprays per season, reduce costs, and limit the threat of insecticide resistance.

Increased knowledge of IYSV transmission, convincing growers to stop planting over-wintering onions and to properly dispose of cull onions. By keeping IYSV pressure from carrying over into the next season, growers benefit from higher yields and reduced costs. Growers in the Idaho-Oregon Treasure Valley who destroyed onion culls and planted over-wintering fields farther from summer fields saw IYSV infestation levels decline.

Recommended drip irrigation and careful irrigation scheduling that growers have adopted, resulting in fewer losses from IYSV.

Encouraged growers to reduce the amount of nitrogen fertilizer they apply to onions, helping to reduce thrips populations, fertilizer costs, and potential problems associated with nitrogen in the environment. In Utah, growers using this low-nitrogen input system saved nearly $200 per acre.

What research is needed?

Scientists need additional resources to bring promising experimental onion varieties into commercial cultivation. Insecticide use needs to be optimized so that farmers can successfully control thrips and IYSV without raising costs or fostering insecticide resistance. Genetic diversity studies of IYSV would help scientists better understand the introduction, spread, and evolution of the virus and how it impacts different types of production systems. Improved precision and reliability of IYSV detection techniques is also needed. In addition, further research is needed to understand the role of weed species as hosts for IYSV and thrips. In general, scientists need to continue to coordinate research and prepare solutions for new pest threats.

Want to know more?

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This project was supported by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. For more information, visit *http://www.waaesd.org/*.

Compiled and designed by Sara Delheimer

W-1008 researchers discovered new leads for developing thrips-tolerant onion varieties. For example, research has shown that plants with yellow-green leaf color (and less waxy leaves) also had lower densities of thrips and less feeding damage compared to plants with blue-green leaf color. Photo by LadyFox, Flickr.

Rangeland Fragmentation

This project has influenced the way public and private land management decisions are made by developing standardized tools for assessing the social, economic, and ecological aspects of rangeland fragmentation in the western U.S.

Who cares and why?

One of the most serious challenges facing the western U.S. is the loss of rangelands to development. Rangelands provide important habitat for wildlife, grazing land for the economically important livestock industry, recreational opportunities, and other ecosystem goods and services. Changes in tenure and ownership have promoted new attitudes towards land that are shifting the direction of land use and management. Grazing has been curtailed as working rangelands are subdivided for development, and private lands are experiencing increasing rates of subdivision. The intermixing of small, unmanaged parcels with extensive rangelands hampers wildland fire protection and invasive weed species control and impedes the capabilities of public land management agencies. Fragmentation can also result in the degradation or loss of important ecosystems. Failure to address issues of rangeland fragmentation could decrease the sustainability of agricultural operations and rural communities in the western U.S. and have serious implications for rural communities, local governments, agricultural operations, and natural resources in the region.

What has the project done so far?

W-1192 researchers have developed and tested surveys, models, and other tools that have been used to determine levels and trends of fragmentation across the western U.S. and to assess the social, economic, and ecological impacts of fragmentation. By standardizing these tools, researchers have accounted for differences across states and provided a blueprint for expanding study areas. Using these tools, researchers have looked at how fragmentation affects conservation practices for watersheds, encounters between wolves and cattle, the spread of invasive weeds and other shifts in vegetation, the incidence and impacts of wildfires, costs of grazing, and the amount of meat available from grazing livestock. Other studies have focused on how property size affects landowners' values, goals, and practices. Researchers have also evaluated rangeland sales, categorized the

Rangelands provide important grazing land for cattle; however, encroaching housing development and fences marking private property boundaries and public land allotments are dividing the landscape, potentially limiting grazing area as well as wildlife habitat. Top photo by Wink Crigler. Middle photo by Mark Brunsun, Utah State University. Bottom photo by Rob Lee, Flickr.

reasons why buyers purchase rangelands, and identified factors that affect the market value of western ranches. Additionally, W-1192 researchers have provided economic analyses for revised forest plans for the Shoshone National Forest and Bridger-Teton National Forest. Overall, W-1192's efforts have provided insight into the relationships between land fragmentation and wildlife habitat, livestock production, land conservation, and public perception of the meaning and value of rangelands.

Impact Statements

Helped policymakers evaluate the social, economic, and ecological impacts of proposed rangeland management policies and make more informed decisions.

Helped appraisers, brokers, ranch buyers and sellers, and others make reasonable estimates of ranch value.

