ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS

North Dakota State University
North Dakota State University Extension Service
North Dakota Agricultural Experiment Station

Federal Fiscal Year 2004
(October 1, 2003 - September 30, 2004)

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Goal 1. An Agricultural System That Is Highly Competitive in the Global Economy

Overview *- Changing climate conditions, pests and prices make crop production a challenge. In addressing these challenges, NDSU specialists and researchers help the state's producers find ways to improve the profitability and sustainability of crop production.*

In 2004, North Dakota led the nation in production of spring wheat, durum wheat, oats, sunflower, barley, dry edible beans, canola, lentils, honey and flaxseed. The state ranks second in production of all wheat and rye; third in sugarbeets; and fourth in rye. Exports of North Dakota commodities and products are valued at more than $1.7 billion. Crop production is critically important to the economy of the Northern Great Plains. Cash receipts from crops provided more than 2.9 billion to the economic base of North Dakota in 2003. A short growing season and low rainfall limits diversification, yields and cropping potential. Still, North Dakota is one of the most agriculturally diverse states in the nation with more than 40 different crops grown.

Similarly, livestock production is big business in North Dakota, accounting for nearly 20 percent of total agricultural cash receipts--$870 million in 2003. And livestock production is the original value-added enterprise adding value to the state's abundant crop forage and rangeland resources. More than 44 percent of North Dakota's land use is associated with rangeland, pasture land and hayland. NDSU programs help producers cut costs, boost returns and fund new opportunities.

Since 1993, disease problems in hard red spring wheat, durum wheat and barley have increased dramatically and reduced acreage, yield and quality. As economic returns from the major crops were reduced, minor crops became increasingly important in North Dakota as producers sought to increase returns or incorporate additional crops into rotations to reduce insect and disease buildup. In North Dakota, lentil acreage increased from about 2,500 acres in 1993 to more than 100,000 acres in 2004. Dry peas increased from about 2,000 acres to more than 300,000 acres during the same period. Canola increased from 20,000 acres to 780,000 acres. North Dakota, despite its northern climate, has 3.75 million acres of soybean and 1.8 million acres of corn for grain production, which is greater than the acreage of barley, an older traditional crop in the region. Potato is the highest volume vegetable crop grown in the North Central region. Predominant cultivars grown include Red Norland, Dakota Pearl, and NorValley which were developed by the potato breeding program at NDSU. NDSU also is the lead U.S. institution for flax variety development and testing. Trials are coordinated throughout the region, including Canada.

NDSU researchers continue to develop genetically improved varieties of major crops as well. Those varieties possess improved agronomic performance and quality and have a major economic impact on the state and region through increased yield, improved disease resistance and quality and improved access to markets. Varieties released by NDSU in 2004 had an annual

economic impact based on increased yield alone of about $30 million annually. Alsen, released in 2000, was the first hard red spring wheat variety which combined high quality and good agronomic characteristics with Type II resistance to Fusarium head blight, a disease that has caused more than 100 million per year in losses to the HRSW crop. In addition to its impact in North Dakota, where it was sown on about 38 percent of the wheat acreage, the variety had an impact in South Dakota, Minnesota, and, Montana. In areas where wheat scab is a major problem, Alsen constitutes almost 60 percent of the spring wheat acreage. In 2004, NDSU-released hard spring wheat cultivars were grown on nearly 65 percent of N.D. spring wheat acreage. Other varieties were released for use by oat, durum, six-rowed barley, flax, soybean, and dry edible bean producers. The acceptance of the two-rowed barley "Conlon" as a malting variety will have a major impact on barley production in central and western North Dakota. The six-rowed barley variety "Drummond" has been accepted by the American Malting Barley Industry as a malting variety and will provide additional benefit to producers in the region. The recent release of several high quality and high yielding durum varieties has had a major impact in northwestern North Dakota and northeastern Montana. The oat variety "HiFi" released in 2001 by NDSU produces grain yield and quality equal to the highest yielding cultivars and the grain is 30 percent higher in soluble fiber concentration than other cultivars, a valuable health trait for human diets. Dry bean cultivars developed at NDSU are the dominant cultivars grown in the region. "Norstar" navy bean is grown on 30 percent of the acreage while "Maverick" pinto bean exceeds 50 percent. These cultivars exceed over $50 million in 2002 in North Dakota alone. Genotypes developed in this program have reduced the fungicide use in the region resulting in less input costs and less pesticide in the environment.

In addition, scientists have focused on improved crop management. The micro-rate system herbicide application system has been widely accepted by sugarbeet growers in North Dakota and Minnesota and shows potential for use in other cropping systems. Average savings per acre of micro-rate application in sugarbeet was $20 with a total industry cost savings of $39 million. The micro-rate system in corn weed control will reduce herbicide costs in North Dakota by $16 per acre annually. This herbicide application method will both increase net economic income and reduce herbicide use.

Extension specialists and researchers in southwestern North Dakota developed a demonstration using a soil fumigant to show producers yield and quality losses that can be expected in continuous wheat, wheat every other year and when at least a two-year break occurs between wheat crops. Producers who are including a two-year break in their crop rotation are seeing an increase in gross income of $36 per acre when wheat is grown in comparison to continuous wheat. Producers are also financially benefitting from alternative/specialty crops seeded during the two years between wheat crops. Some producers have reported up to $40 per acre return on specialty crops grown. Producers have also learned they can produce yields comparable to and sometimes greater than those from fallow. Fallow acreage in southwestern North Dakota has declined by 604,000 acres since the demonstration was initiated. In addition, wheat and barley acreage has decreased by 300,000 acres each, indicating that fewer acres of continuous wheat and barley are being sown.

NDSU specialists work directly with producers to improve their farms. The North Dakota Dairy Diagnostic program helps producers assemble teams of experts that will help identify key roadblocks to production and profitability. The program's intent is not only to enhance dairy farm profit, but to develop strategic alliances between the dairy and its many providers. Additional benefits include: methods of evaluating business growth, establishing long-term business relationships, reducing professional barriers, and improving communication with business partners. Fifty-five farms have participated. On one farm, herd changes resulted in an increase of 9 pounds of milk per cow per day, an increase in income of more than $20,000 for this 50-cow herd. Another farm implemented changes that dropped somatic cell counts with a result of more than $4,000 in higher milk incentives. Another farm decided to add an additional 46 head to better use their dairy facility resulting in an increased gross annual income of $140,000.

In the summer of 2002, West Nile Virus spread across the Upper Great Plains. In North Dakota, 579 horses were affected and 35 percent of those died. In the winter and early spring of 2003, a major education initiative was conducted by the extension service including county agents, private veterinary practitioners and the extension veterinarian. The major focus of the education initiative was appropriate vaccination of horses. In 2004 the surveillance system and education program was continued. A second outbreak has not occurred and for the longer term, West Nile Virus will now be considered endemic and will become a routine vaccination protocol.

The NDSU Extension Service showed that it cost up to 3 cents less per pound to finish cattle in North Dakota compared to an out-of-state feedlot. Extension information prompted a group of cattle producers to pool funds and custom feed more than 7,000 head in North Dakota feedlots. With help from extension specialists and agents, they realized a return of more than 31 percent within one year. Another group built a 7,000-head feedyard in Bowman County. Other producers will earn a premium of up to 3 cents per pound for cattle that meet processing specifications of a new local processing company. More than 350 producers attended extension feedlot schools in the last four years. One participant estimated that better health practices, bunk management and feeding practices cut cost of gain by up to 5 cents per pound. Another participant has increased the number of cattle owned for feeding from 1000 head to 5000 head through the use of custom feedlots.

A North Dakota Reserve Veterinary Corps was initiated. In 2003, twenty-four practitioners were trained and equipped through the Corps. The veterinary practitioners were trained in the use of laptops, GPS units and digital photography to be able to investigate unusual cases rapidly and send those findings electronically to any expert in the world for consultation and verification. This is a model program for the nation. Other states such as Maryland are organizing private veterinary response teams. Agents were familiarized with animal and plant diseases, trained in incident command and familiarized with the extension disaster recovery plan. County agents were not trained to be first-responders, but were trained to assist the county incident commander with education, communication, and recovery efforts.

Program 1: Competitive and Profitable Crop Production

Key Theme - Agricultural Profitability: Assessment of Minor Crops
Much of the agronomic assessment of minor crops is conducted at NDSU research extension centers located throughout the state and by one or two research projects located at the main station in Fargo. Efforts can be divided into minor crops, which involve both research and extension, and new crops, which typically involve research only because these crops are not commercially grown. Research and subsequent extension training on minor crops are typically directed toward answering producers' problems. These include variety evaluation for agronomic performance and quality, disease and insect resistance and information on agronomic practices including stand establishment, weed control, harvesting procedures and storage. Agronomists, plant pathologists, entomologists and extension personnel located at the research extension centers and at the main station and cereal scientists at the main station are involved in all aspects of the work. One of the major factors that limit the production of new crops is that available varieties are not adapted to the region's growing conditions and markets are not always available.

Impact: Since 1993, disease problems in hard red spring wheat, durum wheat and barley have increased dramatically and reduced acreage, yield and quality. As economic returns from the major crops were reduced, minor crops became increasingly important in North Dakota. Acreage of crops such as peas, canola, crambe and lentils, all of which were considered minor crops just a few years ago, became major crops as producers sought increased economic gains or attempted to incorporate them into rotations in an effort to reduce the insect and disease buildup that developed under the more monoculture system.

Impact in North Dakota and neighboring states is demonstrated by the changes in acreage. In North Dakota, lentil acreage increased from about 2,500 acres in 1993 to more than 100,000 acres in 2004. Dry peas have increased from about 2,000 acres to more than 300,000 acres during the same period. Canola increased from 20,000 acres to 780,000 acres. North Dakota, despite its northern climate, has 3.75 million acres of soybean and 1.8 million acres of corn for grain production, which is greater than the acreage of barley, an older traditional crop in the region. Potato is the highest volume vegetable crop grown in the North Central region. Predominant cultivars grown include Red Norland, Dakota Pearl, and NorValley which were developed by the potato breeding program at NDSU. NDSU also is the lead U.S. institution for flax variety development and testing. Trials are coordinated throughout the region, including Canada.

Source of Federal Funds: Smith-Lever and Hatch

Scope of Impact: Multi-state integrated research and extension, MN and MT

Key Theme - Plant Production Efficiency: Develop Management Strategies to Sustain Crop Productivity
Research on methods of correcting iron deficiency chlorosis in soybean by soil scientists indicated genetic selection and development of adapted varieties was the most important method of control, followed by increased seeding rate. Seed treatments were found to be ineffective. In another area of research, significant efforts have been made to reduce the amount of herbicides

applied for weed control. The technique is called micro-rate application and consists of using an adjuvant to increase the activity of the herbicide along with a reduced herbicide rate (for example: 1/8 the rate recommended by the chemical companies). Applications are made two to three times during the season. The end result is a reduction in herbicide costs to the producers and reduced amounts of total herbicide use, resulting in a more environmentally friendly agricultural production system.

Impact: Because varietal sensitivity is the most important factor influencing iron chlorosis in soybeans, pre-screening of experimental lines by soil scientists in cooperation with plant breeders will eliminate sensitive material from being released for commercial products. Because the varieties developed are adapted to North Dakota and to a lesser extent to South Dakota and Minnesota, the research will have regional impact. The micro-rate system has been widely accepted by sugarbeet growers in North Dakota and Minnesota and shows potential for use in other cropping systems. Average savings per acre of micro-rate application in sugarbeet was $20 with a total industry cost savings of $39 million. The micro-rate system in corn weed control will reduce herbicide costs in North Dakota by $16 per acre annually. This herbicide application method will both increase net economic income and reduce herbicide use.

The development of pesticide adjuvants has directly led to increased pesticide efficiency and reduction in applicator rates. The application technology program at NDSU had led to reduction in spray volume and nozzle design which greatly increase application efficiency, reduce risk from pesticide drift, and decrease environmental concerns.

Source of Federal Funds: Smith-Lever and Hatch

Scope of Impact: Multi-state integrated research and extension, MN

Key Theme - Plant Production Efficiency: Developing Hard White Spring Wheat, Specialty Wheat and Sawfly Resistant Wheat

North Dakota spring wheat producers require an alternative to the traditional hard red spring wheat. Specialty spring wheats must have improved agronomic, quality, and pest resistance characteristics.

Goals of the research project are to develop white, specialty, and sawfly resistant wheat varieties for North Dakota and the surrounding region. There is increased interest in the production of specialty wheats and a federal government incentive plan to encourage production of hard white spring wheat.

Research to help develop specialty wheat genotypes with resistance to Fusarium Head Blight (FHB), surveying spring wheat genotypes for the presence of waxy starch mutations and their possible use in specialty wheat genotypes, and comparing the use of a molecular markers and marker-assisted selection for high grain protein with phenotypic selection for high grain protein in specialty wheat genotypes are all part of the goals. FHB research involved the continued rapid development of specialty spring wheats with diverse sources of FHB resistance. Hybrids were

produced between 'Alsen', ND2710, ND2829, ND2831, and ND2891, all with the 'Sumai 3' source of FHB resistance, and white-kernel spring wheats, high grain protein spring wheats, and waxy spring wheats. Double-haploid (DH) lines were produced from these hybrids and seed was increased in an off-season nursery in New Zealand. Several of these putative FHB resistance DH lines were grown in statewide advanced yield trials to determine their agronomic adaptation to North Dakota. Three full-waxy spring wheat lines were developed for possible release as specialty spring wheats. The full waxy genotypes were confirmed by using molecular markers for the waxy mutations and by staining seed with iodine. Indirect selection for advanced lines with resistance to the wheat stem sawfly was practiced by rating lines for stem-solidness at North Dakota locations and testing lines under severe sawfly infestation in Flaxville, MT. Including control genotypes, twenty-five advanced lines were rated for stem-solidness and evaluated for resistance to the wheat stem sawfly under natural infestation.

Impact: One DH line developed from the FHB research, NDSW0345, is especially promising because it has a white kernel color, resistance to the wheat stem sawfly, and it exhibited FHB resistance because of its Alsen source of resistance. Preliminary yield tests indicated that at least one of the full-waxy lines yielded as well or significantly higher than red spring wheat controls. A release of one or more of these waxy lines is anticipated if additional yield tests confirm their adaptation and yield competitiveness. One line developed from the sawfly research, NDSW0246, exhibits a semi-solid stem, moderate sawfly resistance, and consistently higher grain yield compared to other solid stem spring wheat genotypes. It has been approved for pre-release and will be proposed for release as a sawfly resistant spring wheat variety in January 2005.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state.

Key Theme - Plant Production Efficiency: Durum Wheat and Pasta Quality

Growing environment can affect the quality of durum wheat and subsequent end-use products. New tests are needed to evaluate the quality of durum wheat for pasta. The effect of growing environment during grain maturation on the quality of durum wheat and pasta will be studied. Additionally, the suitability of alveograph and gluten index as predictors of durum wheat quality for pasta will be explored.

Quality of durum wheat harvested in 2004 from Montana and North Dakota was determined from 193 samples. The average crop grade was U.S. No. 1 hard amber durum, with 80.3 kg/hl test weight, 1.2% total defects, and 89% vitreous kernel content. Research was conducted to determine the effect of damp conditions prior to harvest on quality of durum wheat. Results from 10 cultivars indicate that dry, mature kernels in spikes that are exposed to moisture will hydrate and expand in size. The hydrated kernels did not constrict to their original size during subsequent drying. The lack of constriction resulted in a nonvitreous appearance of the endosperm. Vitreous kernel content decreased 33% to 75%, depending on the cultivar. In a separate experiment, kernel size, test weight, kernel weight and vitreous kernel content were smaller, and SDS micro sedimentation value and gluten index were greater for grain harvested

from wheat that had been cut when kernel moisture content was 40% or 50% compared to grain harvested from wheat that had kernel moisture content of 20 or 30%. Quality was similar for grain harvested from wheat that had been cut when kernel moisture was 20% or 30%. Kernel weight, kernel size, and vitreous kernel content were greatest for grain that was harvested from standing wheat, intermediate from standing wheat that had been treated with glyphosate, and least from windrowed wheat. Protein content was not affected by harvest treatment. Research was conducted to evaluate processing properties of semolinas that varied in gluten strength. Strong-gluten semolina required more specific mechanical energy to be transferred to the dough during extrusion and resulted in a higher temperature of extruded spaghetti than did weak-gluten semolina. The spaghetti made with strong-gluten semolina had greater mechanical strength and had greater cooked firmness than spaghetti made with weak-gluten semolina. Two semolinas that had strong gluten properties based on gluten index and mixograms differed in their extrusion properties. These results indicate that gluten qualities other than those detected by traditional tests are affecting pasta extrusion.

Impact: Traditionally, durum wheat grown in the northern Great Plains has been cut and windrowed to promote the desiccation of green vegetation and reduction of kernel moisture prior to harvest. Damp conditions before harvest are detrimental to durum wheat quality. During damp conditions, quality deteriorated more quickly for grain harvested from cut/windrowed wheat than for grain harvested from standing wheat. Research indicated that durum cultivars differed in their tolerance to damp conditions prior to harvest. If similar results are obtained in subsequent tests, this information could aid durum producers in cultivar selection and could be used in cultivar development. Research also indicated that traditional measures of gluten or dough strength were not adequate in predicting extrusion properties of semolina. Extrusion properties of semolina would be an economic concern of the pasta processing industry. Information on crop quality is important for marketing durum wheat to domestic and foreign buyers.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state.

Key Theme - Plant Production Efficiency: Evaluation of Hard Red Spring and Hard White Spring Wheat Quality in Relation to End-Use Functionality

Limited information is available regarding the quality requirements for certain specialty wheat-based products such as frozen doughs and Asian noodles. Cultivars with specific starch and protein characteristics are responsible for imparting desirable quality traits. The proposed project is aimed at identifying interesting genotypes from our existing pool of HRS and HWS wheat lines that could then be developed into high quality cultivars that could be sold in an identity-preserved basis for use in a wide selection of wheat-based products other than leavened bread.

As part of our ongoing effort to understand the role of starch in bread staling, baking characteristics and staling properties of breads made from different blends of normal and waxy hexaploid and tetraploid flours were investigated. When starch is composed primarily of amylopectin, it is referred to as 'waxy' starch. Waxy hexaploid and waxy tetraploid wheat flours

were blended with a non-waxy control HRS flour at levels of 20%, 30% and 40%, baked into pan breads, and evaluated after 0, 1, 3 and 5 days of storage. On day 1, all waxy blends exhibited similar or lower crumb firmness than the control. However, on day 5, the waxy blends displayed some shrinkage, which manifested as higher firmness than the control. Results indicated that types and concentrations of waxy flour blends have a significant effect on the loaf and staling characteristics of pan bread. In another related study, using a gel model instead of a bread system, it was validated that the firmness of gels made from waxy wheat genotypes were inversely proportional to the amylopectin content, thus confirming the potential influence of amylopectin on retarding bread staling during storage. As part of the ongoing mission of expanding potential niche markets for value-added HRS and HWS wheats, a new study has been initiated to understand the role of flour starch and protein quality characteristics in producing high quality wheat tortillas. The viability of using flaxseed flour as a functional/nutraceutical ingredient in wheat flour tortillas is also being evaluated. Preliminary research indicates that: 1) flaxseed decreases the brightness of the tortillas compared to the control; however, the color does not decrease further during storage, and 2) ground flaxseed concentration of 15% and higher results in tortillas that firm at a slower rate relative to the control. Research is underway to determine the influence of packaging material, and exposure to light and oxygen on the oxidation rate of flaxseed-composite wheat flour tortillas during storage at room and refrigerated conditions. Data obtained from this study will help optimize the packaging conditions so as to retard rancidity and extend the shelf-life of tortillas containing ground flaxseed.