Kept land managers abreast of trends in land use changes affecting rangelands, helping them tackle issues before they get too serious.

Provided research that helped settle conflicts between public lands and gas and oil industry in Wyoming.

Reduced oak tree cutting and increased oak tree planting among California landowners, thus helping conserve an important ecosystem and natural resource.

Compiled databases, making up-to-date information easier to access.

What research is needed?

Additional collaborative efforts are needed to address the role of tourism in public lands and its impact on livestock grazing. Researchers also need to assess the impact of climate change and emerging carbon markets on rangeland fragmentation and how this interaction influences various western land management issues. Sharing experiences and resources among cooperating states is imperative to ensure that these broad, multi-faceted issues are addressed in a comprehensive way.

W-1192 research has explored the impacts of rangeland fragmentation on the incidence and spread of wildfires, noting that it is often more difficult to manage wildfires when rangelands are divided into small , intermixed private and public parcels. Photo by Jeff Clark, Oregon BLM.

Invasive weeds, like the gold-colored cheatgrass shown above, are often more difficult to control when rangelands are fragmented. If they are not managed effectively, these weeds can choke out native plants, like the sagebrush pictured above, which provide important food and habitat in the rangeland ecosystem. Photo by Neil Rimbey, University of Idaho.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://www.waaesd.org/*.

Compiled and designed by Sara Delheimer

W-2001 (2007-2012)

Rural Population Change

This project has provided data and insights on demographic trends in rural areas that are essential for plans, programs, and policies that support sustainable rural communities and promote residents' quality of life.

Who cares and why?

As rural places and populations change, reformed policies and programs may be necessary to meet shifting needs, overcome new challenges, and take advantage of opportunities. Many rural populations are aging. Younger people are not flocking to rural areas, but many retirees are seeking out rural places. Furthermore, younger people who grew up in rural areas are leaving for urban areas while older residents are staying put. Aging poses both opportunities and challenges, affecting the workforce and economy and changing the kinds of amenities—like health care and recreational activities—that are desired. Rapid population growth, which is happening on the outskirts of major cities and in high amenity rural areas, also presents challenges and opportunities. New residents often revitalize small town economies, but in-migration also creates demands for infrastructure, like houses and schools, and social services. The pressure of these demands can lead to unplanned and environmentally destructive land use. Rapid development can limit agricultural land and local food supplies, degrade air and water quality, and encroach on wildlife habitat. In-migration has also broadened the ethnic diversity of rural areas, impacting rural economies and social norms. For example, new Hispanic residents are raising the fertility of rural populations and increasing the percent of non-English speakers, creating challenges for service providers like schools as well as opportunities for new businesses. Though ethnic in-migrants are often attracted to rural areas by jobs and lower costs of living, they often suffer high poverty rates due partly to limited access to educational opportunities, historic and contemporary racial discrimination in housing and labor markets, and lack of social integration. New research and policies are needed to ensure increased economic opportunities, social integration, and quality of life for all rural area residents.

Understanding how rural populations are changing helps city leaders and service providers plan infrastructure development to support changing needs. For example, rural economies are influenced by Hispanic immigrants, and more and more businesses and service providers are catering to new, ethnically diverse residents, especially those who do not speak English. Top photo courtesy of USDA. Bottom photo by Contemplative Imaging, Flickr.

What has the project done so far?

For the past 10 years, W-2001 participants have been at the forefront of research on rural population change, leading multidisciplinary studies at the national, regional, and local level. W-2001 members have served as consultants for, or made briefings to the: U.S. Census Bureau; USDA; Housing Access Center; National Rural Health Association; members of Congress; advisory councils; and county commissions. The group's recent research has described how migration of older people to rural areas and aging-in-place impact individual and community well-being, political agendas, social values, land use patterns, tax revenues, housing, healthcare, and transportation. Researchers have also made efforts to demonstrate the effects of the recent economic recession

and housing crisis on the wellbeing of the rural elderly. Other studies have analyzed conditions that affect social and economic integration of ethnically diverse immigrants and their impacts on the labor force and social values. A third focus of the project has been the effects of rural population size and composition on land use and land use conflicts. For example, researchers have studied the connection between economic prosperity and increased demand for rural land and recreation in the Intermountain West as well as the impacts of sprawl on agricultural land and wilderness areas. Making research results and insights easily accessible to policy makers and other stakeholders, W-2001 researchers have generated peer-reviewed journal articles, books, and outreach materials, given presentations, hosted conferences and town hall meetings, and created online databases.