Impact: The potential use of wheat starch with reduced amylose content is a current focus of interest among wheat breeders, geneticists and cereal scientists. Waxy and partial waxy wheat offer unique starch functional properties that might extend the use of wheat in many food and non-food applications. Moreover, in order for spring wheat growers to be positioned for maximum economic benefit, they need to market a product that commands premium payments based on end-use quality to a growing grain-based industry. Results from these studies will assist N.D. producers in developing niche markets for value-added wheat varieties grown for specific end-use applications.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state.

Key Theme - Agricultural Competitiveness: Increase the Agricultural Producer, Consumer, Government and Social Sector Awareness, Understanding and Information Regarding Agricultural Systems

Extension specialists, with assistance from research scientists, developed several programs to describe varieties, production and maintenance practices and products available. These programs are designed to address problems by the urban and rural client. Information on the global economy and the opportunities and pitfalls associated with it are being provided. Information that involves case studies of real situations is being taught in classrooms. The objective is to stimulate independent thinking and develop teamwork by asking students to address problems that require the interpretation of concepts from several disciplines.

Impact: Clientele of the NDSU Extension Service and the North Dakota Agricultural Experiment Station are well served by the faculty and staff of the Plant Sciences, Soil Science, Entomology and Agricultural and Biosystems Engineering Departments. All faculty, both research and extension, provide current and unbiased information to specific producers and commodity and business groups upon request. In addition, information on general problems, practices and procedures are available to the general public for farm, rural, urban, commodity and private industry.

For instance, a computer program known as Weed It, (weed information transfer), has been developed to summarize more than 30 years of weed control research results. A land manager can determine the optimum weed control methods by entering known variables such as crop, weed species and growth stage, soil type, etc. The program then shows the user chemical and cultural control options, expected cost and potential affect on yield. The Pesticide Program at NDSU routinely trains 1,500 to 2,000 commercial and private applicators per year in the proper handling and application of crop and home use pesticides. This program is recognized nationally for the high quality of its training programs and the resulting outstanding safety record for pesticide use in the state. More than 25,000 commercial and private applicators have been trained by this program.

Today, food production is global in nature. For some producers, especially older ones, this can often be a difficult concept to comprehend and special efforts must be made to strengthen the concept that rainfall patterns in South America, drought in Australia, etc., have a major impact on them. Updated information must continually be provided for the producer to make sound business decisions.

Several undergraduate classes include case studies where students work in teams to solve or help provide information to solve problems. These problems are often quite complex and require a blending of several disciplines into the development of a final solution. Many of the case studies are taken from problems posed to research and extension faculty from private industry, consultants, commodity groups and research extension centers. Several methods of information dissemination are used, including radio, television, magazines and newspapers, the Internet, consumer service and printed material. In addition, numerous phone calls are received by faculty and staff who are directly accessible. The case studies help students learn to reason out and solve a diversity of problems.

Source of Federal Funds: Smith-Lever and Hatch

Scope of Impact: Multi-state integrated research and extension, MN, MT and SD

Key Theme - Plant Germplasm: Genetic Improvement of Major Crops

The North Dakota Agricultural Experiment Station has breeding and genetic research programs in most of the region's major crops with the goal of releasing new varieties or develop genetic materials for use by other programs. Germplasm from these research programs is shared with public and private breeders worldwide. In sunflower and sugarbeet, which are also major crops,

germplasm is released by the USDA for use by private and public breeding programs. USDA scientists provide basic genetic information and, in some cases develop and provide germplasm to assist the NDSU breeding programs. In some crops, the USDA coordinates regional trials that allow plant breeders to determine the adaptability of their genetic material across a wide range of environments outside North Dakota. The NDSU plant breeders and cereal scientists, located in the Department of Plant Sciences, cooperate with their counterparts in the departments of Plant Pathology, Entomology and the research extension centers in varietal development and genetic research. Crosses made by breeders are evaluated for agronomic characteristics by breeders, for quality characteristics by cereal scientists and for disease and insect resistance by plant pathologists and entomologists. Based on that information, breeders make decisions on which material to discard and which to move forward in the program. The extension service has a major role in educating the producers about new varieties.

Impact: Genetically improved varieties that possess improved agronomic performance and quality have a major economic impact on the state and region. Varieties that have increased yield and improved disease resistance and quality provide producers with the opportunity to increase their economic potential through wider accessibility to markets and improved prices. The genetic improvement of major crops requires research effort by the scientist and subsequent dissemination of the knowledge to producers, product purchasers and end users of the finished product by extension personnel. Extension efforts are directed at the state, county, national and international levels.

Several new and improved crop varieties were developed and released using conventional methods of plant breeding. Some of these varieties have increased yield because of improved disease resistance, especially head, kernel and leaf disease resistance, while other releases have improved agronomic and quality factors and sometimes insect resistance. Examples include: greater test weight, kernel size and higher protein for wheat; improved milling extraction percentage and lower protein in barley for malting; increased fiber level in oat for human consumption; specific oat varieties for race horses; hulless oats for improved livestock feeding efficiency, soybean with greater adaptation to North Dakota environments, and flax with greater disease resistance and improved quality.

Varieties released by NDSU in 2004 had an annual economic impact based on increased yield alone of about $30 million annually. Alsen, released in 2000, was the first hard red spring wheat variety which combined high quality and good agronomic characteristics with Type II resistance to Fusarium head blight. This disease has caused over 100 million per year in losses to the HRSW crop. In addition to its impact in North Dakota, where it was sown on about 38 percent of the wheat acreage, the variety had an impact in South Dakota, Minnesota, and to a lesser extent, Montana. In areas where wheat scab is a major problem, Alsen constitutes almost 60 percent of the spring wheat acreage. Dapps was released in 2003 and had excellent quality with average yield and test weight. In 2004 “Steele-ND”, a HRSW variety with wheat scab resistance from a different source than Alsen, was released. In 2004, NDSU-released hard spring wheat cultivars were grown on nearly 65 percent of N.D. spring wheat acreage.

Other varieties were released for use by oat, durum, six-rowed barley, flax, soybean, and dry edible bean producers. The acceptance of the two-rowed barley, "Conlon", as a malting variety will have a major impact on barley production in central and western North Dakota. The six-rowed barley variety Drummond has been accepted by the American Malting Barley Industry as a malting variety and will provide additional benefit to producers statewide. The benefits will also be felt in Minnesota and South Dakota to a lesser extent. The recent release of several high-quality and high-yielding durum varieties has had a major impact in northwestern North Dakota and northeastern Montana. The education of producers about the strengths and weaknesses of new varieties is a primary function of the extension service. A typical crop variety lasts five to six years, at which time it is probably replaced by another that possesses improved agronomic characteristics, quality, or yield. If the variety finds a niche area or market, it can last much longer. As a result, there is a continual need for programs to provide producers the option to select those varieties that best fit their needs from public and private breeding programs. NDSU is the only public institution that develops corn inbreds adapted for use by industry in the northern plains region. This program has greatly increased corn germplasm for hybrids adapted to the northern region. NDSU lines are distributed elsewhere in the United States and world for evaluation.

The oat variety "HiFi" released in 2001 by NDSU produces grain yield and quality equal to the highest yielding cultivars and the grain is 30 percent higher in soluble fiber concentration than other cultivars. The increased soluble fiber content is a valuable health trait for human diets. The variety Beach, which has an improved product for the race horse feed industry, was released in 2004.

Dry bean cultivars developed at NDSU are the dominant cultivars grown in the region. "Norstar" navy bean is grown on 30 percent of the acreage while "Maverick" pinto bean exceeds 50 percent. These cultivars exceed over $50 million in 2002 in North Dakota alone. Genotypes developed in this program have reduced the fungicide use in the region resulting in less input costs and less pesticide in the environment.

Fusarium head blight (FHB) has reduced barley production in the region in both quality and quantity. NDSU researchers currently have several lines with resistance to (FHB). The release of a FHB resistant variety will have a major impact on barley production, especially in eastern and central North Dakota.

Source of Federal Funds: Smith-Lever and Hatch

Scope of Impact: Multi-state integrated research and extension, SD, MN and MT

Key Theme - Plant Germplasm: Corn (Zea Mays L.) Breeding in the Northern Corn Belt
The record corn production of the past years in North Dakota is limited by growing degree units, length of growing season, and lower than ideal rainfall patterns. Therefore, N.D. corn producers need improved corn varieties adapted to the northern Corn Belt where the seed industry is not fully developed.

Planted acreage was approximately 2 million acres in 2004, a new record for the state. ND lines have been distributed to more than 20 companies nationally and internationally. The development of inbred lines from exotic maize populations to North Dakota has begun. These lines have passed early generation testing with one and two testers across several N.D. locations as well as visual screening across six environments. Test-cross seed of early generation lines with one commercial tester, including selected genotypes from recurrent selection programs, was harvested in Santiago, Chile in 2003-2004. As a result, approximately 500 S2 lines were tested in replicated trials across three ND locations. We have developed genetic materials that will determine the usefulness of GEM material in the northern Corn Belt. Late-temperate and tropical derived maize germplasm are already adapted to North Dakota based on the efforts involved in our EarlyGEM project. Data across environments showed that 20% (45) of population hybrids evaluated were not different ($P< 0.05$) from at least one commercial hybrid for grain yield performance as well as for root lodging and stalk lodging percentages. Commercial hybrids were also lower ($P< 0.05$) in grain protein content than improved populations.

Impact: This maize-breeding program is the only public U.S. program developing very early maturing populations, inbred lines and hybrids. The genetic diversity of early maturing germplasm adapted to North Dakota and its challenging environment is unique and, therefore, very valuable. With the adaptation, development and improvement of this germplasm, we contribute to the genetic diversity of corn in the U.S. northern Corn Belt as well as its movement northward. Breeding efforts toward maize population hybrids at NDSU have demonstrated that germplasm improvement is extremely valuable for a sustainable productivity.

Source of Federal Funds: Hatch

Scope of Impact: Northern Corn Belt

Key Theme - Plant Germplasm: Breeding and Genetics of Flax

ND produces more than 90% of the flaxseed in the United States. The value of the flaxseed crop in ND is estimated at $45 million per year. In recent years, the United States has been a net importer of flaxseed. At present, the only flax breeding and genetics program in the United States is at the N.D. Agricultural Experiment Station. The value and markets for flaxseed as a healthy food continues to develop. A major baby food manufacturer will be adding an enriched Omega-3 product to its products. Research with flaxseed as a feed for beef cattle has generated renewed interest.

The primary objective is to develop and evaluate genetic material to improve yield potential while maintaining resistance to pests, maintaining oil content and oil quality, and maintaining other agronomic characteristics for potential cultivars. Because producers have historically planted later than would be expected to produce greatest yields, a part of the breeding effort will be devoted to evaluation at a delayed seeding date. With the interest in flax as a human food, a minor effort will continue to evaluate material with a yellow seed coat color which is preferred for "eye appeal."

The regional flax nursery was seeded at six locations in ND, with both early and late seedings at Fargo, for yield and other agronomic evaluations. A nursery was planted and evaluated on historic 'Plot 30' for wilt tolerance. Two yellow-seeded lines were continued in 2003. In 1998 the USDA-ARS discontinued research in flax and regional responsibility for coordinating an advance variety trial for the North Central Region (including Canada) was transferred. Results of the World Collection Cd evaluation was completed - crosses were made for planting in 1999-2000. As a result of poor water quality, crosses planned for the fall greenhouse were not successful. Several crosses were completed in the spring greenhouse 2000. Crosses made in the spring greenhouse were not seeded in the field in 2001. In early June 2004 the seed was returned to Fargo as a result of lack of funds. Plans are being made to grow the material in the greenhouse in the winter of 2004-2005.

Impact: North Dakota is the primary production area for flax in the United States. This project develops flax varieties that are higher yielding with disease resistance, high oil content, and high linolenic acid content. Demand for flax seed is increasing. Increased production continued in 2004.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Plant Germplasm: Wheat Germplasm Enhancement

Wheat yield is reduced each year by infestation of various fungi, bacteria, viruses and insects. DNA marker technologies are being used in the wheat germplasm enhancement project to accelerate identification and transfer of genes from wild and related wheat species into adapted germplasm of durum, hard red spring, and hard white spring wheat.

Fusarium head blight (FHB) is a fungal disease of small-grain crops that causes yield loss and poor grain quality. Molecular markers were used to introgress the linked region from resistant species/cultivars into cultivated durum and hexaploid wheat. A molecular study of Wangshuibai, a resistant source from China, has been completed and we are in the process of transferring the newly identified resistant regions. Chromosome asynapsis and hybrid sterility are major obstacles to alien gene transfer, and genes affecting nuclear-cytoplasmic (NC) interactions are directly or indirectly involved. As a lead institution on a large project designed to develop reverse genetic resources in wheat, we have generated nearly 10,000 mutagenized populations in Triticum monococcum and are now characterizing these lines for mutations in important genes.

Impact: This project's focus is developing durum and bread wheat lines better-adapted to North Dakota's growing environment and tolerant to prevalent diseases. The ultimate aim is to provide N.D. growers wheat crops with new commercial applications for increased premiums.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Plant Germplasm: Development of Potato Cultivars for North Dakota Utilizing Germplasm Enhancement and Selection

About 60% of potato production is used for frozen processing and dehydration. Potatoes are produced for a variety of end uses. Diseases and insects present challenges for producers and require chemical inputs as resistant cultivars are unavailable. Stress resistance and quality continue to be issues for the industry. Researchers focus on germplasm enhancement, identification of superior genotypes, and development of multi-purpose cultivars with improved pest and stress resistance, enhanced nutrient-use efficiency, and superior quality that meet consumer needs.

Approximately 105,660 seedlings representing 582 families, were produced in the greenhouse; 35%, 22%, and 17% of the families had one or both parents exhibiting resistance to late blight, cold-sweetening, or Colorado Potato Beetle, priority pests/stresses for resistance breeding. Approximately 71,193 ND and 20,037 out-of-state first-year clones were evaluated in the field; 1,350 were retained. Approximately 501 second and 408 third year and above, selections were evaluated in the field; 739 were retained. Seedling tubers were shared with programs in Idaho, Texas, Michigan, Minnesota and Wisconsin. Eighteen yield trials were grown at 5 locations (3 irrigated and 2 dryland sites), including early and full season trials for all market classes of potato. A specialty trial and chip trials under irrigation were new. Five selections were evaluated for disease reaction to bacterial ring rot in the field, but did not develop tuber symptoms although assays indicated high levels of pathogen present. Twenty-two selections were evaluated for resistance to pink rot and leak. Thirty-six selections were screened for resistance to late blight in the field and many expressed resistance. Approximately 3,322 seedlings representing 25 families were evaluated in the greenhouse for resistance with a detached leaf assay procedure using a suspension of Phytophthora infestans isolates, representing all 11 known virulence genes. Overall, 2.8% of individuals from these directed late blight hybridizations exhibited some level of resistance to P. infestans. Naming and release are anticipated in 2004 of ND3196-1R; this superior selection is a round, dark red-skinned, fresh market type that produces a high percentage of marketable tubers, maintains color in storage, has long dormancy, and has excellent culinary quality. Grower evaluation and interest has been excellent.

Impact: Potatoes were produced on about 120,000 acres in North Dakota in 2002 (NASS, 2002). Predominant cultivars include Russet Burbank, NorValley, Shepody, and Red Norland. NorValley is a 1996 release, and Red Norland, a 1957 release, from the ND potato breeding program. In 2002, about 1,880 acres were eligible for certification with the North Dakota State Seed Department, making North Dakota the second largest seed producer in the United States (NASS, 2002). In 2003, more than 33% of North Dakota certified seed potato acreage was planted to cultivars and advanced selections from the NDSU potato breeding program. Advancing selections continue to gain in popularity. ND2470-27 had more than 39 acres entered for certification in ND, ND5822C-7 was initiated at 1.1, and there were 11 acres of ND3196-1R certified in ND and 11 more in MN in 2003. While some will be retained for seed increase, some will be used for commercial production and evaluation in 2004.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Plant Germplasm: Hard Red Spring Wheat Improvement
In changing wheat production and export market environments, developing new adapted HRSW cultivars with acceptable agronomic and quality characteristics to replace non-adapted cultivars is essential to sustain future wheat productivity in North Dakota. This project aims to develop and provide wheat growers in North Dakota with new adapted HRSW cultivars that will meet their needs and the wheat industry and export market requirements.

Elite and improved germplasm from NDSU HRSW and introduced material from many spring- and winter-wheat breeding programs worldwide, and from various collections will be evaluated on an ongoing basis for desirable agronomic, pest resistance and quality characters. Selected genotypes will be used to cross with North Dakota adapted spring wheat germplasm for sexual recombination to develop breeding populations from which advanced lines leading to variety release will be identified.

Impact: NDSU-released hard red spring wheat (HRSW) cultivars continue to dominate the overall acreage grown to wheat in North Dakota. In 2004, more than 50 percent of N.D. acreage was grown to Alsen, Reeder, and Parshall. Dapps, released in 2003, is steadily gaining acreage. Dapps is an excellent high quality cultivar with average yield and test weight. It has a good package of resistance to foliar diseases but is susceptible to Fusarium Head Blight. In 2004, Steele-ND which combines a good level of resistance to FHB, high grain yield and high end-use quality for the domestic and export wheat markets was released. The release of new improved HRSW cultivars with high quality enhances N.D. wheat production and marketability of the grain produced. The use of genetic pest resistance and stress tolerance aids the stability of production for producers' economic return and for export market development, while protecting our environment and natural resources.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Ornamental/Green Agriculture: Woody Ornamental Evaluation
Researchers evaluate hundreds of woody plants for performance and hardiness in North Dakota. Researchers are beginning the fifth year of evaluations on 100 cultivars of flowering crabapple and those evaluations will lead to significant revisions in recommendations made to nurseries, landscape companies and their clientele. Evaluations were made on more than 390 other woody accessions, many at multiple sites in the state. NDSU researchers collaborate in national and regional nursery plant evaluation programs. Sixty-nine new accessions were added to state-wide trials in 2003.

Impact: NDSU has released 31 superior woody landscape and tree cultivars in recent years and several more are nearing release. The inventory of hardy plants for production and sale in the

industry and use by landscape architects/designers, developers, city arborists, foresters, horticulturists, parks, golf courses, conservation and the public has increased markedly. For instance in 2003, commercial inventory in the region was selected largely based on recommendations from NDSU's program and its collaboration with researchers across the region. Evaluation reports on more than 100 cultivars were submitted to nurseries in 2004.

Four superior winter hardy woody plants were named and introduced. Prairie Expedition(TM) American Elm-Ulmus americana 'Lewis & Clark' is a rapid growing, umbrella-crowned clone with apparent high resistance to Dutch elm disease. Prairie Spirit(TM) Juniper-Juniperus x 'Bison' is a joint NDSU-University of Nebraska-Lincoln introduction. Its striking mature foliage is brilliant green contrasting with gray-blue juvenile growth, creating a bicolor effect. Plants grow 1 to 1 3/4 feet in height with a dense, attractive spreading form. Silvery-blue, berrylike cones contrast markedly with the foliage. Prairie Refection(TM) Laurel Willow-Salix pentandra 'Silver Lake' has shown high survival rate throughout North Dakota, improved adaptation in alkaline pH soils, a dense, rounded form and very dark green, highly glossy foliage quality. Prairie Stature(TM) Oak - Quercus x bimundorum 'Midwest' is being introduced by NDSU in collaboration with the USDA-ARS, North Central Regional Plant Introduction Station, Iowa State University, Ames, IA. This hybrid oak is characterized by quality emerald-green, semi-glossy, leathery foliage, red autumn coloration, retention of tannish leaves into winter, and a fairly dense pyramidal growth habit.