Impact Statements

Taught rural residents, community leaders, congressional committees, rural program managers, and non-governmental organizations how to access, analyze, and use population data

Helped public policy makers and rural residents design or modify programs so that they address important issues and are adapted to current and projected rural population trends.

Enabled federal, state, and local decision makers to compare situations and learn from each other's experiences.

Helped government leaders and rural residents decide where and when intervention is needed.

What research is needed?

Further research is needed to investigate the effects of The Great Recession on rural demographics. Additional research will also be needed to determine the impacts of the outreach material generated by W-2001, especially the two books: *Rural Aging in 21st Century America* and the *International Handbook on Rural Demography*.

Members of W-2001 (E. Helen Berry, Joachim Singelmann, Nina Glasgow, Douglas Gurak, Howard Silver, and Kenneth Johnson) have briefed Congressional representatives on changing rural populations, helping these leaders make decisions that meet changing rural needs.

The ethnic composition of many rural areas is changing as ethnically diverse immigrants seek work and low costs of living in rural areas. Photo by Laura Elizabeth Pohl, Bread for the World.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://www.waaesd.org/*.

Compiled and designed by Sara Delheimer

Bioactive Dietary Chemicals

This project advanced our understanding of bioactive dietary chemicals that can be either beneficial or harmful to human health, thus identifying ways to improve food safety, prevent common diseases, and ensure that consumers have a safe, healthy food supply.

Who cares and why?

Bioactive chemicals can be found naturally in foods or introduced during food processing. These chemicals can have both beneficial and undesirable effects on human health. For example, certain fungal compounds found in corn, ground nuts, and tree nuts can damage DNA and promote cancer. Conversely, omega-3 fatty acids produced by plants and algae and concentrated in certain fish species can promote cardiac health. In recent years, the herbal products and food supplement industry, valued at an estimated $20 billion per year in the U.S., has taken off. Effective products could reduce medical costs and provide farmers with new specialty crop opportunities; however, inadequate quality control and understanding of potential toxicity could allow harmful substances to enter the food supply. Therefore, understanding the complex relationship between bioactive dietary chemicals and human health is a paramount concern to consumers, agricultural producers, food processors, health professionals, and policymakers charged with maintaining a safe and nutritious food supply.

Salmon is a source of omega-3 fatty acids, bioactive chemicals that promote cardiac health (photo by Andrea Pokrzywinski). On the other hand, *Aspergillus* species of fungi produce mold toxins that are potent carcinogens and can lead to serious human health problems when consumed (bottom left, photo courtesy of IITA). Another common fungal disease on corn ears, fusarium ear rot, can produce fumonisin, a mold toxin that is suspected to contribute to birth defects in Hispanic women who eat large amounts of corn (bottom right, photo by Thomas Lumpkin).

What has the project done so far?

This multidisciplinary group of scientists from 15 U.S. universities and the USDA-Agricultural Research Service has been collaborating since 1971 to improve food safety and human health worldwide. Their most recent efforts have investigated how food-borne bioactive chemicals can protect against human diseases such as cancer, inflammation, birth defects, and microbial infections, as well as how food-borne toxins are created by processing, preparation, and other post-harvest activities. Project scientists have also discovered bioactive chemicals that have adverse effects on human health. Using this information, W-2122 researchers have developed approaches to increase beneficial—and decrease adverse—effects of bioactive food chemicals and microbial contaminants. Research has also led to improved understanding of how changes to the human body's natural collection of bacteria and other microorganisms are related to chronic metabolic diseases. W-2122 extension experts have shared research results with stakeholders using multimedia materials.

Impact Statements

Shed light on possible dietary strategies for preventing and treating metabolic syndromes (including type 2 diabetes hypertension, high cholesterol, and cardiovascular diseases) that afflict over 47 million Americans.

Helped consumers make more informed, healthier choices about whether to take dietary supplements. For example, University of Illinois researchers found that the estrogen-like compounds (isoflavones) in some soy supplements can stimulate growth of estrogen-dependent breast cancer and can negate the effectiveness of breast cancer therapies (e.g., tamoxifen and aromatase inhibitors), depending on dosage.

Developed ways to increase beneficial effects of bioactive chemicals so they are more active but have fewer adverse side effects for consumers.

Improved food safety by identifying how to prevent contamination from food-borne toxins during processing, preparation, and other post-harvest activities.