Source of Federal Funds: MacIntire - Stennis, Hatch and Smith-Lever

Scope of Impact: Multi-state integrated research and extension, MN and SD

Key Theme - Agricultural Competitiveness: County Cropping Systems
Extension staff developed a comprehensive program to provide LaMoure County producers up-to-date and local information on cropping systems while helping them make transitions from one crop to another with as little negative impact on profitability as possible.

To help producers with information on soybeans, small grain, and sunflower varieties, staff work with area groups and establish variety plots. An addition in 2004 was working with a few seed corn dealers in the county helping with establishment of corn comparison trials, while not quite set up in the traditional university trials these smaller plots across the county did provide corn producers with information on which corn hybrids do best in the area. Annual plot tours feature a review of varieties/hybrids and topics of interest to producers, such as insect problems, crop rotations, production practices, markets, herbicide comparisons and plant population studies. After the plots are harvested, data is disseminated to producers in LaMoure and neighboring counties. Results are published in the annual Crop Production Guide and variety trial bulletins. Throughout the winter meeting season, staff invite producers to area meetings to fine-tune their production skills.

Cooperating institutions and organizations: LaMoure County Extension Office, Allied Agronomy Services of Edgeley, Larson Grain Company, Witt Consulting of LaMoure, Dakota

Prairie Ag, Edgeley, National Sunflower Association, North Dakota Soybean Council, soybean and sunflower seed companies, NDSU oat breeder Mike McMullen, NDSU soybean breeder Ted Helm, NDSU Carrington Research and Extension Center, ADM Plant of Enderlin, LaMoure County Ag Improvement Association and producers Tom Kiecker of Edgeley, Dennis Feiken of LaMoure and Kerry Ketterling of Marion.

Impact: With more favorable prices and reduced problems with insects and disease, many producers were looking to switch from hard red spring wheat to soybean and corn production. Most had little or no experience growing these crops. Because of crop tours, workshops and seminars, most producers made the switch and successfully increased gross revenues. In 1994, LaMoure County had fewer than 9,000 acres in soybeans, 3500 aces in corn and more than 228,000 acres in hard red spring wheat and 187,000 acres of sunflowers. By 2004, soybean acreage had increased to more than 253,000 acres corn to just over 100,000 acres and hard red spring wheat acres had decreased to 80,000. Not only have soybean and corn acres increased, so have yields. In 1994 county soybean yield was 26.8 bushels per acre. In 2004 county soybean yield was 32.3 bushels per acre(would have been more but the cool weather hurt yields). Corn yield have also improved from 83.4 bushels per acre in 1994 to 110 bushels per acre in 2004 (again weather reduced yields).

The economic impact from this change in 2004 was approximately $5.5 million of additional gross revenue for LaMoure County producers.

Source of Federal Funds: Smith-Lever

Scope of Impact: State specific

Key Theme - Plant Health: Diagnosis and Management of Root Disease in Western North Dakota

The area extension cropping systems specialist, state extension plant pathologist and county agents in southwestern North Dakota developed a demonstration using a soil fumigant to show producers yield and quality losses that can be expected in continuous wheat, wheat every other year and when at least a two-year break occurs between wheat crops. Also, nitrate levels in the root zone were compared between fumigated and non-fumigated soils to illustrate the potential environmental impact that continuous wheat may have should nitrates leach below the root zone. These demonstrations were observed and discussed with producers at field days and county agricultural improvement tours. Presentations were developed and given to producer groups and were included in the NDSU Extension Service CD distributed to county agents across the state.

Cooperating institutions and organizations: North Dakota State University Extension Service, Montana State University Extension Service, Dickinson Research Extension Center, Hettinger Research Extension Center, county extension services and county crop improvement Associations in Adams, Golden Valley, Hettinger, Mercer, McLean, Morton, Oliver and Sioux counties and the Sustainable Agriculture Mini-grant Program administered by NDSU Extension Service.

Impact: Producers who are including a two-year break in their crop rotation increased gross income $36 per acre when wheat is grown in comparison to continuous wheat. Producers are also financially benefiting from alternative and specialty crops planted during the two years between wheat crops. Some producers have reported up to $40 per acre return on specialty crops grown. Producers have also learned they can produce yields comparable to and sometimes greater than those from fallow. Fallow acreage in southwestern North Dakota has declined by 604,000 acres since the demonstration was initiated. In addition, wheat and barley acreage has decreased by 300,000 acres each, indicating that fewer acres of continuous wheat and barley are being sown in this part of the state. In 1996, 72 percent of the wheat planted in southwestern North Dakota was on wheat, barley or durum stubble. Acres planted to other crops have increased. In 2002, 67% and in 2004, 65% of the wheat grown in southwestern North Dakota was grown on wheat, barley or durum stubble. These data would indicate that producers are increasing the use of crop rotations to improve efficiency in crop production. In 2003, producers utilizing good rotations to control soil-borne fungal diseases reported 80 bushels per acre of barley that met malting standards. Malting barley will bring about 50 cents per bushel premium or in this case, $40 per acre return over feed barley. In 2004, weather conditions over much of southwest North Dakota was dry but those producers utilizing good rotations experienced an increase in wheat yield of about 3 to 4 bushel per acre over continuous wheat rotations.

Source of Federal Funds: Smith-Lever

Scope of Impact: Multi-state extension, MT and SD

Key Theme - Plant Production Efficiency: Sunflower Date of Planting in Western North Dakota

The area extension cropping systems specialist and the Slope County extension agent developed a demonstration to show producers the effect that moving the planting date from late to early has on yield and quality of NuSun sunflower oil produced. In the three years that this demonstration has been conducted, plant stand establishment for late-April and early-May seeding dates was significantly lower than for sunflower planted after mid-May. Seed yields were greatest two out of the three years when sunflower was sown May 23. In terms of oleic content, a desirable fatty acid, mid-May to early-June planting was significantly higher than either the early seeding dates or planting dates after early-June. The information gained from the demonstration has been shared with producers during tours of the demonstration plot as well as at producer meetings. Several producers in 2004 planted sunflower in early May because the spring was dry. Loads from several of these fields were rejected because oleic content was low.

Cooperating institutions and organizations: Slope County Crop and Livestock Improvement Association, Slope County Extension Service, NDSU Extension Service, National Sunflower Association, North Dakota Board of Agricultural Research and Education, USDA Agricultural Research Service, Hettinger Research Extension Center, Dickinson Research Extension Center and Mycogen Seeds, Inc.

Impact: Twenty-three producers indicated they have adjusted sunflower planting dates to occur at or about May 23. It is estimated that these 23 producers increased income based on yield and quality factors by $35 per acre or a total of $241,500. In 2004, producers suffered losses from low oleic content because of early seeding. Producer losses included expenses for transportation of rejected loads and the difference between the contract price for oleic sunflower seed and the spot price for birdseed. This provided an opportunity to visit with producers about the impact of planting date on oleic content in seed.

Source of Federal Funds: Smith-Lever

Scope of Impact: Integrated research and extension

Key Theme - Plant Production Efficiency: Improving Forage Production and Quality in North Dakota

Alfalfa productivity is limited by poor management practices and variety selection. Soil subsidence caused by alfalfa production may be reducing productivity of subsequent crops. This project examines new management for forage crops, primarily alfalfa and determines if soil subsidence is detrimental to subsequent crop production.

Alfalfa forage yields were similar among 6-32 pounds per acre seeding rates across three production years with slightly higher yield at 32 pounds per acre the third year. Autotoxicity occurred each year (4-year experiment) on spring-tilled stands, but the days after tillage for maximum autotoxicity varied with year, which may explain reports of no autotoxic effects. Fall management experiments indicate that fall harvest may be possible any time in the fall if the alfalfa has reached 40-50% bloom or is initiating regrowth; is a persistent cultivar, and is well fertilized. Alfalfa forage yields have increased the past 4 years when harvest at very early bud, mid to late bud, 30-40% bloom, and 50% bloom during the first, second, third, and fourth harvest, respectively, compared to waiting for a killing frost to take the fourth. Roundup Ready alfalfa has performed adequately at Fargo during seeding and first years of production.

Impact: Selection of alfalfa cultivars by producers should be based on across-location averages rather than a local test site to remove harvest management effects that favors one cultivar over another. Alfalfa should never be established on an old alfalfa field due to autotoxicity without at least one other crop intervening. Decreasing the stubble height following hay harvest by two inches increased the seasonal forage yield by 1 ton per acre for a three-cut system.

Source of Federal Funds: Hatch

Scope of Impact: Statewide

Key Theme - Plant Health: Plant Diagnostic Lab in Southwest North Dakota

Growers and the agricultural industry expect fast and accurate response in identifying agricultural pests and potential pests. Proper identification of pest problems is important for

implementing effective corrective actions or avoiding costly and unnecessary pesticide applications. Five satellite plant diagnostic labs were initiated around the state of North Dakota.

Cooperating institutions and organizations: NDSU Extension Service, NDSU plant pest diagnostician, extension service plant pathologist, extension service entomologist and participating area extension specialists.

Impact: Thirty-seven agricultural problems were identified using the plant diagnostic equipment at the Dickinson Research Extension Center. An elevator brought in one insect that had originally been identified as a confused flour beetle. Under close examination with a stereoscope, the insect was identified as a fungus beetle and treatment of grain with a fumigant was avoided, saving the elevator $1,500. Wheat curl mites were identified on Wheat Streak Mosaic Virus (WSMV) symptomatic plants using the diagnostic equipment. In the summer of 2002, several producers lost entire fields or suffered yield and quality losses from WSMV. Seven producers are known to have delayed seeding of winter wheat, a recommended practice for the control of WSMV, because of the diagnosis. WSMV was not found in 2003 in fields where producers applied the recommended practices for controlling this disease. In 2003, adult Dectes longhorn beetles were identified using equipment in the Plant Diagnostic Lab. Pesticide applications are not an option for controlling this pest. It was recommended to the four producers who participated in the identification to not spray for the pest but to harvest early to avoid severe yield lost. Producers saved $11 per acre from ineffective pesticide applications on 800 acres of sunflower, reduced harvest losses from and saved an estimated 250 pounds per acre to 100 pounds per acre. Tan spot in spring wheat was identified early in 11 producer fields. It was recommended that the addition of a fungicide at $5 per acre be included with their herbicide applications. Producers claim that yields in treated fields were 3 to 5 bushels higher than untreated fields. These 11 producers treated a total of 6,000 acres of wheat for tan spot. In 2004, Tan spot was identified for 25 producers using the diagnostic equipment. Twenty-four of these producers included a fungicide with there herbicide. Even though the weather was dry, producers felt that they increased yield by 3 to 4 bushels per acre over their untreated fields. The diagnostic equipment was also used to identify mites and insects brought in by producers, IPM field scouts, and crop consultants. Identification of these pest problems provided the necessary information needed to make effective recommendations for 12 fields representing over 7,600 acres.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Innovative Farming Techniques: No-till Equipment Selection and Management Practices

The area extension cropping systems specialist, Hettinger County extension agent, NDSU extension agriculture engineer, and a Dickinson Research Extension Center scientist developed a demonstration no-till drill designed to incorporate the most current ideas known about the biology of seed germination and its response to the environment during early growth and establishment. John Baker, New Zealand inventor of the cross-slot opener, addressed the direct

seeding seminar. A demonstration was conducted in an indoor arena because of winter weather in November 2003.
Low-disturbance no-till demonstrations were held in cooperation with the Oliver County extension agent, Hettinger County extension agent, Dunn County extension agent and the Stark County extension agent in the summer of 2004. Presentations on no-till were given during county agriculture improvement summer tours and the Dickinson Research Extension Center Field Day including a presentation by Keith Saxton, Agriculture Research Service Scientist (retired), who discussed germination requirements and how equipment design affects crop stand establishment.

Fumigated plots in two locations provided an indication of the importance of beneficial microorganisms in soils during 2004. Corn, which is very dependent on arbuscular mycorrhizal fungi for supplying phosphorous and water showed severe phosphorous deficiency and yielded little. This has provided an opportunity to discuss with producers and the general public the importance of maintaining healthy, productive soils.

A PowerPoint presentation was developed in cooperation with the extension agronomist at the Carrington Research Extension Center on no-till system practices.

Cooperating institutions and organizations: Hettinger County Extension Service, Oliver County Extension Service, Dunn County Extension Service, Stark County Extension Service, North Dakota Barley Council, North Dakota Dry Pea and Lentil Association, Dickinson Chamber of Commerce and Agriculture, Dickinson Research and Extension Center, Carrington Research Extension Center, NDSU Extension Service.

Impact: The 2003 direct seeding seminar drew 225 producers. Three traveled from northeast Colorado to attend. Twenty-two producers from adjacent states attended. Of the producers surveyed after the program, 87 percent expressed the desire to learn more about low-disturbance seeding and to view a demonstration of various styles of drill openers. Five demonstrations using the cross-slot plot drill were conducted in 2004. The drill was shown to establish consistent stands of pea, oat, wheat, and flax in conditions that were drier and colder than normal. More than 300 producers viewed demonstrations and attended agriculture improvement tours and attend the field day in 2004. Producers from Canada, Montana, South Dakota, and the Ukraine as well as from North Dakota viewed the demonstrations. One producer indicated he switched from a high-disturbance direct seeding drill to a low-disturbance direct seeding drill based on his attendance of the previous year's direct seeding seminar and the summer of 2004 demonstrations. Producers who viewed the fumigated soil plots saw the importance of arbuscular mycorrhizal fungi particularly in corn. Producers have seen how no-till systems maintain these beneficial organisms and improve the soil's productive capacity and sustainability of cropping in southwest North Dakota. The PowerPoint presentation has been used for in-service training of six county agents. The program and portions of the program has been used to teach producers about no-till practices at county producer meetings as well as the Western Pest Management School.

Source of Federal Funds: Smith-Lever

Scope of Impact: Multi-state ND, MT, and SD

Key Theme - Plant Health: Development of Midge-Resistant Sunflower

Populations of the sunflower midge, *Contarinia schulzi*, are sporadic but in outbreak situations the midge severely impacts sunflower yield. Because insecticides have not been effective in controlling this insect, there is an emphasis on the development of resistant germplasm. However, unpredictable field populations of the midge have greatly limited progress in resistance development. To avoid reliance on field populations of the insect, a simulated damage assay was developed that uses plants grown to the reproductive stage to identify midge-tolerant germplasm. However, the assay has not been used to a large extent because it is costly in time, space, and labor requirements and treated plants are not suitable for later breeding trials. An improved simulated damage assay using seedling plants was developed. The seedling assay has the advantage of being fast, not requiring much space, and preserving the plants for later germplasm development.

Impact: Presently, sunflower growers experiencing midge infestations have no remedy. The most promising approach to managing midge damage is the development of midge-resistant hybrids. Resistance to the midge has been identified, but no midge resistance hybrids are available because of difficulties in identifying resistant germplasm. A quick and simple seedling assay was developed that will identify sunflower germplasm with the tolerance mechanism of sunflower midge resistance. This procedure will allow germplasm with a low midge reaction to be more effectively identified and incorporated into sunflower hybrids.

Source of Federal Funds: Hatch, National Sunflower Association, and SBARE

Scope of Impact: Sunflower midge is widely distributed in eastern North Dakota, western Minnesota, and adjacent areas of Manitoba and is found in parts of South Dakota. Localized and occasionally widespread outbreaks occur.

Key Theme - Plant Health: Integrated Disease Management of Dry Edible Beans in North Dakota

Objectives of the project are: Identify and evaluate cultural practices with potential to reduce disease incidence on dry edible beans in North Dakota; and develop screening procedures to identify germplasm with resistance against principal diseases affecting dry edible beans in North Dakota. Greenhouse experiments were conducted to evaluate the impact of relative humidity and leaf wetness on the development of white mold. Our hypothesis was that cultural practices or plant architecture that favor aeration of the canopy and quicker drying of leaves may help crops escape infection by white mold. Our findings indicate, however, that white mold is rather resilient to drying. Delays in disease development were not longer than two days once infection of senescent flowers was achieved and moist conditions returned. A new anthracnose race was identified in North Dakota. This new race is capable of infecting Topaz, the only commercially available pinto bean cultivar resistant to anthracnose race 73.

Impact: Management practices that promote aeration of canopy and speed up drying of dew from leaves have been successfully used to manage foliar pathogens in other crops. Practices like reducing plant populations and widening rows, or traits like porous canopy varieties may increase aeration of canopy and could have an impact on white mold. However, to evaluate the value of these traits for white mold control, it is necessary to understand first the role of discontinuous or short relative humidity periods on white mold development. Early detection of new diseases or new strains of an existing pathogen, like anthracnose, will help develop strategies for effective control measures.

Source of Federal Funds: Hatch

Scope of Impact: Statewide.

Key Theme - Plant Health: Biology and Management of Soybean Diseases

Soybean has become a major oilseed crop in North Dakota. There are soybean diseases that can seriously reduce yield and quality of soybean and affect grower decisions on soybean production. The purpose of this project is to understand the biology of soybean diseases and develop management practices that can reduce losses from diseases. Objectives are to: 1) Monitor soybeans for threatening diseases such as soybean cyst nematode, sudden death syndrome and bean pod mottle virus; 2) Investigate the biology of important soybean diseases such as Phytophthora root rot, Fusarium root rot and Sclerotinia stem rot and; 3) Develop disease management practices with an emphasis on disease-resistant soybean cultivars.

Surveys for soybean diseases will be conducted in the principal soybean producing counties of North Dakota. Surveys will concentrate on soybean cyst nematode (SCN), sudden death syndrome and virus diseases. Pathogens will be identified using a variety of taxonomic and molecular methods. Virulence phenotypes of Phytophthora sojae from North Dakota soils will be characterized. If SCN is found in the state, field studies will be initiated on survival and reproduction in soils and cropping systems found in North Dakota. The effect of inoculum density on Fusarium root rot of soybean will be investigated in the greenhouse. Studies will also be conducted on the effect of temperature and water potential on disease development. Incorporation of disease resistance into public cultivars is a primary goal of disease management.

The survey of races of Phytophthora sojae, the cause of Phytophthora root rot of soybean was continued in 2004. The pathogen was baited from 151 soil samples collected in 2003 and virulence patterns were identified on eight standard differentials. The commonly used resistance genes (RPS genes) in North Dakota are RPS 1c, 1k and 6. Our sampling indicated that of the total P. sojae isolates, 57.8 % defeated RPS 1c, 17.1 % defeated RPS 1k and 3.9 % defeated RPS 6. These data indicate an increasing diversity of virulence in the pathogen population in North Dakota. Cooperative research with the soybean breeder was continued in 2004 to incorporate resistance to P. sojae races 3 and 4 into public soybean cultivars and germplasm. Approximately 1,400 soybean lines were screened for resistance to races 3 or 4. Because the soybean cyst nematode (SCN; Heterodera glycines) was confirmed in North Dakota in 2003, cooperation with

the soybean breeder has been increased to incorporate SCN resistance (rhg 1 gene) into North Dakota soybean germplasm. We used molecular marker assisted selection to screen 175 soybean breeding lines and identified 80 lines with the rhg 1 resistance gene. Evaluations of 43 soybean germplasm lines and cultivars for resistance to Sclerotinia sclerotiorum were conducted in the field as part of a North Central Soybean Research Project. Plants were artificially inoculated and grown under misters. Cloudy, cool weather contributed to good disease development resulting in disease severity indices ranging from 44 to 86. The effect of inoculum density (ID) on Fusarium root rot of soybean was studied in the seedling stage in natural and autoclaved Bearden fine sandy loan soil using isolate 115-3. Root characteristics were measured using WinRhizo software and scanning hardware. After three weeks growth in IDs ranging from 0 to 500,000 spores/g air dried soil, there were no differences in root length, volume, number of root tips or fresh weight of roots between treatments. Average root diameters were decreased at higher inoculum densities in natural but not autoclaved soil. Additional studies on Fusarium root rot are in progress.

Impact: This research has a major impact on reducing losses from disease through incorporating resistance to Phytophthora root rot and SCN into soybean cultivars. In addition, understanding the effect of cultural practices on populations of pathogens will lead to control strategies.

Source of Federal Funds: Hatch

Scope of Impact: Statewide.

Key Theme - Plant Health: Resistance of North Dakota Wheat to Tan Spot and Leaf Rust
Leaf rust and tan spot are two serious leaf diseases of wheat in the United States. Combined yield losses can exceed $100 million in North Dakota alone. Genetic resistance in the host is the efficient and safe way to control plant disease. This project will assist in the development of wheat varieties resistant to these two diseases.

Breeder's lines and commercial cultivars of durum, hard red spring, and winter wheats were evaluated in three nurseries for resistance to the natural population of leaf rust (Puccinia triticinia). Most widely-grown commercial cultivars are either susceptible or moderately susceptible to T races of the fungus. This means that North Dakota wheat production is at risk to devastating rust epidemics. However, newer varieties, such as ND Steele appear to possess excellent resistance against the T races. This resistance probably comes from the Lr21 gene. Greenhouse and field experiments suggest that several advanced breeding lines appear to possess this gene. In other experiments conducted in collaboration with USDA-ARS, a toxin-insensitivity gene associated with resistance to Stanonospora nodorum, was mapped to chromosome 1B. This gene, designated SnTox1, was identified in a segregating population derived from W-7984 and Opata 85. Chromosomal location was confirmed with Chinese spring wheat nullisomic-tetrasomic lines.

Impact: This research will enhance farm productivity in the short- and long-term by identifying and incorporating disease resistance genes into adapted cultivars and by enhancing our basic understanding of plant/pathogen interactions.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Plant Health: Annual Weed Control in Crops
Weeds reduce crop yield, inhibit harvest, and diminish economic returns. This project investigates chemical, additive, plant, and environment interactions of weed management systems that use herbicides to control weeds. Researchers also determine the efficacy and crop response of newly registered herbicides through field and greenhouse bioassays.

Clethodim caused 6% to 15% wheat injury and 0% to 5% corn injury when applied 14 or 7 days before seeding but caused 86% to 90% injury when applied the day of seeding. Sethoxydim caused 53% injury to corn when applied at seeding. Mesosulfuron at 0.036 ounces per acre gave better control of wild oat than all reduced rate treatments, but control did not exceed 58%. Flucarbazone gave 59% to 64% control of wild oat. Diammonium sulfate solution increased foxtail control with flucarbazone and MSO an average of 33%. Split-application treatments of flucarbazone or mesosulfuron followed by clodinafop provided 83% control of wild oat on June 29 but only 74% control on July 19. Flucarbazone at 0.32 ounces per acre provided 90% wild oat control. Clodinafop, fenoxaprop, and tralkoxydim provided 84% wild oat control. Mesosulfuron at 0.036 ounces per acre gave 70% control, and imazamethabenz could not be distinguished from the untreated. Bromoxynil and MCPA antagonized wild oat control with clodinafop or fenoxaprop while dicamba antagonized flucarbazone. Carfentrazone caused 5% to 10% wheat injury unless thifensulfuron was included in the tank-mix. Treatments that included carfentrazone caused quicker weed desiccation and better control than other treatments. Treatments containing tribenuron and 2,4-D gave 78% control of Canada thistle, while clopyralid and fluroxypyr at 1.5 and 1.5 ounces per acre provided 93% control. Imazamox injury to wheat ranged from 25% to 80% when treatments were applied to 2-leaf wheat, but treatments caused less injury when applied to 4-leaf wheat. On August 18, control of yellow foxtail was better with BAS 777 plus pendimethalin, 95%, than with BAS 777 alone, 85%. Wheat injury from BAS 777 tank-mix was consistent with injury from the partner alone. V10137 at 1.5 or 2 ounces per acre performed similar to clethodim at 2 ounces per acre, 99% control. PRE Mesotrione caused 10% injury or less to flax but gave less than 50% wild buckwheat control and less than 80% redroot pigweed control. POST mesotrione generally providing greater than 80% broadleaf weed control, but flax exhibited 25% bleaching injury. POST mesotrione injury was reduced to 3% when bromoxynil and MCPA was included. Thifensulfuron at 0.03 ounces per acre increased redroot pigweed control, 94%, in flax obtained with bromoxynil and MCPA, 80%, resulting in greater yield. Herbicide application to flax 4-inches tall or smaller resulted in the highest yield. Sulfentrazone resulted in the least amount of injury, 0% to 8%, and presented the best potential for registration in chickling vetch. PRE imazethapyr gave 4% injury on July 23

but 20% injury was observed August 13 on chickling vetch in plots treated with PRE or POST imazethapyr. Propoxycarbazone at 0.5 ounces per acre caused less than 10% stunting to Kentucky bluegrass and no chlorosis was visible. Propoxycarbazone provided greater than 80% quackgrass control 4 months after spring application. Tribenuron at rates as low as 0.06 oz/A caused a minimum of 10% chlorosis and 30% stunting when applied to 2 inches of alfalfa regrowth. Tribenuron at 0.12 ounces per acre caused similar injury unless applied immediately after alfalfa harvest.

Impact: Eliminating Roundup Ready volunteer crops before the new crop emergence will maximize yield potential and profitability. Delaying application of herbicides to control Roundup Ready corn allows more weed emergence and better weed control but can injure the emerging corn and wheat crop. Experiments support reducing the replanting interval of corn and wheat crops after quizalofop or fluazifop to allow control of weeds at seeding, which will make the crop more competitive with newly emerging weed seedlings. Flucarbazone control of grass weeds can be improved by adding a nitrogen source to the spray mixture. For yellow foxtail, this means better weed control than could be expected from flucarbazone and a nonionic surfactant, resulting in cleaner fields and more grain yield. For wild oat, a nitrogen source provides more consistent control at 70 to 75% of previous use rates. Fewer weed escapes or failures at reduced rates leads to greater economic returns with less exposure to the environment. Experiments have been conducted to demonstrate the benefit of reduced herbicide rates for wild oat control. Cool, wet weather this spring demonstrated the risk associated with this practice. Many wild oat herbicides gave less control at reduced rates, especially when the broadleaf herbicides bromoxynil and MCPA were included in the spray mixture. Clodinafop provided similar control at rates tested without a broadleaf partner but also was antagonized by broadleaf herbicides. The grass herbicide should be applied three days before broadleaf herbicides are applied to maximize weed control.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Emerging Infectious Diseases: Sugarbeet Disease Research

North Dakota ranks second in the production of sugarbeets, providing 17 percent of the nation's supply. In 1998, sugarbeet growers in North Dakota and Minnesota lost $113 million to a Cercospora leaf spot epidemic. Isolates of Cercospora were found to be resistant and/or tolerant to the benzimidazole and triphenyltin hydroxide (TPTH) fungicides. From 1999 through 2004, the EPA has granted our sugarbeet extension specialist request to use Eminent, a tetraconazole fungicide, to control Cercospora leaf spot. The average number of fungicide applications applied per acre was reduced from 3.74 in 1998 to 2.06 in 2004, and Cercospora control was good to excellent in most fields. Rhizomania, Rhizoctonia and Fusarium are also becoming more severe in sugarbeet fields. Management strategies are being developed to better manage these diseases using resistant varieties and fungicides where applicable.

Impact: Researchers tested different fungicides to control Cercospora including resistant and/or tolerant strains. This has led to the full registration of two new effective strobilurin fungicides, Headline and Gem. Efforts are still in place to have a full label for Eminent to be used in an alternation program with the strobilurins to control Cercospora and manage fungicide resistance. Growers are now successfully controlling Cercospora leaf spot without losing millions of dollars as they did in 1998. The use of Eminent and the strobilurins fungicides in an alternation program with TPTH has resulted in improved efficacy of TPTH, and *Cercospora beticola* populations that are more sensitive to TPTH. Researchers in North Dakota, Minnesota and Montana are also looking at control strategies that integrate disease-resistant crops and timely fungicide applications to manage new and emerging diseases.

Source of Federal Funds: Hatch and Smith-Lever

Scope of Impact: Multi-state research and extension, MN and MT.

Key Theme - Niche Market: Evaluation of Wheat Quality in Relation to End Use

Demand and market opportunities for value-added wheat-based products have been growing rapidly over the past few decades. Broad-based economic growth in developing countries has given rise to an overwhelming demand for high quality wheat, resulting in an escalation of global agricultural trade. Presently, buyers and consumers are more cognizant to quality, and they have well-defined quality specifications. In response to this demand of the global market, NDSU researchers are seeking new quality criteria in hard red and hard white spring wheat genotypes, which could broaden the application of these wheats for myriads of different wheat-based products.

Impact: Researchers identified key quality characteristics and identified several wheat genotypes with potential for frozen dough and noodle production. Significant improvement in quality has been observed in bread, frozen dough and noodle products when wheat starch with reduced amylose content is used. Research continues to identify starch requirements necessary to obtain specific characteristics in various wheat-based products. The information from the research will allow wheat breeders and cereal chemists to improve the quality of existing wheat lines, broaden the applications of hard red spring wheat and hard white spring wheat in specialty products and allow the industry to respond faster to new emerging domestic and international market demands.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research, MN, SD

Key Theme - Niche Market: Improved Processes for Foods

To develop standard methods for characterization of oilseeds and their fractions, the use of solid phase microextraction (SPME) for analysis of headspace volatiles from flaxseed oil was evaluated. This approach was expected to lead to a more sensitive method than other methods of

oil quality analysis, and therefore provide a valuable tool for evaluating the effect of process parameters on flaxseed processed for food use. Nine flaxseed lots deemed to be of varying acceptability were cold-pressed. The headspace of the resulting oil and of a commercial product (control) was analyzed using SPME. Four samples that yielded a broad range of SPME profiles, and the control, were selected for sensory evaluation by a panel of 10 trained judges. The judges evaluated the oil for nutty, paint-like, and bitter flavors, and overall acceptability using category scaling. ANOVA showed significant differences between samples for 3 of 4 sensory attributes. SPME sample profiles showed striking differences in number of peaks and in peak heights. Areas under peaks corresponding to select retention times, were correlated with either bitter or paint-like flavor. The SPME-GC method appears to be a promising tool for screening flaxseed lots for cold-pressed oil production.

Impact: Sensory analysis combined with headspace analysis are expected to be valuable tools for evaluating the effect of process parameters on flaxseed processed for food use, and should lead to a more sensitive method for oil quality analysis than methods currently in use (e.g. peroxide value). Storage at various conditions has profound effect on the quality of food soybeans. Specific Mechanical Energy (SME) is an important parameter of screw press design and performance. Analysis of SME and its dissipation will improve our understanding of oil temperature increase during screw pressing, and will in turn lead to better protection of heat sensitive materials, such as alpha-linolenic acid in flaxseed oil.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Niche Market: Feasibility of Biodiesel from Minor Oil Crops
Tools are needed to evaluate and compare different available raw materials, and process parameters and modifications for biodiesel production. To address this need, a biodiesel process model was developed with commonly used spreadsheet software and process-engineering principles. The basis of the model is a continuous process with two stirred-tank reactors and sodium methoxide catalysis. The model can be readily adapted for use on most personal computers, and requires little training compared to specialized process modeling software. The biodiesel process was represented as 27 units with 51 flows and 18 components. Mass flow rates and compositions of the process input and output streams were quantified using mass and component balances, energy balances, stoichiometric relations, and using established process parameters. Based on commonly reported process parameters, the model computes (in kg/hr) inputs of 13.8, 10.8, 34.7 for methanol, 10% sodium methoxide in methanol and process water, respectively, and outputs of 92.8, 10.3, 55.6 for soy biodiesel, glycerol and waste stream, respectively. These mass flow rates can be linked to cost data for calculating the material costs from various raw fats and oils, and readily adapted to factor in alternative parameters and units.

Impact: Biodiesel use is established in the United States, however, a more efficient process to use different fats and oils is needed. This will ensure that the biodiesel industry will be competitive with other transportation fuels and meet sizable future demand. A number of

alternative processes and raw materials for biodiesel have been proposed in recent years, but models such as the one just developed will permit much more than the previous superficial analyses of alternative processes.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Program 2: Competitive and Profitable Animal Production

Key Theme - Agricultural Profitability: North Dakota Dairy Diagnostic Program
The North Dakota Dairy Diagnostic Program (ND3P) focus is to retain and grow the state's existing dairy farm families by enhancing income and improving lifestyles, or otherwise assisting with successful transitions.

Impact: With the help of the ND3P facilitator, dairy farm families monitor and measure the impact of the decisions formulated by the advisory committee and adapted for the farm, the dairy enterprise, and the family. Since the inception of program, nearly 15% of the current dairy farms (NDDA, January, 2005) have participated in the program.

Dairy is the original value-added agricultural industry. According to university research, for each dollar spent in dairying, the community can expect it to be reinvested from 2.67 to 7 times in the form of locally purchased supplies, hired labor, equipment, taxes, etc.

The program's intent is not only to enhance dairy farm profit, but to develop strategic alliances between the dairy and its many providers. Many intangible benefits are derived as a result of ND3P participation and include: methods of evaluating growth, establishing long-term business relationships, reducing professional barriers, improving communication and setting personal goals and professional strategies.

Accomplishments from selected farms (56 farms have been involved in the program):
Gross annual economic impact
Farm #1 Implementing herd changes resulted in an increase of 9 pounds of milk per cow per day. This represents an additional 2,735 pounds per cow per lactation. Using this year's average base price of $14.70 per hundredweight, the changes resulted in an additional $402.17 per cow or $20,108.50 for this 50-cow herd.
Farm #2 Changes in nutrition management yielded an addition 4.8 pounds of milk per cow per day and an added $1,047 to cash inflows.
Farm #3 Methods to reduce environmental challenges in housing dropped somatic cell count 76,000 SCC. This equated to $4,052 more income from higher milk incentives.
Farm #4 A 70,000 somatic cell count reduction increased milk quality incentive payments worth another $4,697 for the dairy enterprise this year.

Farm #5 The cost of replacement heifers is the second largest drain on the dairy business. By implementing changes that reduced the cull rate by 5% improved farm income by $23,100.
Farm #6 Expanding with an additional 46 head to better utilize their dairy facility, this dairy increased gross annual income by an additional $140,917.
Farm #7 This collaborative debt management team effort reversed the farm financial stress. Changes in business management techniques reduced the debt load and resulted an additional $367,000 of annual gross economic return.

Dairy Marketing Club: The South-Central Dairy Marketing club focuses on dairy farmers. It is lead by a ND3P facilitator who assists them in addressing current topics related to dairy marketing, livestock risk protection, animal health, dairy records, contract agreements, and price protection.

Source of Federal Funds: Smith-Lever

Scope of Impact: State specific

Key Theme - Agricultural Competitiveness: Dairy Retention and Sustainability
The North Dakota Dairy Coalition (NDDC) is a grass-roots effort to revitalize our dairy industry. The NDSU Extension Service Animal and Range Sciences Department, North Dakota Department of Agriculture and the North Dakota Association of Rural Electric Cooperatives have joined to provide statewide momentum. The coalition has prepared a vision and printed a mission statement, established goals, defined a plan of work, assigned committees, and selected an executive director.

Impact: Dairy is ranked second in the state for its contribution to gross cash receipts from animal agriculture. However, the resources consumed by dairies are second to none. Projections suggest that by 2020 the Upper Midwest will be the only region suited for dairy growth. A North Dakota survey confirms the state's dairy infrastructure is at risk and that decisive action is essential to positioning our state for that opportunity. It is well-established that the economic multiplier of dairying exceeds that of any other agricultural enterprise. The future of North Dakota's dairy industry is at stake.

The plan of work is a collaborative effort by the members of the NDDC:
A.) Expansion and retention of existing North Dakota dairy farms,
B.) Recruitment of non-resident dairy operations,
C.) Investment by external interests.

NDSU and North Dakota Department of Agriculture - Dairy Division have taken the lead for addressing the needs of existing of dairy farm. The NDDC will focus on recruitment from beyond our borders, external investment interests, and responsibilities associated with the legislature.

Source of Federal Funds: Smith-Lever

Scope of Impact: State specific

Key Theme - Animal Health: Volunteer Johne's Program for North Dakota
In conjunction with the Office of the State Veterinarian, we assessed and developed a voluntary Johne's control program for North Dakota dairy and beef producers to help control Mycobacterium avium paratuberculosis in cattle.

Impact: Through the combined efforts of the Office of the State Veterinarian and the NDSU Extension Service, the confidentiality laws of North Dakota were changed in 1999 so that testing results for Johne's disease status were exempt from public disclosure. From 1984 to 1994, approximately 25 cases of Johne's disease were reported in cattle. In the year 2000, 370 herds were tested for Johne's and 210 were positive, indicating that more producers are willing to have their herds tested and control of the disease will be improved.

In 2001, a voluntary Johne's control program was implemented to help those producers wanting to "clean up" their herds. The Office of the State Veterinarian administrated the program and the North Dakota extension veterinarian provided educational materials and clinics for veterinarians and producers. During this initial year, 19 herds were enrolled in the program. In 2003, 78 producers were enrolled in the program. In 2004, 140 producers were enrolled in the program and of these, two were goat herds, 93 were beef herds and 45 were dairy herds.

An additional initiative, called the “C-punch” was implemented with the 2001 voluntary Johne's control program. To control Johne's in cattle, a permanent identification needs to be placed on the animal. Some states have instituted a "J-punch" program whereby infected cattle are ear notched with a letter "J" to signify Johne's. In North Dakota, we were concerned about stigmatizing producers and their cattle by placing a "J" in the cattle's ear. In response, the "C-punch" was developed. The letter "C" stands for cull. Animals ear notched by this means signify to sale barns, order buyers and other potential purchasers of livestock that cattle marked with a "C" are intended for the slaughter market only and are not to be put back into a production unit. The "C-punch" does not imply a production unit is infected with Johne's. "C-punches" have been provided to all livestock auction markets across the state and to veterinarians and producers who wish to use the device. Multiple states have contacted North Dakota with the desire to start a "C-punch" program. The long-range impact of this program will be national. Many states (e.g. Hawaii) have contacted North Dakota with the hopes of following North Dakota's lead in establishing a voluntary Johne's control program and the use of the "C-punch."

Source of Federal Funds: Smith-Lever

Scope of Impact: Multi-state research and extension

Key Theme - Animal Health: West Nile Virus

In conjunction with the State Veterinarian's office, the North Dakota Dept. of Health and the NDSU Veterinary Diagnostic laboratory, a surveillance system for West Nile Virus and an education initiative were implemented.

In the summer of 2002, West Nile Virus spread across the Upper Great Plains. In North Dakota, 579 horses were affected and 35 percent of those died. The first case was reported on June 30. August had the most cases with 350. In response to this emerging disease, a conference was organized to educate veterinary practitioners on West Nile Virus and appropriate response and treatment.

In the winter and early spring of 2003, a major education initiative was conducted by the extension service including county agents, private veterinary practitioners and the extension veterinarian. The major focus of the education initiative was appropriate vaccination of horses.

In 2004 the surveillance system was continued during the vector season. West Nile programming aimed at the horse owner was continued in an effort to educating producers for the need to continue vaccination in order to protect their horses.

Impact: An outbreak in 2003 never occurred. For the longer term, West Nile Virus will now be considered endemic and will become a routine vaccination protocol unless some unknown adverse event occurs.