Found ways to assess and reduce harmful levels of aflatoxin B1 (a carcinogenic mold toxin) in turkey and grain. This information helps ensure safe food products for consumers and is useful in parts of Asia and Africa where 10% of adults may die of aflatoxin-related liver cancer.

Advanced strategies for protecting and treating individuals exposed to bioactive toxins through deliberate use in chemical terrorism or warfare or natural contamination of foods.

Saved taxpayers millions of dollars by simplifying risk assessments for fumonisin, a carcinogenic mold toxin.

Characterized the fetus stage that is most susceptible to carcinogens to which the mother is exposed, leading to better prevention protocols for pregnant women.

Studies found that consuming dry bean or rice bran (the outer layer of the rice grain) increases beneficial bacteria that produce food for cells lining the colon, while also reducing the growth of harmful bacteria that can cause intestinal inflammation. Photo courtesy of Rob Qld, Flickr. Other studies showed that bitter melon prevents obesity-associated metabolic disorders like diabetes. Studies also linked the bioactive chemicals in bitter melon to improved glucose, insulin, triglyceride, and cholesterol levels. Bitter melon is widely cultivated throughout the year in Asia, eastern Africa, and South America and is used extensively in folk medicines. Thus, it provides a cost-effective treatment or preventive strategy that is widely acceptable, especially among culturally sensitive populations and developing nations. Photo courtesy of Lao Foods Flickr.

What research is needed?

Despite significant progress in this field, much remains unknown about the impact of bioactive dietary chemicals on human health and food safety. Researchers are continuing to explore ways to increase the beneficial impacts and minimize the risks of bioactive dietary chemicals. Continued collaboration and communication of results among consumers, agricultural producers, food processors, health professionals, and policy makers is needed to maintain food safety and improve human health worldwide.

Want to know more?

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Compiled and designed by Sara Delheimer

W-2185 (2007-2012)

Biological Control of Pests in Plant Systems

This project provided successful, cost-effective, and sustainable pest control in agricultural and natural settings by releasing, manipulating, and conserving the predators, parasites, and pathogens that attack harmful insect and weed pests.

Who cares and why?

Insect and weed pests cause serious damage to agricultural and natural areas, resulting in economic losses, environmental damage, and human health hazards. Pest populations are expanding and new pests continue to arrive in the western U.S. every year. Many of these pest populations have or will become permanently established. Growers often rely largely on chemical pesticides to control pests, but an integrated pest management (IPM) approach considers additional or alternative tactics to keep pest densities below levels that cause economic or environmental harm. One tactic is biological control, which uses native and foreign natural enemies (e.g., parasites, predators, and pathogens) to suppress pests. Biological control is a natural process, but can be enhanced by releasing natural enemies in a new area where a target pest occurs, supplementing or manipulating natural enemies already present, and/or modifying the environment to give existing natural enemies the upper hand. Biological control is a high-priority alternative because of the potential benefits to agriculture, rural communities, and consumers. Biological control allows farmers to reduce pesticide use and cut costs. Lower pesticide use also reduces risks of air, water, and soil contamination, thereby protecting the quality of life for farm workers, area residents, and native wildlife. This makes biological control a particularly useful option for organic farming, which continues to increase at roughly 20% per year in the U.S. Still, successful biological control has to overcome many challenges. To comply with federal regulations, scientists must carefully select the appropriate natural enemy species, so that they control the target pests but do not harm non-target species or the environment. In-depth studies and rigorous data are needed to support practical biological control recommendations. Furthermore, because target pests often occur in more than one state or area, research and biological control approaches must be highly coordinated.

The banana aphid (top right) is a costly pest of banana and other tropical/subtropical food and ornamental plants. By feeding on plant tissues, these aphids can kill the plant, suppress growth, and/or transmit devastating plant diseases. Scientists have discovered that *Endaphis fugitiva* parasitizes banana aphids. Field and laboratory observations have shown that adult flies lay eggs on plant leaves near aphid colonies (left). Hatched fly larvae pierce aphid bodies and continue to develop inside. Aphids die shortly after the parasite re-emerges. Scientists have also found an effective biological control agent for another insect pest, Erythrina Gall Wasp (bottom right), which defoliates and destroys coral trees in Hawaii and Florida. Photos by Russell Messing, University of Hawaii.

What has the project done so far?