Source of Federal Funds: Smith-Lever

Scope of Impact: Multi-state research and extension

Key Theme - Agricultural Profitability: Feedlot Development in North Dakota

Numerous demonstration projects were conducted to determine the value of feeding producer-owned cattle in North Dakota and demonstrate that cattle can be cost-effectively fed to finish in North Dakota. With initial information, cattle producers from across the state developed the North Dakota Statewide Cattle Feeders Consortium. That group conducted a feasibility study and developed business plans for building large cooperatively owned feedyards. The NDSU Extension Service developed the North Dakota feedlot school and advanced cattle-feeding workshops and backgrounding/feeding seminars for lenders and feeders to enhance feedlot management skills and improve knowledge of feeding and marketing.

Impact: The NDSU Extension Service showed that it cost up to 3 cents less per pound to finish cattle in North Dakota compared to an out-of-state feedlot. Extension information prompted a group of cattle producers to pool funds and custom feed more than 7,000 head in North Dakota feedlots. With help from extension specialists and agents, they realized a return of more than 31 percent within one year. Another group built a 7,000-head feedyard in Bowman County. Other producers will earn a premium of up to 3 cents per pound for cattle that meet processing specifications of a new local processing company. More than 350 producers attended extension feedlot schools in the last four years. Lenders are exploring additional financing of cattle, feed,

and cattle feeding facilities in North Dakota and have creatively increased funds for expanding feedyards. One participant estimated that better health practices, bunk management and feeding practices cut cost of gain by up to 5 cents per pound. Another participant has increased the number of cattle owned for feeding from 1000 head to 5000 head through the use of custom feedlots. Privately owned custom feedyards are being built in a response to increased education and public funds for improving water quality with reduced manure runoff.

Source of Federal Funds: Smith-Lever

Scope of Impact: Multi-state integrated extension and research, KS, MT, SD, MN, WI and WY

Key Theme - Agricultural Competitiveness: Leadership and Economic Development
Through a series of hands-on leadership development classes, cattle producers developed business plans for economic development opportunities. Cattlemen then explored implementing the plans and assessed community and economic feasibility. Through continued extension facilitation and guidance and informational assistance, business plans, financing packages and equity drives and management strategy were developed for cooperative cattle feedlots, a limited liability partnership that owns cattle for custom feeding, a cattle financing cooperative, a limited liability company owning a local meat processing plant with sole-source delivery rights, and a limited, limited liability partnership (LLLP) for owning cattle for feeding to finish. Producers involved in the program have emerged as directors and managers of the proposed plans.

Impact: Cattle producers in central North Dakota realized that working as a group would provide more economic development than could be accomplished individually. Through educational sessions and continued facilitation and instruction, producers were able to develop several new vertically integrated cattle business ventures. The cooperative cattle feedlot plan has constructed a 7,000-head cattle feedlot located in a cow-calf region where feed grains are traditionally low-priced. The limited liability partnership that owns cattle for custom feeding has returned a 23.5 percent return on equity during a one-year period for 23 cattlemen involved. Other cattle feeding alliances have been developed as limited liability partnerships (LLP) and limited, limited liability partnerships (LLLP).

A cattle-financing cooperative was developed for local producers and now provides financing for 95 percent of the calf purchase price with low-interest notes. The finance cooperative has grown 25 percent per year for cattle financed. Fifty-six cattle producers wanted to develop an outlet for supplying finished cattle at a 10 percent added-value premium and opened a 5000 head capacity beef processing plant. They then developed another limited liability company to sell fresh and processed meats into a regional market.

Source of Federal Funds: Smith-Lever

Scope of Impact: Multi-state extension. Cooperative feedlot owners are from ND, MT, SD and WY. Financed cattle are marketed to IA, SD, NE and MN. Processed meat products have markets in ND, MN, WI, SD, CA, IL, MI, NJ, NY, LA, CO, IA and internationally.

Key Theme - Adding Value to New and Old Agricultural Products: Dakota Heritage Beef and Sheyenne Valley Brand Beef

Two surveys and a focus group were conducted for Dakota Heritage Beef, a group of southwestern North Dakota and northwestern South Dakota ranchers. The purpose of the first survey was to determine consumer interest and potential for a test market in a branded beef product. The second survey was to gauge consumer satisfaction of their purchase. Important findings included: Consumers indicated they were interested in buying locally produced beef (64.3 percent would pay a premium). Quality was more important than price as the determining factor in buying beef (85.8 percent). More than 77 percent of the survey respondents found the product through in-store promotions. And more than 91 percent were interested in future purchases. Producers are considering purchasing shares in a multi-state beef processing cooperative. Another meat processing company developed by local cattle producers has started marketing fresh and processed meats via the Sheyenne Valley brand label.

Impact: Consumer willingness to pay for locally produced food products is an important element in determining the feasibility of value-added ventures. Impacts of the survey indicate further analysis is warranted in determining the feasibility of facilities for producing branded beef product. Job development was attained though building and operating a processing facility for harvesting, processing and cooking meat from animals grown in the local community. The new feeding ventures increased cattle fed special diets specifically for the new marketing company. A home delivery business was developed to aid meat sales in the community.

Source of Federal Funds: Smith-Lever

Scope of Impact: State specific

Key Theme - Animal Production Efficiency: Improving the Reproductive Performance of Livestock

Reproductive performance of farm animals is a major limiting factor in efficient production of meat animals. NDSU researchers are studying the growth and development of the blood vessels in ovarian tissues to develop improved methods of superovulation in cattle and sheep. They are also evaluating the role of placental size and blood vessel growth in fetal growth and development in cattle and sheep. A recent focus of nutritional effects on pregnancy outcome and fetal and placental growth increases the scope of this research area.

Impact: Results of the studies will lead to improved methods of regulating ovarian function, of obtaining large numbers of high-quality embryos for use in embryo transfer programs and of optimizing placental function and fetal growth in livestock. These improvements will give livestock producers' tools to improve the reproductive management of their animals.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research

Key Theme - Animal Production Efficiency: Enhancement of Reproductive Parameters in Domestic Livestock

Economic analysis has shown that a critical aspect of reducing the high input costs of livestock production is to improve reproductive efficiency. Because maintenance of reproductively sound females is the primary expense for livestock producers, reproductive failure remains one of the most costly factors facing the livestock industry.

The long-term objectives are: 1) to optimize assisted reproductive technology (ART) techniques to obtain large numbers of good quality oocytes and embryos for embryo transfer programs, 2) to evaluate the mechanisms resulting in the development of healthy oocytes and embryos for increasing reproductive efficiency in domestic livestock, and 3) to evaluate the role of gap junctions in the regulation of reproductive function in domestic animals. In Experiment 1, we demonstrated that the rates of in vitro fertilization were similar for control and underfed (60% of maintenance diet) ewes, but early embryonic development was decreased for underfed ewes. This indicates that nutrition affects the quality of oocytes. In Experiment 2, on Gap Junctional Connexins (Cx) we have shown that expression of Cx26 was about 70% greater on day 10 than on days 5 or 15 of the estrous cycle, which were similar. In contrast, expression of Cx43 was the greatest on day 5 and then decreased by about 40% on days 10 and 15 of the estrous cycle. The PGF-treatment decreased Cx26 expression during luteal regression; at 4 h after PGF treatment Cx26 expression decreased by about 50%, at 8 h by about 80%, and at 12 and 24 h by about 90%. PGF-treatment tended to increase Cx43 expression transiently 8 h after induced luteal regression. Expression of Cx32 was 50-fold less than Cx26 and Cx43 during the estrous cycle and during PGF-induced regression and was not affected by stage of luteal development. This study indicates that the expression pattern of Cx26 and Cx43 depends on the stage of luteal development, differentiation and regression, and also indicates a role of Cx26 in luteolysis. Knowledge of the pattern of connexin expression coupled with studies on the functional consequences of connexin expression will provide a better understanding of the regulation of cell growth and function in the corpus luteum and other tissues. In Experiment 3 we demonstrated that after an initial increase, the endothelial component of the vascular bed decreases during PGF-induced luteal regression. However, smooth muscle cell actin expression remained high during luteal regression, indicating a role of pericytes and vascular smooth muscle in luteolysis. In addition, the rate of cell death increased dramatically by 12 h after PGF-treatment. We suggest that the high rate of cell death during early luteolysis is primarily due to the loss of endothelial cells. The presence of pericytes and smooth muscle cells during early luteal regression may serve to regulate tissue remodeling and to maintain the integrity of larger blood vessels.

Impact: The improvement and optimization of assisted reproductive procedures and better understanding of mechanisms resulting in the development of healthy oocytes and embryos for increasing reproductive efficiency may lead to practical and/or commercial applications in domestic livestock production and human medicine. There is a growing demand among farm animal producers for modern methods to improve reproductive efficiency and lower the cost of producing better quality animals. Improved embryology/ART methods will provide the means to help producers apply modern biotechnologies such as cryostorage of embryos, preimplantation

genetic diagnosis, and embryo cloning to meet their needs. Modernization and/or adoption of existing techniques and discovery of new ones could have immediate benefits to animal production.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research

Key Theme - Rangeland/Pasture Management: Evaluating the Effects of Drought and Grazing on Rangeland

Grasslands of the Upper Great Plains region are important to the well-being of the livestock industry and wildlife populations. Controlling drought is not a possibility, but proper livestock management during drought periods should temper the impacts of drought. NDSU researchers are using automated rainout shelters to simulate drought on mixed grass prairie.

Impact: Researchers found that heavy grazing leads to declines in herbage biomass, root biomass and randomness in distribution of forb populations after 12 years of season-long grazing. Moderate grazing intensity appears to maintain plant species diversity and allows deeper rooting of plants compared to the heavy grazing intensity which should be beneficial to proper rangeland ecosystem functioning, health, and sustained yield. After 15 years of continuous grazing and two years of simulated drought, basal cover of green needlegrass decreased while total and sedge basal cover increased. Total herbaceous yield trended down under intensive grazing and simulated drought. The drought treatments will continue to be monitored in the next year for drought effects and possible recovery signs.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research, SD and MT

Key Theme - Bioterrorism: Preparing for Biological Terrorism

Homeland security and more specifically biological terrorism are real threats for an agriculturally based state like North Dakota. There were two primary areas of programming in bioterrorism, the North Dakota Reserve Veterinary Corps and the training of all livestock and agronomic agents in bioterrorism.

In conjunction with the State Veterinarian's office, a plan of action was implemented to raise the awareness of veterinary practitioners about homeland security and then develop the concept of the North Dakota Reserve Veterinary Corps. As a continuation of efforts initiated in 1998, the office of the extension veterinarian helped to plan, coordinate and deliver a bioterrorism preparedness and response training initiative for veterinary practitioners within North Dakota.

In 2004 an auto-tutorial and training materials were created for use by county agents and others. These educational materials are available via the extension web site and offer PowerPoint

presentations for use by the individual or in a classroom setting. This was a collaborative project with the USDA:APHIS Veterinary Services and the N.D. State Veterinarian.

Because agricultural agents reside in every county of the state, they are a key resource in the monitoring, surveillance, and recovery efforts involved in a bioterrroristic event. All agricultural agents were trained utilizing a two-day course developed by the extension service.

Impact: A North Dakota Reserve Veterinary Corps was initiated. In 2003, twenty-four practitioners were trained and equipped through the Corps. The veterinary practitioners were trained in the use of laptops, GPS units and digital photography to be able to investigate unusual cases rapidly and send those findings electronically to any expert in the world for consultation and verification. This is a model program for the nation. Other states such as Maryland are organizing private veterinary response teams.

Agents were familiarized with animal and plant diseases, trained in incident command and familiarized with the extension disaster recovery plan. County agents were not trained to be first-responders, but were trained to assist the county incident commander with education, communication, and recovery efforts.

Source of Federal Funds: Smith-Lever

Scope of Impact: Multi-state extension

Key Theme - Animal Production Efficiency: Feed Utilization

Animal feed utilization studies have focused primarily on cattle and sheep. In addition to productivity realized by traditional, co-product and new feed regimens, considerable attention has been directed at sources, intake, and fates of metabolizable protein. Research has also addressed selenium metabolism and interactions between nutrition and pregnancy in domestic livestock.

Impact: Processing barley finer in backgrounding diets increased feed efficiency when total mixed rations were fed to growing steers. No differences in average daily gain were noted as barley was processed finer. No benefits were noted when corn was ground finer in similar backgrounding rations.

Feeding safflower seed high in linoleic acid to gestating ewes increased subsequent lamb survival. Mechanistic studies indicated the effect was not due to increased brown fat stores in the neonates.

Field peas can be used as a portion of creep feeds for nursing calves with no negative effects on forage digestibility or forage intake.

Processing flax by grinding or rolling improved cattle performance compared to feeding whole flax. Cattle fed flax had increased levels of alpha-linolenic acid (ALA) in the resulting meat

products compared to cattle not fed flax. Flax-fed cattle may produce beef that can be a source of ALA in the human diet. No negative effects on palatability of the resulting meat products were noted.

Canola seed can be used as a protein supplement for cattle fed low quality forage. However, canola must be processed, either by rolling or grinding, to improve digestibility prior to feeding.

Source of Federal Funds: Hatch and Smith-Lever

Scope of Impact: Statewide research and extension

Key Theme - Animal Production Efficiency: Supplementation Strategies to Improve Cow-Calf Production Efficiency and Profitability

Many forages do not contain enough nutrients for gestating or lactating beef cows, making supplementation necessary. The purpose of this project is to determine the effect of supplementation on cow weight gain and digestibility of the forage.

One objective is to evaluate the effect of supplementation strategies on forage intake, forage digestibility, ruminal fermentation, and ruminal microbial protein production. Fourteen Holstein steers (980 pounds initial bodyweight) with ruminal, duodenal, and ileal cannulae were used to evaluate effects of whole or ground canola seed (23.3% CP and 39.6% EE; DM basis) on intake, digestion, duodenal protein supply, and microbial efficiency in steers fed low-quality hay. Basal diet consisted of switchgrass hay (5.8% CP; DM basis) offered ad libitum at 0700 daily. Treatments consisted of: hay only (CON); hay plus whole canola (8% of diet DM; WC); or hay plus ground canola (8% of diet DM; GC). Total DMI, OM intake, and OM digestibility were not affected by treatment. Likewise, no differences were observed for NDF or ADF total tract digestion. Bacterial OM at the duodenum increased with canola-containing diets compared with CON and increased in steers consuming GC compared with WC. Apparent and true ruminal CP digestibilities were increased with canola supplementation compared to CON. Canola supplementation decreased ruminal pH compared with CON. No treatment effects were observed with ruminal fill, fluid dilution rate, or microbial efficiency. Canola supplementation at 8% of diet DM had little impact on forage intake and diet digestibility. Results suggest that canola processing enhances in situ degradation, but has minimal effects on ruminal or total tract digestibility in low-quality, forage-based diets.

Impact: Research in this area will increase understanding of forage nutritive value and the value of supplementation for cow-calf producers in the northern plains area. This will lead to increased competitiveness and enhanced profitability for ranchers in the region.

Source of Federal Funds: Hatch

Scope of Impact: Statewide

Key Theme - Animal Production Efficiency: Role of Compensatory Growth in Lactation Persistency

The success of replacement heifer programs is measured in terms of efficiency of body growth, and more importantly, by the milk-yield potential of the heifer. The capacity to produce milk in turn is largely influenced by the degree of mammary development. Nutritional management during gestation is critical to mammary development and life-long lactation performance. This research will examine the effectiveness of compensatory mammogenesis induced nutritionally during late gestation on permanent enhancement of lactation persistency.

The proper nutritional status during hormone-sensitive growth phases prior to first parturition can affect mammary development and subsequent lactation performance. We have developed a compensatory nutrition regimen, which is designed to stimulate mammary growth by exploiting the biological characteristics of the energy restriction and compensatory growth phenomenon. We examined the effect of compensatory growth induced only once during late gestation upon mammary development and subsequent lactation potential over two lactation cycles. Female rats were mated and randomly assigned to either the control or the compensatory nutrition regimen group. Control rats were offered control diet throughout the experiment. Compensatory nutrition rats were subjected to 40% energy restriction during the first 10 days of gestation followed by free access to the control diet for the remainder of the experiment. Dams on the compensatory nutrition regimen produced 14% more milk than control dams during the first lactation. Mammary cell proliferation rates were approximately 46% and 27% higher in the compensatory nutrition group than in the control during late gestation and early lactation of the first lactation cycle, respectively. These results indicate that compensatory growth induced only once during late gestation increases mammary cell proliferation and differentiation as well as decreases regression of mammary cells over consecutive lactation cycles.

Impact: Compensatory mammary growth induced during late gestation by using a stair-step nutrition regimen results in overall improvement in the efficiency of heifer development and transition health without affecting maternal performance. The stair-step compensatory nutrition regimen has been shown to have lasting effects on mammary development, differentiation, and lactation. Thus, the principal challenge will be to document the extent to which nutritionally directed compensatory mammary hyperplasia induced once during the first gestation affects methylation status thereby producing stable epigenetic changes in genes with the result being a metabolic imprinting process.

Source of Federal Funds: Hatch

Scope of Impact: Statewide

Program 1

Allocated Resources ($ x $1,000)		**FYO4**
1862 Extension ($)	Smith-Lever	658

	State	987
	FTE	23.5
1862 Research ($)	Hatch/McIntire	1,343
	State	1,975
	FTE	39.5

Program 2

Allocated Resources ($ x $1,000)		**FYO4**
1862 Extension ($)	Smith-Lever	308
	State	462
	FTE	11
1862 Research ($)	Hatch	170
	State	250
	FTE	5

Goal 2: A Safe and Secure Food and Fiber System

Overview: *North Dakota and the United States have seen an increased awareness of food safety issues. Large-scale food production and marketing systems and food prepared in institutional or restaurant settings has the potential for large scale outbreaks of foodborne illness.*

At the same time, food-related businesses are a growing sector of the North Dakota economy and North Dakota agricultural producers play a key role in supplying food for the nation and world. Efforts to safeguard that food supply at the consumer level and by improving food safety during food processing and by protecting crops are important functions of NDSU research and extension.

The NDSU Extension Service has developed materials and partnered with other agencies to help ensure the safety of North Dakota-produced foods for the past ten years. "Nutrition Facts" labeling of North Dakota food products has been provided since 1994. More than 170 food products have been tested for acidity and water activity for compliance to federal regulatory standards at NDSU. Several products did not meet the federal government standards for acidity and were re-formulated for safety. "Nutrition Facts" labels have been developed for more than 350 North Dakota food products currently on the market.

Initiated in 2002, the "Wash Your Hands" project has involved over 3,800 children in grades K-12 in schools throughout North Dakota. Among the 335 kindergarten students participating in the program the past year, 69 percent were not washing their palms carefully and 51 percent were not completely washing their thumbs. About 91 percent said they would wash their hands

more often, and 93 percent said they would wash their hands more carefully. Among the 198 first graders, 78 percent did not fully wash their palms and 75 percent did not fully wash their fingers. About 90 percent said they would wash their hands more often and 86 percent said they would wash their hands more carefully.

Nearly 40 percent of U.S. seed potatoes have originated in North Dakota and Minnesota. In recent years, nearly a third of seed potatoes from the region have been rejected because of disease problems leading to a decline in seed potato production. A team of scientists from entomology, plant sciences and pathology are researching potato resistance for managing the green peach aphid (GPA) and a virus vectored by the pest, potato virus Y. A promising source of resistance has been derived from a wild potato. The development of virus-resistant potato cultivars could help restoring the Red River Valley of North Dakota and Minnesota as a leading supplier of seed potatoes to major potato-producing states.

An unprecedented epidemic of Fusarium head blight (FHB or scab) occurred in eastern North Dakota in 1993, and severe outbreaks have occurred each year since 1993 throughout portions of the state, resulting in more than a $3 billion loss to North Dakota's economy. NDSU fungicide trials indicate that proper timing of an appropriate fungicide resulted in yield increases averaging 10-12 bushels/acre, with corresponding increases in test weight and market grade. Economic returns from use of the fungicides were between $21 - $28 per acre in 2004, based on current wheat prices and cost of the fungicides. In 2004, the extension plant pathologist again applied for a Section 18 emergency exemption for a specific fungicide with the best efficacy against the disease, and it was granted by EPA. The fungicide was applied to approximately 1 million acres of wheat in 2004. An average net return of $25 per acre was realized, after cost of fungicides and indirect and direct costs were subtracted from the gross return/acre. This translates to a positive economic impact of $25 million for wheat producers in 2004 and helps sustain the area as one of the leading wheat-producing areas of the world.

Even mild levels of Fusarium in harvested barley may lead to the production of mycotoxins during malting. NDSU researchers are examining treatments that may prevent mold growth and subsequent mycotoxin production during malting. As a result, a larger supply of barley may become available for malting increasing the value for farmers. A valuable benefit of the research may the reduction of the growth of microbes in finished malt.

The American Bison is an emerging meat species gaining increased popularity in U.S. and European meat markets. Because the animals are not subjected to the same growth promoting hormones and antimicrobials often used in the beef industry, the microbiological safety of bison is not fully understood. Researchers are studying the microbilogical status of this unique meat product and their data will help consumers and processors assess and address foodborne risks from the meat.

NDSU specialists studied management practices to control the disease Sclerotinia in sunflowers. Consequently, producers in the north central region of North Dakota who stored sunflower seed following best harvest practices were able to clean the seed and many producers were able to market clean loads that sold for contracted price of 13 cents per pound versus 5 cents per pound

for bird seed or confection market. Producers were trained on the biology and management of Sclerotinia for sunflower and other susceptible crops.

Based largely on NDSU research and outreach programs, biological control of leafy spurge is expected to be valued at $58 million per year by 2025 by restoring thousands of acres of rangeland to productivity and by reducing herbicide costs. Once established, biological control of leafy spurge and other pests will provide self- sustaining control without further input cost to the grower.

NDSU scientists are evaluating the use of miniaturized sensors to alert consumers of possible safety risks before the food is consumed. In tests, the achieved accuracy ratings of up to 100 percent in detecting gases and other compounds indicating the growth of select pathogens.

Key Theme - Food Safety: Consumers

Despite widely publicized foodborne illness outbreaks associated with undercooking foods, particularly ground beef, only 6 percent of consumers "sometimes" or "always" measure the temperature of burgers with a food thermometer (USDA-FSIS). Research has shown that color of meat does not ensure that it has reached a safe internal temperature. The purposes of the "Thermy Project," initiated in 2000, were to develop culturally appropriate lessons, evaluation tools, posters and handouts based on the national "Thermy" campaign to promote use of food and refrigerator thermometers; to pilot test the materials on an Indian reservation; and to increase the monitoring of final cooking temperatures and food storage temperatures among Native American families. Educational sessions were conducted and thermometers were distributed at commodity food distribution sites, senior centers, Head Start centers and in Women, Infants and Children (WIC) offices. Follow-up classes were conducted at least one month after the initial training and refrigerator thermometers were distributed. The materials were also used in statewide programming targeting limited income audiences through the EFNEP/FNP programs. In 2003, the materials were adapted for use with refugees from Somalia, Bosnia and the Sudan, and hands-on classes were held with this target group.

Since 2000, more than 3,100 consumers have participated in the “Thermy” food safety educational efforts with the goal of increasing home food thermometer use. The participants reported preparing food for groups vulnerable to foodborne illness, including infants/young children (65 percent), seniors/elderly (41 percent), pregnant women (12 percent) and immune-compromised individuals (5 percent). About 96 percent of the participants reported preparing food at home for themselves or others at least once per week, with 60 percent reporting preparing food at home seven or more times weekly. About 96 percent said they planned to use the food thermometer they received.

Impact: About 58 percent of original participants participated in a follow-up class and survey. In a follow-up educational session, 94 percent correctly identified the recommended internal cooking temperature for ground beef as 160 degrees or higher, 91 percent identified using food thermometers as a way to help prevent foodborne illness and 81 percent reported that they were feeling more confident they were serving safe food to their families as a result of using a

thermometer. About 72 percent reported they had used their thermometer in the previous month. Of those, 32 percent had used the thermometers at least five times in the previous month. About 92 percent planned to use the refrigerator thermometer they received.

On a follow-up survey with non-native speakers, 88 percent indicated they had used the thermometer at least one time in the previous month; 56 percent had used the thermometer five or more times. About 99 percent planned to use the refrigerator thermometer.

Source of Federal Funds: Smith-Lever

Scope of Impact: Regional Extension

Key Theme - Food Safety: Food Processing

Because food-related businesses are a growing sector in the North Dakota economy, the NDSU Extension Service has developed materials and partnered with other agencies to help ensure the safety of North Dakota-produced foods for the past ten years. A resource binder, "Starting Your Food Business in North Dakota," was developed by the NDSU Extension Service and the Institute for Business and Industry Development in partnership with the North Dakota Department of Agriculture. Available in all county extension service offices, the resource binder includes information on food industry rules and regulations regarding food safety/quality control. A Web site, "Food Entrepreneur: Guide to the Food Industry," is regularly updated with information on food safety, testing/labeling and other issues: http://www.ag.ndsu.nodak.edu/cdfs/foodent/entrpnr.htm

"Nutrition Facts" labeling of North Dakota food products has been provided since 1994. Participants in the most recent FDA-sponsored "acidified foods" training showed increased knowledge in these areas: microbiology of processed foods, safe food handling/processing procedures, acidity testing and acidity levels of various foods, processing equipment, registration and process filing with the FDA and regional/state food processing issues.

Impact: More than 170 food products have been tested for acidity and water activity for compliance to federal regulatory standards. Several products did not meet the federal government standards for acidity and were re-formulated for safety. "Nutrition Facts" labels have been developed for more than 350 North Dakota food products currently on the market.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide Extension

Key Theme - HACCP: Foodservice

Increases in daycare, hospital and nursing home populations as well as a growth in restaurant and deli businesses means a growing portion of the population is at risk from outbreaks of foodborne illness. In addition, quantity food preparation presents unique challenges for safe

food handling and preparation. In this environment, government regulation is demanding more attention to the development of food safety practices. As a result, there is high demand for training and educational materials in food safety. The National Restaurant Association estimates that a single outbreak of foodborne illness will cost a restaurant at least $75,000.

In the past eight years, more than 2,000 food service managers and employees from restaurants, nursing homes, senior centers, hospitals, daycare centers and schools in more than 100 different North Dakota cities have attended NDSU Extension Service food safety workshops held across the state. The four-hour workshops focus on the Hazard Analysis and Critical Control Point (HACCP) approach to food safety that was developed by NASA to ensure safe food for its astronauts. In addition, the National Restaurant Association's ServSafe certification program has been implemented in North Dakota food safety workshops.

A five-lesson food safety curriculum, "Teens Serving Food Safely," was developed and piloted in classrooms for students ages 15 to 19 in 2001-02. More than 300 students completed the lessons and passed the exam with a score of 80 percent or higher. Average test scores increased from 59 percent on the pre-test to 96 percent correct on the post- test. The follow-up test score average was 93 percent, indicating good retention of the facts they learned. USDA Integrated Research, Education and Extension funding was received in 2002.

In 2003-04, about 125 educators, including extension agents and family and consumer sciences teachers from across North Dakota, participated in training sessions and received a copy of the curriculum. To date, more than 1,000 North Dakota teens have been trained and received completion certificates. In addition, partnerships with the regional office of the Food and Drug Administration, North Dakota Nutrition Council and North Dakota Beef Commission allowed the distribution of 1,500 food safety "kits" to students and their families across North Dakota. This project is an opportunity to create a model system to change how food safety education is accomplished for youth, at-risk and limited income audiences.

Impact: In 2004, knowledge scores of about 450 teenage food handlers, measured by pre/post testing, increased from 56 percent correct on the pre-test to 88 percent on the post-test. About 64 percent of participants had been involved in food preparation for the public. In a follow-up survey one month later, 83 percent reported washing their hands more often when preparing food, 69 percent were more careful about cleaning and sanitizing, 52 percent were thawing food in the refrigerator more often, 20 percent were using a food thermometer more often, 26 percent were checking refrigerator/freezer temperatures more often, 28 percent were reheating to 165 degrees more often, 53 percent had shared their knowledge about food safety with others, and 40 percent had applied what they learned when preparing food for the public. Following the pilot project, about 90 letters were sent to food service/restaurant managers in the sites where training had taken place alerting them of the training that youth in their communities had completed and encouraging them to ask youth applicants if they had been part of the program. Some businesses have provided an additional monetary incentive to students who had completed the training and showed a certificate.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide Extension

Key Theme - Food Safety: Children
According to the Centers for Disease Control and Prevention (CDC), hand washing is the single most important means of preventing the spread of disease. Studies in schools and childcare centers have shown links between improper or infrequent hand washing and colds, flu and foodborne illness outbreaks.

Initiated in 2002, the "Wash Your Hands" project has involved over 3,800 children in grades K-12 in schools throughout North Dakota. The instructors used a fluorescing dye and ultraviolet light to show areas the students missed washing. The students were provided a handout showing a hand and asked to mark the spots they missed washing (where the dye remained). Fingertips, back of hand and wrists were commonly missed areas.

Impact: Among the 335 kindergarten students participating in the program the past year, 69 percent were not washing their palms carefully and 51 percent were not completely washing their thumbs. About 91 percent said they would wash their hands more often, and 93 percent said they would wash their hands more carefully. Among the 198 first graders, 78 percent did not fully wash their palms and 75 percent did not fully wash their fingers. About 90 percent said they would wash their hands more often and 86 percent said they would wash their hands more carefully.

Source of Federal Funds: USDA

Scope of Impact: Statewide Extension

Key Theme - Food Security: Protecting Potato through Pest Resistance
Crops resistance to insect and plant pathogenic pests is an integral component in sustainable agriculture production. A team of scientists from entomology, plant sciences and pathology are researching potato resistance for managing the green peach aphid (GPA) and a virus vectored by GPA, potato virus Y (PVY). PVY infections have resulted in rejection rates at 30-40 percent of certified seed potato fields and the decline of seed potato production in the Red River Valley of North Dakota and Minnesota. Germplasm derived from Solanum etuberosum, a wild potato, is a potential source of resistance to PVY as well as its vector GPA.

Impact: A high incidence of PVY in potatoes has a great impact in North Dakota where the state ranked sixth in the United States in potato production during the 2001 production season. Nearly 40 percent of the U.S. supply of seed potatoes has been derived from North Dakota and Minnesota. However, rejection rates of 37.7 percent, 32.3 percent and 31.6 percent of certified seed fields from 1999 to 2001 have resulted in the decline of seed potato acreage in the Red River Valley.

Source of Federal Funds: Hatch

Scope of Impact: Multi-disciplinary (entomology, plant sciences and plant pathology) research. The seed potato industry will benefit from virus resistant potato cultivars, restoring the Red River Valley of North Dakota and Minnesota as a leading supplier of seed potatoes to the major potato producing states.

Key Theme - Food Security: Managing Field and Storage Diseases of Potatoes
NDSU researchers are studying seven key storage and field diseases of potato: late blight, early blight, pink rot, black dot, silver scurf, ring rot and dry rot that are important to producers, industry and consumers. In addition, they are studying two emerging diseases including recombinant tuber necrotic strains of potato virus Y and phytoplasmas that have a negative impact on processed potato products. Fusarium graminearum, a fungus that is the cause of wheat scab, has recently been identified as a cause of dry rot of potato. This finding has important epidemiological and food safety implications. Researchers will screen germplasm for resistance to many of these diseases and evaluate field and storage conditions and management techniques for reduction of disease incidence and severity. Control measures are targeted for diseases that affect fresh and stored potatoes and include resistant varieties, fungicides, cultural practices and biological control. The researchers are also studying how and why pathogens that cause disease are becoming resistant to the fungicides used to control them.

Impact: Results from the research will help the potato industry implement control measures that improve quality and quantity of fresh and processed potatoes, and provide better and safer fresh and processed potatoes to the consumer.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research

Key Theme - Food Security: Biological Control - Sugarbeet Root Maggot
Previous laboratory research has demonstrated the virulence of an insect-pathogenic fungus, *Metarhizium anisopliae*, for causing mortality to sugarbeet root maggot larvae. Other work showed that establishment of spring-seeded cereal cover crops can provide low to moderate protection from feeding injury by this insect. The main focus of biological control research is now aimed at development of a truly integrated pest management system that combines the use of *M. anisopliae* with cover cropping for control of the root maggot. Preliminary findings suggest additive root protection results from combining the two control strategies. F-52, a commercialized strain of *M. anisopliae*, has been demonstrated as having improved virulence to the root maggot when compared with the previously used strain. Future research efforts will be aimed at evaluating the biological control potential of this alternative strain and its interactions with cereal cover crops for root maggot control.

Impact: The sugarbeet root maggot is the most serious insect pest of sugarbeet in the Red River Valley of North Dakota and Minnesota, and is capable of causing yield losses of 40 to nearly 100 percent in the absence or failure of control measures. For nearly 30 years, producers in the north

central and western United States have relied on chemical insecticides with the same mode of action for controlling the pest. Therefore, the potential threat of insecticide resistance development is a major concern, and alternative control materials are needed. Bio-based control materials that can be applied via conventional equipment would provide a readily adoptable alternative to traditional control that typically involves the use of chemical insecticides.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state integrated research and extension. This insect is a major pest in over two-thirds of the sugarbeet growing areas of the United States. Growers in ND, MN, CO, ID, MT, NE and WY are likely to benefit from this program.

Key Theme - Food Security: Preventive Pest Management - Sugarbeet Root Maggot
Trap cropping is being evaluated as a cultural strategy for protection of fields from yield losses associated with sugarbeet root maggot, *Tetanops myopaeformis*, feeding injury. Essentially, the concept involves planting sugarbeet, the insect's preferred host, in previous-year sugarbeet fields (root maggot overwintering sites) to delay or prevent their colonization of current-year sugarbeets in neighboring fields.

Impact: The available body of literature suggests that the sugarbeet root maggot is capable of causing yield losses of between 40 and 100 percent in the absence of control measures. Chemical insecticides are under frequent regulatory and public scrutiny and some have been shown to cause harmful impacts to non-target and beneficial organisms in crop production habitats. Thus, the development of cultural strategies for management of agricultural pests is a worthy endeavor. Development of cultural means for controlling this important sugarbeet pest could potentially allow for major reductions in chemical pesticide use.

Source of Federal Funds: Hatch and Smith-Lever

Scope of Impact: Multi-state integrated research and extension. This insect is a major pest in over two-thirds of the sugarbeet growing areas of the United States. Growers in ND, MN, CO, ID, MT, NE and WY are likely to benefit from this program.

Key Theme - Food Security: Genetic Resistance to Pests - Sugarbeet Root Maggot
In this long-term ongoing project, annual evaluations are carried out on cultivated varieties of sugarbeet, *Beta vulgaris*, and on wild accessions from the world collection of Beta germplasm to identify native sources of host plant resistance to feeding injury from the sugarbeet root maggot. If successful, genetic material from these evaluations will be made available for incorporation into elite commercial lines.

Impact: Host plant resistance to insect injury is an attractive insect management strategy, most notably due to its direct benefits that include reduced applicator exposure to insecticides and low risk to nontarget organisms. The potential for insecticide resistance in sugarbeet root maggot

populations, as well as the possible removal of conventional chemical insecticides from federal registration, also provide a strong impetus for the development of alternative strategies to manage this major insect pest of sugarbeet. Extensive grower adoption of cultural tools such as resistant varieties for controlling the root maggot could potentially allow for major reductions in the overall pesticide load on the environment in areas infested by the insect.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state integrated research and extension. This insect is a major pest in over two-thirds of the sugarbeet growing areas of the United States. Growers in ND, MN, CO, ID, MT, NE and WY are likely to benefit from this program.

Key Theme - Food Security: Preventive Pest Management - Lygus Bug

Lygus bug (*Lygus lineolaris*) infestations have caused significant late-season injury in North Dakota and Minnesota sugarbeet fields in recent years. This project has been broadened to include the three following major objectives: 1) characterize the seasonal activity and abundance of Lygus populations in major crop hosts of the Red River Valley; 2) quantify the effects of feeding injury on sugarbeet yield and quality; and 3) develop safe, cost-effective tools for controlling Lygus in sugarbeet.

Impact: The economic impacts of this sugarbeet pest are not well understood. However, tens of thousands of Red River Valley sugarbeet acres have been treated for its control over the past several years. To date, two years of field efficacy testing have been conducted. A major outcome of this work is the conclusion that control is achievable with foliar-applied insecticides; however, yield losses in excess of 20 percent are likely if the insecticides are tank-mixed with fungicides that are commonly required for cercospora leaf spot control Additional work on economic injury level and economic threshold establishment has been carried out. This research will provide more concrete information to assist producers in affected areas with making prudent pest management decisions. This investigation should lead to the development of an action threshold for growers to apply control measures and prevent economic injury, and the information generated is also anticipated to reduce the incidence of unnecessary insecticide applications when Lygus infestations are not at economically injurious levels.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state integrated research and extension. This insect has been a problem for producers throughout the sugarbeet growing areas of eastern North Dakota and all of western North Dakota.

Key Theme - Food Security: Preventative Pest Management - Sunflower Crop

Many insects attack the sunflower crop. Pests of this crop are unpredictable, varying from year to year, although outbreaks of one or more of these pests can be disastrous for the crop in localized regions. Because it is highly desirable to develop new environmentally friendly,

sustainable controls for insect pests in agriculture, we are identifying and developing host-plant chemicals for use in control of sunflower pests. Five varieties of sunflower were analyzed for content of two diterpenoid alcohols that stimulate egg-laying by female banded sunflower moth as well as for diterpenoid acids that are known to be toxic to insect species. The data showed variation in quantity of both alcohols and acids. Two of these chemicals are not volatile and appear to influence females only when they are on the plant. A number of volatile terpenoids are currently being tested for ability to attract female banded sunflower moth; if successful, these attractant chemicals have the potential to assist control of this pest, either by providing an effective monitoring tool for this pest, or by using them to remove female moths from the population.

Impact: Insects can have very significant impacts on the sunflower crop. For example, in 2001, roughly 70 percent of sunflower heads surveyed in North Dakota had some damage by caterpillars, and consequent loss of seed yield. Knowledge of the host-plant chemicals that influence these pests could lead to the development of new methods for insect control.

Source of Federal Funds: Hatch

Scope of Impact: Sunflowers are grown extensively throughout the mid-central states. This research is of potential benefit to sunflower growers from Manitoba to Texas.

Key Theme- Food Security: Breeding North Dakota Wheat For Resistance to Insect Pests

Farmers growing wheat in North Dakota face many challenges, two of which are the wheat midge and Hessian fly. The 1995 wheat midge outbreak in northeastern and north-central North Dakota caused estimated revenue losses of $30 million to wheat farmers. As well as being a pest and causing yield and quality losses to North Dakota farmers, the wheat midge may play a role in the spread of wheat scab (pers. Comm.. Bob Lamb, AgCanada). The Hessian fly appeared in North Dakota wheat during the summer of 2003 when farmers in two areas, one northwest of Devil's Lake and one north of Minot, reported Hessian fly in both Hard Red Spring (HRS) and durum wheat fields.