The W-2185 project has formed a network for exchanging information, collaborating on research projects, and coordinating biological control efforts. W-2185 scientists have studied pests and their natural enemies in both their native habitats and the areas where they have been newly introduced. Based on this information, researchers have released a variety of predators, parasites, and pathogens that biologically control vine mealybug, red imported fire ant, Diaprepes root weevil, spotted knapweed, purple loosestrife, and other insect and weed pests. Scientists have developed standard procedures for raising, storing, and releasing natural enemies, as well as ways to genetically or physically enhance them. Scientists have also protected naturally occurring pest enemies by

making changes to habitats and agricultural practices. To understand which methods are sustainable, the group has evaluated non-target environmental and economic impacts and has consistently monitored which efforts succeed and which ones fail. W-2185 publications, presentations, websites, and policy recommendations have provided government agencies, agriculture industries, and farmers with the latest news, findings, and recommendations.

Impact Statements

Formed a network of scientists, agencies, and industry members that worked directly with farmers and initiated informed, coordinated, and tailored biological control efforts.

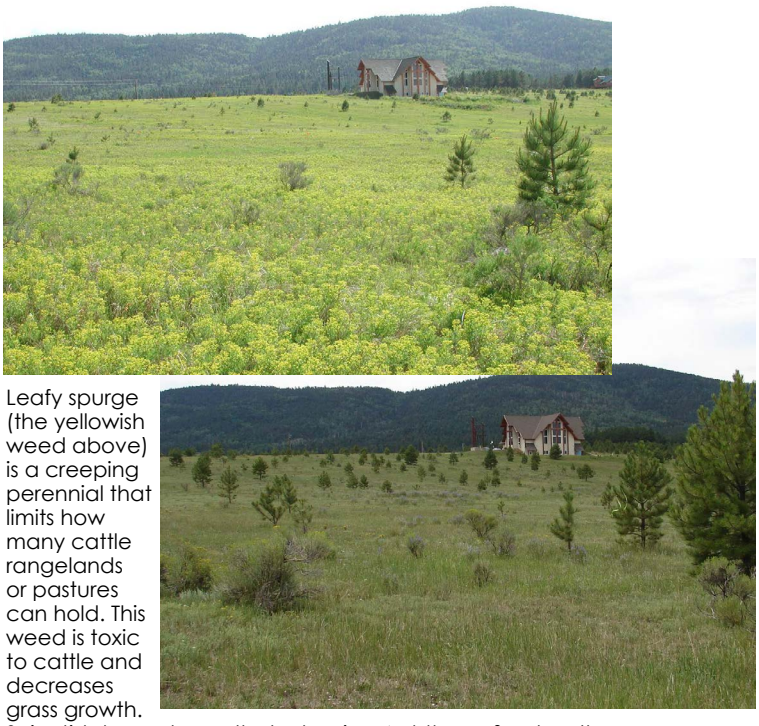
Increased acceptance for biological control efforts among farmers and government agencies by sharing updated knowledge about the environmental and economic impacts.

Reduced risks of air, soil, and water contamination and human exposure to potentially harmful chemicals by decreasing chemical pesticide use in the western U.S.

Helped farmers cut costs. From 2007 through 2010, property owners/managers in the northwestern U.S. saved an estimated $500,000; in 2011 alone, they saved $250,000 by biologically controlling weeds. Over the last 16 years, an IPM program that incorporates natural enemy conservation saved Arizona cotton growers $388 million by reducing crop loss and chemical pesticide use. In turn, farmer savings can translate into lower prices for consumers.

Introduced natural enemies that limit plant reproduction, but are not fatal. This provides the option to plant certain species for ornamental or other uses (e.g., erosion control, hedgerows) without risking serious infestation and damage.

Protected food security, biodiversity, and cultural heritage on Samoan islands by introducing predatory beetles to control pests that damage breadfruit trees—a traditional food source and major component of the island landscape.



Leafy spurge (the yellowish weed above) is a creeping perennial that limits how many cattle rangelands or pastures can hold. This weed is toxic to cattle and decreases grass growth. Scientists have shown that releasing *Aphthona* flea beetles can control leafy spurge by feeding on roots and foliage. These photos show the same field before (top) and after (bottom) flea beetles were introduced. Photos by David C. Thompson, New Mexico State University.

What research is needed?

Despite many advances in recent years, the understanding of success and failure in biological control efforts falls short of meeting certain current and future requirements. Ideally, scientists need to better predict the appropriate species or biotype(s) to release for control of a target pest in a given situation as well as potential environmental impacts resulting from the use of exotic species for biological control. Furthermore, conservation biological control requires detailed ecological understanding of the production system so that growers can be given very specific and practical advice on how to conserve existing beneficial species in that system.

Want to know more?

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Compiled and designed by Sara Delheimer

Monitoring Rangelands

This project has provided tools that help landowners and land managers assess the ecological status of rangelands and make management decisions that support the sustainability of healthy rangelands.

Who cares and why?

Rangelands include grasslands, shrub lands, deserts, alpine communities, marshes, and other ecosystems, including the juniper-dominated landscape above. WERA-040 researchers have standardized specific descriptions of the various ecological sites that occur on rangelands, making it is easier to evaluate rangeland health. Photo by Mike Borman, Oregon State University.

Rangelands in the western U.S. form a vast and varied landscape that provides important habitat for wildlife, grazing land for economically-important livestock, and recreational opportunities. Ecological processes that occur on rangelands generate clean water to drink and air to breathe. Periodically assessing the general ecological health of rangelands is key to supporting the long-term sustainability of rangelands. Since 1974, the USDA has been charged with conducting a "comprehensive assessment of present and anticipated uses, demand for, and supply of renewable resources from the nation's public and private forests and rangelands." The Natural Resource Conservation Service (NRCS) conducts a similar inventory of private rangelands across the nation. However, interpreting rangeland conditions has always been controversial, especially when debates over public policy and resource allocation occur. Furthermore, collating assessments of private lands with those from various public land units into a cohesive national report has been difficult because different agencies have used different criteria. A single, unified method for assessing rangeland condition is clearly needed, but identifying a method that accurately measures rangeland health across a broad spectrum of climate, geology, soil types, and ownership patterns is complicated.

What has the project done so far?

During the past five years of the WERA-040 project, participating scientists have developed new science-based approaches and models for assessing, monitoring, and managing rangelands. In particular, researchers have formulated and standardized detailed descriptors for various ecological processes and features that are being assessed. They have also designed models that track and forecast rangeland conditions given different potential land use or management options. Another focus has been developing methods for determining whether or not ecological processes are working properly within various rangeland ecosystems. These tools have been designed to work for many different agencies, in all types of rangeland ecosystems, and for rangelands in all states of health. Data collected by WERA-040 researchers have been used to set thresholds for ecological processes and features and recommend specific management options. WERA-040 researchers and Extension professionals have hosted successful symposia and published many papers to share the latest information and technology among various conservation organizations, state and federal land managers, legislative authorities, the agriculture industry, and private landowners.

Impact Statements

Helped private landowners and public land managers make informed decisions by improving means of assessing rangeland resources and making monitoring data more readily available.

Increased adoption of monitoring guidelines in western states, helping land managers spot degrading conditions before they become too serious.

Protected the sustainability of western rangelands by developing models that can be used across the western U.S. to design more adaptive management plans.

Raised awareness about possible restoration options for rangelands of all conditions.

Provided detailed information on the status and sustainability of natural resources that rural communities rely on for economic progress. For example, increased implementation of rotational grazing practices in North Dakota has generated about one million dollars per year for North Dakota producers.

What research is needed?

One focus for future research is understanding how vegetation treatments affect the movement, distribution, and quality of water resources on different ecological sites. Researchers also need to verify the models and ecological site descriptions used to predict transitions between vegetative states.

WERA-040 research and outreach has helped rangelands professionals sharpen their skills for identifying ecological sites on rangelands. Photo by Bobbie Davis, NRCS.

Knowing what types of ecological sites are present on rangelands helps guide management practices and helps land managers recognize threats and damage to these ecosystems. Photo by Mike Stirling, NRCS.

Want to know more?

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This project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://www.waaesd.org/*.

Compiled and designed by Sara Delheimer

Management of Pesticide Resistance

This multidisciplinary project continues to develop resources, tools, and methods that significantly reduce the threat of pesticide resistance, thus helping to sustain the usefulness of important pest management tools and strategies, reduce losses from pest damage, and protect public and environmental health.

Who cares and why?