For wheat midge, we made progress in collaboration with NDSU plant breeders and NDSU microscopy specialists towards the development of North Dakota spring and durum wheat with resistance to wheat midge. Major accomplishments were: 1) testing of spring and durum wheat genotypes in the spring of 2004 for the transfer of a resistance gene effective against the wheat midge, and 2) microscopy work to determine the method of feeding of the wheat midge and the mechanism whereby wheat carrying a major resistance gene inhibits feeding by the wheat midge.

For the Hessian fly, we are using a colony of a North Dakota population of Hessian fly to determine whether there is any resistance present in currently-grown North Dakota HRS, white and durum wheats. We also have obtained 30 wheat genotypes with the 30 known *R* or resistance genes for the Hessian fly. We are currently growing these genotypes to increase seed.

Once we have sufficient seed, we will test our North Dakota Hessian fly population for virulence to each of the 30 resistance genes.

Impact: In the last decade, the wheat midge and Hessian fly have emerged as serious pests of durum and hard red spring wheat grown in North Dakota. Management practices including planting dates, scouting, and insecticide treatments, have mitigated the impact of these pests somewhat, but the best long-term solution is the introduction of insect-resistant wheat varieties. Multiple sources of that resistance would help prevent adaptations that might help the pest overcome resistance. When scouting reveals infestation, producers spend an estimated $10 per acre to control the wheat midge, a cost that would be all but eliminated by the introduction of resistant varieties. For the Hessian fly, insecticides can again be used to kill the pest; however, by the time the pest is found in the crop, it is usually too late to reduce crop losses.

Source of Federal Funds: Hatch

Scope of Impact: Statewide research

Key Theme - Food Security: Fusarium Head Blight in Wheat

Fusarium head blight (FHB or scab) is a major disease of spring wheat and durum wheat in North Dakota. An unprecedented epidemic of this disease occurred in eastern North Dakota in 1993, and severe outbreaks have occurred each year since 1993 throughout portions of the state, resulting in more than a $3 billion loss to North Dakota's economy over this time. As a result of these epidemics, producers in eastern North Dakota have sought alternative broadleaf crops, resulting in fewer spring wheat acres. Much of the durum wheat production has moved west in the state, an area traditionally drier and less susceptible to FHB than the east. However, in 2000 and 2001, severe outbreaks of FHB also occurred in north central and northwest North Dakota because of favorable weather for infection occurring during grain flowering. Yield losses in the region ranged from 10 to 90 percent and were especially severe in susceptible durum fields. Weather patterns were drier statewide in 2002- 2004, so overall loss due to FHB was much less, but pockets of severe infection still occurred in parts of the northeast and central districts of the state. Fungicide trials established in the affected regions have indicated that proper timing of an appropriate fungicide resulted in yield increases averaging 10-12 bushels/acre, with corresponding increases in test weight and market grade. Economic returns from use of the fungicides were between $21 - $28 per acre in 2004, based on current wheat prices and cost of the fungicides. Extension specialists provided this information on fungicide results to growers via numerous county and regional meetings, demonstrations and news releases. In 2004, the extension plant pathologist again applied for a Section 18 emergency exemption for a specific fungicide with the best efficacy against the disease, and it was granted by EPA. The fungicide was applied to approximately 1 million acres of wheat in 2004. An average net return of $25 per acre was realized, after cost of fungicides and indirect and direct costs were subtracted from the gross return/acre. This translates to a positive economic impact of $25 million for wheat producers in 2004.

Impact: Producers utilized fungicides as a management strategy on 900,000 acres of wheat and 160,000 acres of barley realized an average return of $25 per acre, resulting in an additional $26.5 million revenue to producers who used this strategy in 2003. The Extension Specialist wrote the specific exemption for use of the fungicide, which was sent to the N.D. Dept. of Agriculture and subsequently approved by EPA. Producers were provided training on proper use of the fungicide and how this strategy should be integrated with other management strategies for optimum control of FHB.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension.

Key Theme - Food Security: Sclerotinia Disease Development in Sunflower

Sclerotinia is a major disease of broadleaf crops in northeastern North Dakota. Because of the increased acreage of susceptible broadleaf crops, this particular disease is becoming a greater problem over larger areas. For example, in the fall of 1999 wet weather resulted in statewide problems with Sclerotinia head rot disease of sunflower causing losses reaching 60 to 70 percent in some areas. A similar situation was also observed in the fall of 2004. The National Sunflower Association estimated losses in 1999 alone at $1 million. Especially hard hit were confectionary sunflower producers who produce seeds for human consumption and bird feed. Sclerotinia tolerance levels are very low for confection seed producers and if sclerotia bodies or damage to the seeds exceeds 3 percent, the field is rejected for human consumption. Producers in 1999 and 2000 were faced with the problem of what to do with highly contaminated confection sunflower seeds. Extension specialists worked with a group of farmers in north central North Dakota to determine if significant reductions in sclerotia contact could be obtained through harvest machine adjustments or in cleaning of the grain sample after harvest. Field studies in the fall determined that some techniques might reduce harvested sclerotia body content, but a more thorough cleaning with specialized equipment would be necessary to reduce sclerotia content, and to some degree dark seed content, in confection seeds. Information gathered in the study was ultimately compiled into an extension publication that was widely used in the fall of 2000 as this problem reoccurred. Surveys of sunflower fields for Sclerotinia and other diseases have been conducted in 2001, 2002, and 2003. Additional information on the field surveys and biology and management of Sclerotinia in sunflower and other susceptible crops was made available in 2001, 2002, and 2003 via training sessions and contributions to a CD-ROM provided to county and area Extension personnel for grower training. Training sessions on how to deal with the large amount of sclerotia returned to the field after harvest have been ongoing in winter meeting of 2004/05.

Impact: Producers in the north central region who stored sunflower seed following best harvest practices were able to clean the seed and many producers were able to market clean loads that sold for contracted price of 13 cents per pound versus 5 cents per pound for bird seed or confection market. Producers were trained on the biology and management of Sclerotinia for sunflower and other susceptible crops.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension.

Key Theme - Food Security: Biological Control of Weeds, Pathogens and Insect Pest
Natural enemies of weeds, pathogens, and insect pests are a potentially-important component of integrated pest management strategies. These biological control agents offer a mechanism to reduce the impact of weed, diseases, and insect pests without the use of expensive and potentially dangerous chemical controls. A major research and extension effort involving the Departments of Entomology, Plant Science, and Animal and Range Sciences is under way to manage leafy spurge, a key weed pest of rangelands. Leafy spurge causes more than $23 million in losses each year in North Dakota. Insect predators of spurge, such as the Aphthona flea beetle, are being evaluated for impact and adaptability to local environments. Some of these experiments involve integration of the beetle with herbicide applications and interseeding with warm and cool season native grass species. Another project focuses on evaluating the impact of ground cover on the winter survivability of the Aphthona flea beetles. In addition, grazing animals that will eat spurge, such as sheep and goats, are recognized as a valuable management tool. Other research has identified grasses that will compete with spurge in the natural environment. All of these efforts reduce the need for herbicides while maintaining spurge populations at sub-economic levels. Biocontrol programs using predators, parasites and pathogens of insect pests such as banded sunflower moth, sunflower midge, sugar beet root maggot, Colorado potato beetle, and crucifer flea beetle on canola are all under way. Sclerotinia, the causal agent of white mold, is a fungus that limits production capacity of many row crops including sunflower, dry beans, canola, and soybean. Several biological control agents of Sclerotinia were recently found in North Dakota soils, including species in the genera Trichoderma, Giiocladium, Coniothyrium, and Sporidesmium. Some of these are being evaluated for their ability to control the pathogen. "Intercept," a commercially-produced biological control agent of Sclerotinia, is being investigated for its efficacy of white mold control in the field. The fungus Acromonium strictus is being investigated for its ability to control two storage diseases of potato, silver scurf and black dot. Several experimental biological control agents were evaluated in greenhouse and field trials for control of Fusarium head blight (scab) of wheat.

Impact: Biological control of leafy spurge is expected to be valued at $58 million per year by 2025 by restoring thousands of acres of rangeland to productivity and by reducing herbicide costs. Once established, biological control of leafy spurge and other pests will provide self-sustaining control without further input cost to the grower.

Source of Federal Funds: Smith-Lever and Hatch

Scope of Impact: Multi-state integrated research and extension. Growers in North Dakota and the surrounding states benefit from the leafy spurge biological control program. Leafy spurge flea beetles are redistributed in ND, MN, WY, SD, NB and MT.

Key Theme - Food Security: Genetic Resistance to Pests - Genes
A major objective of crop plant research involves the identification, characterization, and use of resistance genes effective against insect and disease problems. Sources of resistance to Hessian fly are being sought in wild relatives and ancestors of wheat and in cytogenetic stocks of wheat. In other studies, a recently-identified resistance gene, designated *Sn1*, effective against wheat midge, is being incorporated into wheat breeding lines and other germplasm as a first step toward incorporating this gene into new cultivars. Similarly, new sources of resistance to sunflower midge are being sought from wild relatives and other genetic stocks. Fusarium head blight (FHB) has caused more than $1.5 billion in combined small grains losses for producers in the Dakotas and Minnesota since 1993. Plant pathologists developed screening techniques for use in the greenhouse and in the field to test thousands of lines of small grains for resistance to the disease. Alsen, a FHB-resistant hard red spring wheat variety recently released by NDSU, was developed with this approach. Tens of thousands of acres have been planted to this variety in recent years. Recently, two other scab-resistant varieties (Steele ND and Glenn) were developed with this approach. Other pathologists are working to identify potential new sources of resistance to problematic races of the leaf rust fungus now firmly established in the northern Great Plains. Future goals are to work with breeders to combine FHB and rust resistance into new cultivars. The potato breeding program has a major objective of developing cultivars with late blight resistance. Several selections have been identified with good resistance to the new genotypes present in the United States. One objective of dry bean pathology is to identify new sources of resistance to rust and white mold for use by the bean breeding program. Incorporating disease resistance genes into soybean cultivars has major impact on improving soybean production and profitability for growers. This is especially pertinent now because soybean is the most widely-grown row crop in North Dakota and Minnesota and because soybean cyst nematode, the most destructive disease of soybean, is now in both states. Extensive research in this area is now producing soybean cultivars with disease resistance.

Impact: Genetic resistance is the most efficient and safe way to control diseases and pests of crops. Genetic resistance eliminates or reduces the need for other pest management inputs and reduces grower expense. Genetic crop resistance saves growers management time because of reduced need for monitoring of pest populations. The economic impact of the FHB resistant wheats should result in millions of dollars saved over growing FHB susceptible cultivars. This will also save huge amounts in reduced fungicide sprays. Late blight resistance in commercial potato production could save millions in reduced spray applications and improved yields. Resistance to rust and white mold in dry beans would be elimination of two of the major problems in the dry bean industry. Incorporating disease resistance in soybean cultivars has had a major impact on improving soybean production especially in the area of root rot.

Source of Federal Funds: Smith-Lever and Hatch

Scope of Impact: Multi-state integrated research and extension. Growers in the tri-state area of MN, ND and SD and in Manitoba profit from resistance to pests in the major crops. Resistance to FHB alone is worth millions to cereal growers. In addition, breeders and pathologists have added resistance to important pests in the minor crops.

Key Theme - Food Security: Mycotoxins in Cereal Grains
Viable Fuarium spp. can become post-harvest food safety and quality problems in cereals, particularly in malting barley. To find, evaluate and develop technologies to allow utilization of Fusarium-head-blight-infected cereal grains.

Utilization of Fusarium-infected barley for malting may lead to mycotoxin production and decreased malt quality. Methods for treatment of Fusarium infected barley may prevent these safety and quality defects and allow use of otherwise good quality barley. Gaseous ozone and hydrogen peroxide were evaluated for effectiveness in reducing Fusarium survival (FS) while maintaining germinative energy (GE) in barley. Gaseous ozone treatments (GOT) included concentrations of 11 and 26 mg/g for 0, 15, 30, and 60 minutes. Hydrogen peroxide (HP) treatments included 0, 5, 10, and 15% concentrations with exposure times of 0, 5, 10, 15, 20, and 30 minutes. For GOT, in naturally Fusarium-infected barley, a decrease (24-36%) of FS occurred within 15 minutes of exposure at either concentration. GE was affected by 30 minutes at both concentrations in naturally Fusarium infected barley, but not in sound barley. GOT did not cause any significant effect on GE in sound barley at either concentration over the full 30 minute exposure time. For HP, FS was significantly decreased (50-98%) within 5 minutes of exposure. With the exception of two treatments (10% and 15% HP agitated for 20 minutes) GE was not statistically significantly different from the control in naturally Fusarium infected barley. In sound barley, HP had no significant effect on GE. The results suggest that GOT and HP may have potential for treatment of Fusarium infected malting barley.

Impact: Barley with mild FHB may lead to the production of mycotoxins during malting. Maltsters have strict limits for malt quality that ultimately have severely affected barley production in the USA. Treatment of FHB infected barley may prevent mold growth and further mycotoxin production during malting allowing utilization of otherwise good quality barley. Another issue for food-grade malt producers is high microbial loads in finished malt. The treatments we find effective for control of Fusarium during malting may also be effective in reducing levels of other undesirable microbial flora.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research

Key Theme - Food Quality: Influence of Storage Conditions on Soybeans for Tofu
Soybeans are stored on the farm or during shipping after harvest until they are processed for foods. Tofu is a key value-added soy food. Under certain environmental conditions, the food and nutritional qualities of soybeans deteriorate and lead to tremendous economical loss if they have reduced processing yield of tofu. NDSU researchers are studying the molecular and functional changes of soybeans stored under various temperatures and humidities to learn how these changes influence the texture, color and flavor of tofu products.

Researchers have continued to characterize proteins isolated from stored soybean and to characterize the color, yield, and quality of tofu made from stored soybean. They have

characterized the structures of the glycinin isolated from adversely storage conditions and mild storage conditions. The glycinin showed an increase in sugar content, and a reduction in hydrophobic interactions after three months. The protein structures from three mild storage conditions did not change significantly after 18 months of storage. The molecular mass of glycinin remained in the range of 313-340 kDa during the entire storage duration of the storage. Another objective this study was to investigate the influence of a total of 18 storage conditions on Proto and Vinton soybeans as related to soymilk and tofu making. Storage conditions covered relative humidity (RH) from 55% to 80% and temperature from 4 C (at cooler) to 50 C. The duration time varied from several weeks to 15 months. After storage and processing into soymilk and tofu, various physical and chemical properties were determined. The results showed that soybean color became darker with time. Color changes were mainly caused by temperature, although high RH also made contribution. For 1 year duration, 30C and 75% were crucial points to influence tofu making. Beyond these points, a rapid deterioration in the soybean quality was observed, which was characterized by substantial decreases in water absorption rate, solid content in soymilk, protein extraction rate, soymilk pH and tofu yield. Although the protein content decreased in soymilk, it increased in tofu due to a reduction in water binding capacity and product yield. Tofu hardness, brittleness and elasticity increased with storage time, which could be explained by the increase in the tofu solid content. The effect of storage on biochemical changes under these medium to high humdities and temperatures and under on-site farm storage is being continued.

Impact: Total soybean production has exceeded 3.7 million hectares. It has become the second largest group of crops produced in North Dakota. Characterizing physical, chemical, nutritional and microbiological properties of the soybean will lead to better utilization of this crop. Soybean is well known for its health benefit and the consumption in the Western world is increasing quickly. Our work on storage effect contributed to the quality improvement of soybean and soy food products and, therefore, will lead to the improvement in the utilization of food soybean, and will benefit both the growers and the consumers.

Source of Federal Funds: NRI-CGP

Scope of Impact: Multi-state research

Key Theme - Foodborne Pathogen Protection: Determining Potential Foodborne Pathogen Risks from Bison

The American Bison is a relatively new, emerging meat species gaining increased popularity in U.S. and European meat markets. However, little is known regarding this meat type except that it is not subjected to the same subtherapeutic growth-promoting hormones or antimicrobials often used in the beef industry. Therefore, these animals and their natural microbiological flora may not be subjected to the same selective pressures seen elsewhere. Currently, little is known of the microbiological safety of bison meat destined for human consumption. This study offers the opportunity to examine and study the epidemiology of an emerging meat species. The study will examine aspects of the microbiological safety of bison meat and its production to determine potential foodborne illness risks for man.

Impact: Data obtained from these studies has and will continue to provide useful information on the microbiological status of a unique meat product. Bison ranchers and processors have been interested in the value of the data and consider it useful when comparing their product with other meat species. The data from this study will also allow consumers and processors to be more informed in their choices of meat. Our data will also provide interesting information for other researchers in antimicrobial resistance and foodborne pathogens of animals - we have shared isolates with fellow researchers.

Source of Federal Funds: USDA CSREES NRI

Scope of Impact: Multi-state research

Key Theme: Food Quality: Intelligent Systems for Evaluating Crops and Food Products.
A computer-imaging system and techniques were developed for color classification of French fry samples. Neural network models were developed using back propagation and probabilistic neural network architecture for classifying a French fry sample into one of the possible three color groups. The back-propagation algorithm provided a classification accuracy of 93%. A computer vision technique was used to evaluate internal hollowness, an important textural attribute of French fries. Three computer vision algorithms were implemented and evaluated on color French fry cross section images. A maximum of 100% classification accuracy was obtained. Self-organizing map combined with a fuzzy clustering for color image segmentation of edible beans were developed and evaluated. It outperformed the spatial thresholding method in identifying the objects. The average percent of correctly matched pixel was 99.31%. Quality of edible beans was evaluated by computer vision using rough sets theory as pattern classification tool. It provided 99.6% and 90.3 correct recognition of the training and tests sets respectively. The discriminant analysis generated 5.6% more error than the rough classifier did. A prototype quality control system for nondestructive evaluation of confectionary sunflower was developed and evaluated. Spectral signal were acquired using 700-1050 and 900-1700 nm. Statistical, neural network and other spectral signal processing techniques were developed and evaluated to discriminate among good, moldy and rancid sunflower kernels. The maximum discrimination accuracy using neural network was 100%. The 900-1700 nm spectrum provided better accuracy than that provided by 700-1050nm. A non-destructive, non-contact intelligent system was developed to predict chlorophyll content of potato leaves. The walking type sensor provided an average prediction accuracy of 84% with a correlation coefficient between actual and predicted chlorophyll content >0.9. Multi-spectral and color imaging techniques for nitrate and chlorophyll determination of potato leaves were evaluated in controlled environment. Multi-spectral band images were found to be linearly correlated with R square of 0.95 with chlorophyll contents. Auto-fluorescence characteristics of meat was found to be useful for evaluating the spoilage of meat.