Pesticides are important tools used in managing pest populations; however, some individual pest organisms are naturally resistant to pesticides. These resistant individuals survive and reproduce, passing on genetic resistance to generation after generation until most of the population is resistant and certain pesticides are no longer effective. In recent years, use of conventionally-applied herbicides, fungicides, and insecticides has increased significantly and pesticide resistance has multiplied rapidly. In addition, some insect pests have developed resistance to insecticidal proteins that are expressed in genetically modified plants. When resistance develops and commonly-used pesticides fail to control pest populations, damage to crops, property, and landscapes intensifies and costs skyrocket. For example, cotton growers in the southeastern U.S. face serious crop losses due to weeds that are resistant to the commonly-used pesticide, RoundUp®. Soybeans, rice, and other crops are expected to face similar problems soon. Pesticide resistance often leads to overuse or misuse of pesticides, risking harm to the environment and public health and making the crops less desirable to certain markets and consumers. Quickly and successfully addressing pesticide resistance requires the work of scientists from many disciplines and up-to-date information. Managing pesticide resistance also relies on persistent monitoring and consistent, effective strategies in the field. Better management of pesticide resistance will lead to improved protection from pests, a more stable supply of quality crops for consumers, better profits for growers, and healthier humans, animals, and environments.

Even though many kochia plants— highly invasive weeds—were killed by RoundUp® treatments, a track of healthy kochia plants grew in the field above when a a single RoundUp®-resistant plant shed its seed as it tumbled across the field in the wind. Photo by Andrew Wiersma, Colorado State University. Along with weeds, plant pathogens can also develop resistance to pesticides. For example, fungicide-resistant powdery mildew can severely damage pumpkin crops. Photo by Meg McGrath, Cornell University.

What has the project done so far?

Over the past five years, WERA-060 researchers and extension specialists have worked with industry representatives and government regulators to develop resources, tools, and methods for managing pesticide resistance. Researchers have detected resistance in a wide variety of pests—including insect pests, plant pathogens, and weeds in cotton, peanut, corn, squash, and melon—and have described how resistance develops in many situations. Scientists have also developed guidelines for preventing pesticide overuse and misuse and have evaluated how well new pesticides control pests and how quickly, if ever, pests develop resistance. Other studies have determined how new pesticides impact non-target species and the economy and how well they are accepted by users and communities. In addition, researchers have investigated how to block the genes and specific mutations that cause pesticide resistance. To share research findings, the group has organized symposia about pesticide resistance management, produced over 20 educational videos (*http://ag.arizona.edu/crops/vegetables/videos.html*), revised and expanded training programs, delivered updates to farmers via web, email, and smart phone (*http://ag.arizona.edu/crops/vegetables/advisories/advisories.html*), organized online databases, and distributed newsletters.

Impact Statements

Advanced data, tools, and strategies for preventing or delaying the evolution of pesticide resistance in pest populations by enabling cooperative research and extension.

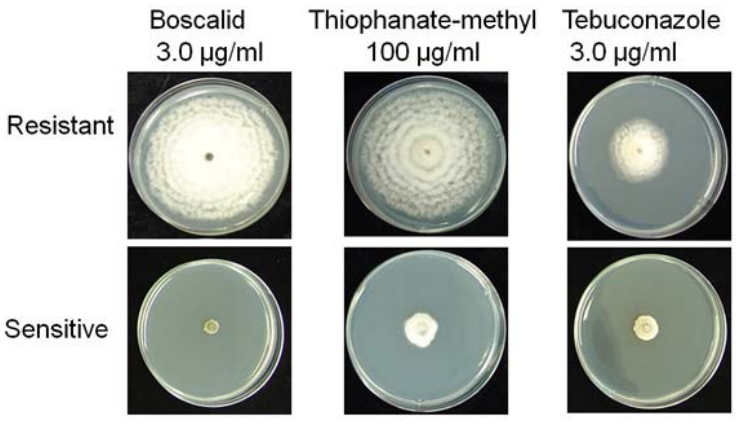
Helped farmers, pesticide manufacturers, and regulators make more economically and environmentally sustainable decisions by sharing data, tools, and recommendations.

Helped users choose and apply pesticides properly by developing and updating management guidelines. Proper pesticide use prevents resistance build up, reduces damage from pests, saves time and money, minimizes pollution, and lowers health risks.

Detected new cases of pesticide resistance, getting the upper hand on these cases before they cause serious problems.

Made it easier to monitor pesticide resistance by creating the Arthropod Pesticide Resistance Database (APRD), which has encouraged online pesticide resistance case reporting and has become the most complete database on resistant organisms in the world. Pest managers, industry specialists, researchers, the EPA, and the EU use the database to support pesticide registration and decisions about managing cases of pesticide resistance.

Above, a graduate student working with a WERA-060 scientist samples plants for pesticide-resistant gummy stem blight. In the lab, tests revealed that the gummy stem blight is resistant to multiple types of pesticides. The gummy stem blight samples that are resistant to pesticides continued to grow in the petri dishes (below). Photo and chart courtesy of Katherine Stevenson, University of Georgia.



What research is needed?

There is a critical need for scientists to quickly develop ways to combat pesticide resistance and to work with policymakers to set guidelines for using and enforcing these tactics. RoundUp®-resistant weeds and Neonicotinoid-resistant insects are of immediate importance. In general, research is needed to better understand the biology and genetics that underlies pesticide resistance and to ensure more precise and accurate predictions about when and where pesticide resistance may develop.

Want to know more?

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This project was supported by the Multistate Research Fund (MRF) established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. For more information, visit *http://www.waaesd.org/*.

Compiled and designed by Sara Delheimer

Improving End-use Quality of Wheat

This project improved the quality of existing and new wheat varieties, giving growers more profitable choices, helping U.S. wheat compete in domestic and international markets, and providing a stable supply of high quality wheat products for industrial partners and consumers.

Who cares and why?

There are many varieties of wheat, each with unique traits that influence its quality and how it can be used. Because they have diverse uses for wheat, different industrial partners prefer specific varieties. In the Pacific Northwest (PNW), about 85% of the wheat is exported, mostly to Asian and Middle Eastern countries where it is made into noodles, cookies, steamed breads, flat breads and other similar products. The total market value of U.S. wheat exported to Asian countries alone is estimated at over $400 million per year; however, exports have been declining over the last 20 years because of increased competition from Australia, Canada and eastern European countries. In order to remain competitive, PNW producers need to be continually improving overall grain quality and developing innovative wheat varieties. This requires a clear understanding of how wheat quality is affected by genetics and agricultural practices, such as tilling, fertilizing, and processing. The farming community and wheat industries must collaborate to set quality standards and make sure that technologies and practices protect wheat quality. If wheat quality is not improved, U.S. wheat producers will not be able to provide a steady supply of high quality wheat for industrial partners and consumers.

Most Western states test new wheat varieties during on-farm trials to determine how they are affected by environmental conditions and how well they could adapt to different farm settings. Above, Jianli Chen stands in fields of University of Idaho varieties. Photo by Cindy Snyder. Below, Bon Lee conducts bread baking tests in the Wheat Marketing Center lab. Measurements of texture and other qualities tell wheat breeders and industrial partners which wheat varieties are best suited for baking. Photo by Andrew Ross.

What has the project done so far?

This project has created a multidisciplinary committee that has shared wheat quality information among growers, researchers, and industrial partners. Using standardized testing methods that they developed, WERA-1009 scientists have evaluated wheat quality and measured how it is affected by specific plant genes, environmental factors, and grower practices. Over the last five years, the group has developed and released a number of unique new varieties of spring and winter wheat that have been top-yielding and have demonstrated excellent pest resistance, extreme weather tolerance, and desirable traits, such as better coloration and softness. Many of these varieties have become the most planted wheat varieties in western states. For their accomplishments, WERA-1009 received the Western Region Award of Excellence in Multistate Research in 2012.

Impact Statements

Engaged scientists and domestic and foreign industrial partners in research and development that led to improved wheat quality.

Reduced economic losses due to poor crop yield and/or quality and enhanced wheat production's resilience to climate change by developing and releasing new wheat varieties that are high yielding, drought tolerant, disease resistant, and/or have desirable traits for diverse uses.

Improved farmers' understanding of how their agricultural practices impact the ways their wheat crops can be used, thus helping them select higher quality varieties, use best management practices, and ultimately earn more for their crops.

Promoted domestic and international wheat trade by using knowledge about the quality and uses of different wheat varieties to predict how they will behave in markets and by increasing the overall acreage of valuable wheat varieties across the western region.

What research is needed?

Environmental conditions are constantly changing, as are customer needs. The median income level of Asian and Middle Eastern countries is increasing, which translates into increased demand for existing and new wheat products. Additional research on the genetics and environmental factors that affect wheat quality is needed so that the wheat industry can continue to adapt to climate change, new pests and changing customer needs. All western states are encouraged to participate in wheat breeding and testing programs. There is also need to begin investigating how different qualities of wheat affect human health.

Want to know more?

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Compiled and designed by Sara Delheimer

With the exception of soft red wheat, all classes of wheat are grown in the Western region. Photo by Rob Valkass, Flickr.