Impact: This research shows the potential of computer-based imaging and sensing techniques for quality characterization of agricultural and food products. Once further validated and proved, this technique may be used for developing sensors or intelligent sensing systems for quality characterization of agricultural and food products.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research

Key Theme:- Food Safety: Development of Intelligent Quality Sensors
The long-term goal of our research projects is to develop miniaturized portable sensors to provide quality information about specific food and agricultural products. Researchers have three on-going projects. The research project focuses on the development and evaluation of intelligent sensors (based on electronic nose technology) for evaluation of quality and safety of selected food products, spoilage of beef, contamination of beef (with Salmonella), mold growth in wheat and barley, quality of soymilk. Researchers adopted sensor-fusion concept to investigate the capability of infrared gas sensing mechanism for quality and safety characterization of the selected food products included in our study. For the proposed intelligent electronic sensors, they are following a modular approach for developing and/or evaluating different sensor/sensing modules including a commercial system, Cyranose 320 TM. Each sensing module has its different sensing mechanism or characteristics. Experiments were conducted using GC-MS and SPME (solid phase micro extraction) technique identification of volatile compounds of packaged meat (beef) during spoilage and contamination with *Salmonella.* **3-Hyroxy-2-Butanone** and **Acetic acid** were found as two indicator compounds representing spoilage of beef in packaged condition. We evaluated three different electronic nose modules for classification of spoiled and ***Salmonella*** contaminated beef. Two storage temperatures (4 and 10 degree C) have been used for storing the meat samples and testing these electronic nose modules. The highest total accuracies obtained for classifying spoiled beef samples (out of all three different electronic nose modules) was 100% for both the storage temperatures. For classification of ***Salmonella*** contaminated beef, the highest total accuracy obtained (out of all three electronic nose modules) has been 89 % for 4 degree storage and 85% for 10 degree storage condition. Additional work is continuing to further validate these findings on larger sample size. Current work is underway for evaluating porphyrin and metalloporphyrin thin film materials for their potential for sensing of volatile compounds. Our parallel study on grain quality sensing revealed that the production of volatiles and ergosterol increased with increase in moisture content and storage time. Performance evaluation of two electronic nose module for their combined performance in identifying DON (deoxynivalenol) content in stored barley based on olfactory sensing of head space of grain. Provided a total maximum classification accuracy of 69%. We are also evaluating advanced signal processing and pattern recognition techniques for analysis of electronic nose signals so that these new techniques could provide better accuracies. Work is also underway to obtain FT-IR spectra of the headspace of spoiled meat samples at different days of storage (representing different spoilage conditions) and to check if the indicator compounds (identified from our GC-MS study) could be identified from the FT-IR spectra.

Impact: Miniaturized sensors can help provide consumers with safe and high quality food products. The proposed intelligent sensors, based on electronic nose technology, show promise. The proposed sensors could alert consumers of possible safety risk before the food is consumed.

Source of Federal Funds: USDA-CSREES-Special Grant

Scope of Impact: Multi-state Research

Key Theme:- Food Safety: Enhancing the Competitiveness of U.S. Meats
Impacts of functional food attributes and health claims in beef and bison marketing are not well defined or integrated into valuation models. The changing structure of the beef industry may have conflicting impacts on traceability, disease risk factors and valuation of associated meat products. This project determines the value consumers place on meat product health claims and associated functional food attributes. The project examines beef supply chain structures and how shocks impact channel participants.

An outbreak of Bovine Spongiform Encephalopathy (BSE) can have devastating impacts on the beef industry and supply channel participants. A study was conducted to simulate the impacts of a BSE outbreak on North Dakota beef producers and associated financial capital providers throughout the North Dakota beef supply chain. A one-time price shock during different phases of the cattle cycle was modeled on market animals, breeding livestock and pasture/grazing land owned by North Dakota producers. Data from 482 producers in the North Dakota Farm Business Management Education Program were used in the study. The simulation produced changes to the overall financial health of the producers and the viability of their businesses. These changes then impacted the financial health of agricultural portfolios of North Dakota rural banks and their long-term abilities to finance cattle production and marketing. Results showed deterioration of financial health of varying severity relative to the phase of the cattle cycle and the market price impact or severity and longevity of the outbreak. Plans are to continue the study in other cattle producing areas of the country.

Impact: Results show that during a time of average cattle prices or middle of the cattle cycle, a minimal BSE outbreak can have extreme adverse impacts on North Dakota cattle producers. Beef producers on average did not receive sufficient revenues to cover all term debt obligations and average ending cash balances become negative. A minimal outbreak (similar to a single BSE discovery) during the liquidation phase or high price phase of the cycle produced less severe short term damage to the financial health of producers, but did cause negative return on equity (ROE), which is not sustainable over the long term. A severe outbreak during the expansion (low price) phase of the cycle caused extreme short and long term negative impacts, including negative ROE, cash balances and net income and an inability to service debt, indicating potential loan foreclosures and a severe disruption and loss to the North Dakota cattle industry.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state Research

Key Theme - Food Quality: North Dakota Beef Quality Assurance

Beef Quality Assurance (BQA) training sessions have been held throughout North Dakota for the past six years to improve the quality, safety and consistency of beef, resulting in a more consumer-acceptable product. A recertification program has been developed to allow producer to become recertified using a variety of methods, including attending a BQA training session or becoming recertified over the Internet.

Impact: As a result of these training sessions, 1,900 operations have been certified, and more than 2,500 cattle producers were educated in beef quality assurance practices. These operations produce more than 349,000 head annually, 36 percent of the state's calves. Comparison of pre- and post-tests taken by participants at each session found an average improvement of 22 percent in test scores. Producers and marketing organizations report a heightened interest in North Dakota BQA certified cattle by alliance programs such as Nebraska Corn Fed Beef. These groups have also reported some increased prices for calves certified in the North Dakota BQA Program. To improve the visibility of BQA certified feeder cattle, a "Feeder Fax" website was developed in 2002. This site allows producers to list their feeder calves for sale. Included in the listing is number of cattle, sex, approximate weight, breed composition, past production and carcass data, prevention animal health program, and date and location of sale. The number of cattle listed on this site has increased over the past year.

Producers have reported receiving up a $7 per hundredweight premium on their feeder cattle because the were certified through the BQA program. As a result of the BQA training program, both county extension agents and veterinarians report a change in producer's behavior in how they administer injections and in their record keeping practices. They report producers are moving their injection site from the hind quarters to the neck, and are keeping more detailed animal health, husbandry, and production records.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension.

Key Theme - Food Quality: The Impact of Micronutrients on Meat Quality and Safety
Increasing the selenium (SE) content of meat could contribute to the healthfulness of humans. This project investigates the quality and safety aspects of the incorporation of selenium in meat.

Selenium contains antioxidant properties which may increase meat quality. Forty-three crossbred steers were stratified by body weight and assigned to one of four treatments: Se adequate or supranutritional Se provided as high Se wheat, high Se hay or sodium selenate. At the conclusion of the trial, steers were slaughtered and a shank muscle sample obtained for Se analysis. At 48h postmortem, NAMP #180 strip loins were removed from the carcass. 2.54 cm thick steaks were cut from the cranial end and used for retail shelf studies and nutrient analysis. Additional steaks were utilized for in-house and consumer sensory evaluation. No differences were seen between treatments for muscle dry matter, ash, crude protein, or fat. Shank selenium concentrations were different between treatments where CON=SEO, less than hay, less than wheat(28.27,39.28.90.31, and 108.58 ppm). Expressible moisture, ph, cooking loss, and drip loss

were not different among treatments. There was a reduction in overall quality as indicated by a change in color. However, no differences were found between treatments for nutritive analysis or shelf life of product. When we did in-house or consumer sensory evaluation for flavor, tenderness, juiciness, and overall acceptability the participants found the product acceptable in all aspects about 80% of the time. This leads us to conclude that increased levels of Se in the meat did not have any deleterious effects on the overall taste. We also asked consumers specific questions about selenium to see how aware they were of this mineral and its relation to health. Sixty eight % were not aware of the benefit of selenium as it may be related to the incidence of heart disease and cancer, probably through its antioxidant functions. Another 79% were not aware of the fact that increasead selenium in the diet can reduce the risk of heart disease and another 85% were not aware that selenium supplements can lower cancer and death rates from lung, prostate, and colon cancer.

Impact: Selenium content can be increased in beef by feeding an organic source of selenium. The nutritive value of beef can be increased without any deleterious effects on shelf live or consumer acceptance of beef.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Allocated Resources ($ x $1,000)		**FYO4**
1862 Extension ($)	Smith-Lever	784
	State	1,176
	FTE	28
1862 Research ($)	Hatch	544
	State	800
	FTE	16

Goal 3: A Healthy, Well-Nourished Population

Overview: *As reported in by the National Centers for Disease Control, nearly a third of all adults in the United States are classified as obese. About 30 percent of adults 20 years of age and older, more than 60 million people had a body mass index of 30 or greater compared to 23 percent a decade ago. The percent of children who are overweight also continues to increase. Among children and teens ages 6-19, 16 percent, more than 9 million, are overweight, triple the proportion in 1980. Obesity that begins in childhood often remains in adulthood and could set the stage for many health issues including heart disease, certain forms of cancers and type 2 diabetes.*

Risk for several chronic diseases such as heart disease, cancer, type 2 diabetes, and osteoporosis are related to diet and physical activity. These health conditions cost society an estimated $200 billion a year in medical expenses and lost productivity. Despite strong evidence supporting the health benefits of a healthy lifestyle, Americans, including North Dakotans, do not meet national nutrition and health goals.

Research by the Centers for Disease Control and Prevention estimated that medical expenditures in the United States attributable to obesity amounted to $75 billion dollars in 2003. Nationally, researchers estimate that unhealthy eating and physical inactivity are responsible for 35 percent of premature deaths in the United States, or about 1200 deaths per day. Cancer, the second leading cause of death in North Dakota, accounted for 23 percent of deaths in 1997. Despite research on the health benefits of fruits and vegetables, particularly for reducing the risk of cancer, about 80 percent of North Dakota adults do not consume the recommended five or more servings of fruits and vegetables a day.

With regard to physical activity, nearly 50 percent of American youth are not vigorously active on a regular basis and one-fourth of American young people ages 12-21 report no vigorous physical activity. Participation in all types of physical activity declines as age and grade in school increases. Among North Dakota students in grades 9 to 12, 63 percent do not participate in even one physical education class during the school week, and about 37 percent fall short of recommendations for moderate physical activity on five or more days of the week. Nearly 48 percent of North Dakota high school students report they are trying to lose weight, and 83 percent do not eat the recommended five servings of fruits and vegetables daily. About 73 percent said they drink less than three glasses of milk per day. Habits begun in childhood often persist in adulthood. About a fourth of the adult U.S. population fails to engage in physical activity during their leisure time while only 15 percent regularly engage in vigorous physical activity during leisure.

About 6.1 percent of the total adult population of North Dakota has diabetes, up from 3.6 percent in 1994. That rate rises to more than 14 percent for those 64 and older. Among Native Americans in North Dakota, more than 15 percent have diabetes. NDSU has developed a range of programs that target those problems. In addition, the variety of crops grown in North Dakota presents opportunities for producers and processors to look for innovative ways to improve the healthy qualities of the food supply.

The NDSU Extension Service has helped form 20 “5 Plus 5" coalitions across the state to bring together local experts to increase the consumption of fruits and vegetables to at least five servings daily and increase physical activity levels to at least 30 minutes of moderate activity on five or more days of the week. In one multi-session county 5 Plus 5 program with 53 participants, 90 percent reported changing their food choices to include more servings of fruits and vegetables, 53 percent of participants reported eating five or more servings of fruits and vegetables daily compared to 33 percent on the pre-survey, and 58 percent reported increasing the number of times they engage in moderate physical activity per week.

"On the Move to Better Health" is a school-based collaborative program of public health and extension targeting fifth grade students and promoting a variety of healthy lifestyle behaviors. The month-long program promotes fruit and vegetable consumption, physical activity, and healthy snacking/drink choices. In the past four years, more than 2,000 children have completed the program. Surveys of fifth grade students indicate the number of students consuming the recommended number of daily fruits and vegetables increased from 15 percent as reported on the pre-test to 34 percent on the post-test. The number of children consuming three or more servings of milk per day increased from 77 percent to 85 percent. Children engaging in physical activity at least five days a week increased from 68 percent to 81 percent.

In an information campaign directed toward women statewide, awareness of folic acid has significantly increased. A statewide task force has implemented the campaign statewide. According to the most recent national Gallup Survey, of the total population, folic acid awareness increased to 79 percent from 52 percent in 1995. Among women ages 18-44, 80 percent of North Dakota women were aware of folic acid compared to 70 percent of U.S. adults nationally. Only five infants were born in North Dakota with neural tube birth defects last year.

For some families, education in basic food shopping, selection, budgeting, menu planning and safety practices are needed to improve health and nutrition. In six North Dakota counties, the Expanded Food and Nutrition Education Program teaches limited-resource audiences how to improve their dietary practices and become more effective managers of available food resources. Evaluations show 88 percent of homemakers showed improvement in one or more nutrition practices such as plans meals, makes healthy food choices, prepares foods without adding salt, reads nutrition labels or has children eat breakfast. Participants in the food safety classes received food thermometers to ensure proper cooking temperature of their food. Follow-up evaluations show 57 percent of homemakers showed improvement in one or more of the food safety practices such as thawing and storing foods properly. Surveys show a new curriculum entitled "Money for Food" helped 81 percent of homemakers improve one or more food resource management practices, such as meal planning and making price comparisons.

In a partnership with the North Dakota Department of Health and the Dakota Diabetes Coalition, NDSU Extension has mapped the location by county in North Dakota of health professionals working in diabetes (dietitians, certified diabetes educators and physicians). A workshop will introduce the curriculum,"Dining with Diabetes," to North Dakota to provide diabetes nutrition education for medically underserved areas. This curriculum partners local Extension agents with dietitians or certified diabetes educators to present a food-based curriculum to help diabetics make better food choices.

Key Theme - Human Health: Fruit and Vegetable Consumption and Inactivity

Cardiovascular disease is the leading cause of death in North Dakota. Nationally, 40 percent of the deaths in the United States are due to heart disease and stroke, with a national annual health care cost of $260 million. Proper nutrition and regular physical activity are two ways to reduce the risk of cardiovascular disease and other illnesses. A North Dakota Department of Health survey found that only 18 percent of North Dakota adults eat five servings of fruits and

vegetables per day and 34 percent of North Dakotans are completely physically inactive outside of work.

In a collaborative effort with the North Dakota Governor's "Healthy North Dakota" initiative, the North Dakota Department of Health, NDSU Extension Service and other agencies and institutions statewide are promoting healthy behaviors. The 5 Plus 5 program promotes eating at least five servings of fruits and vegetables and getting physical activity on five or more days of the week. Participants in 5 Plus 5 programs range in age from children to adults. Programming has included multi-session walking groups and classes in businesses and community settings. For example, more than 400 people participated in a five-county 5 Plus 5 "Walk Northwest North Dakota" Community project. People from neighboring communities in Montana also participated.

Impact: Twenty community-based groups, some multi-county in scope, across North Dakota have received "5 Plus 5" recognition for their community coalitions. In a multi-session county 5 Plus 5 program with 53 participants, 90 percent reported changing their food choices to include more servings of fruits and vegetables, 53 percent of participants reported eating five or more servings of fruits and vegetables daily compared to 33 percent on the pre-survey, and 58 percent reported increasing the number of times they engage in moderate physical activity per week.

According to a post-survey of 400 participants in a walking program, 80 percent reported walking five to seven days a week, 64 percent reported their daily steps increased overall, and 37 percent met the goal of walking 10,000 or more steps daily. About 86 percent planned to continue walking on a regular basis after the program ended.

Source of federal funds: Smith Lever

Scope of Impact: Statewide extension

Key Theme - Human Health: Youth Obesity and Inactivity
The prevalence of overweight and obesity among the nation's children is on the rise, particularly among minority populations including Native Americans.

"On the Move to Better Health" is a school-based collaborative program of public health and extension targeting fifth grade students and promoting a variety of healthy lifestyle behaviors. The month-long program promotes fruit and vegetable consumption, physical activity, and healthy snacking/drink choices. The program includes a parent component and is evaluated using pre and post-test surveys. A variety of community partners help implement the program, which is funded in part by local PTA chapters.

Impacts: In the past four years, more than 2,000 children have completed the program. Pre- and post-test results have indicated increases in knowledge of nutrition and physical activity. The program has been packaged and distributed for statewide use, and a video was created. According to surveys of fifth grade students, the number of students consuming the

recommended number of daily fruits and vegetables increased from 15 percent as reported on the pre-test to 34 percent on the post-test. The number of children consuming three or more servings of milk per day increased from 77 percent to 85 percent; and the number of children consuming more than two servings of soda pop per day decreased from 28 percent to 17 percent. Children engaging in physical activity at least five days a week increased from 68 percent to 81 percent, and children watching two or more hours of television per day dropped from 72 percent to 55 percent.

"Exploring the Pyramid with Professor Popcorn" was a nutrition education project conducted in an elementary school on a North Dakota Indian reservation. Most students at the school are eligible for free or reduced-price meals, and standardized test scores in the district are far below state average. About 260 students in grades 1-4 participated in monthly classroom lessons with hands-on activities and games, using a curriculum developed at Purdue University. Topics included healthy eating, safe food handling techniques and incorporating daily physical activity. Lessons took cultural values, traditional foods and food patterns into consideration. Monthly take-home newsletters with nutrition tips and recipes accompanied the classroom lessons and informed families of in-class activities. To track physical activity, students monitored their daily physical activity level with pedometers for five school days. Evaluation was conducted using pre/post surveys.

Impacts: On the post-survey, 73 percent responded that they "almost always" drink milk or eat cheese at least three times a day, compared to 29 percent on the pre-survey. On the post-survey, 88 percent responded that they are physically active every day compared to 54 percent on the pre-survey. As a result of this intervention, 93 percent of participants report they are eating more fruits and vegetables. Participants, grades 2-4, averaged 2.4 miles a day (4800 steps) during school time for a five-day pedometer tally of 2,154 miles for the school.

Source of federal funds: Smith Lever

Scope of Impact: Statewide Extension

Key Theme - Human Health: Calcium Consumption among Youth

Calcium is the nutrient most likely lacking in the American diet. According to the USDA, 70 percent of pre-teen girls and 60 percent of pre-teen boys do not meet daily calcium recommendations. Calcium-rich foods benefit overall bone health, which is important for growing children and teens. This in-school educational intervention used education and promotion to increase calcium consumption and knowledge/awareness among pre-teens and their parents of the role 3-A-Day of dairy plays in building strong bones. The eight-month effort included monthly classroom lessons with participation incentives, educational materials in the libraries, monthly "Dairy Day" taste testing activities in the cafeterias for all students in two schools, and activity booths at school carnivals. Parents received newsletters designed to improve knowledge of calcium-rich foods' health benefits. The 83 participants (72 percent Caucasian, 4 percent Hispanic, 9 percent American Indian, 8 percent Asian or Pacific, 17 percent Bosnian, African American or other) were from five fourth-grade classrooms at two local

elementary schools. These schools have the highest subsidized school lunch program participation rate.

Impact: About 65 percent of participants correctly identified four as the number of servings of calcium-rich foods kids ages 9 to 18 need, compared with 32 percent correctly answering the question on the pre-test. Sixty-five percent of participants correctly identified that bones grow the most during the teenage years, compared with 33 percent on the pre-survey. Ninety-eight percent of the students indicated they were drinking more milk and eating more calcium-rich foods after the eight-month project.

Source of federal funds: Smith-Lever

Scope of Impact: County level extension

Key Theme - Human Health: Folic Acid Consumption

Research shows that folic acid intake prior to pregnancy and throughout the first trimester can prevent 50-70 percent of neural tube defects. Because half of all pregnancies are unplanned, the Centers for Disease Control and Prevention (CDC) recommends all women of childbearing age consume 400 mcg of folic acid each day. Two-thirds of women in the United States report consuming insufficient levels of folic acid. Preventing birth defects would ultimately have a significant impact on the reduction of health care costs. According to the CDC, the average lifetime health care cost to society for a child born with spina bifida is more than $530,000. In addition to prevention of birth defects, a growing body of scientific research links adequate folic acid with reduced risk for heart disease, certain types of cancer and possibly, Alzheimer's disease.

This project, with some funding from March of Dimes, targeted 18-24-year-old women across North Dakota with folic acid education based on the CDC's "Ready or Not" national campaign. Collaborators included extension agents, public health nutritionists, college wellness coordinators, nurses, pharmacists, and dietetics students from two campuses. The multi-faceted campaign used radio, newspaper ads, bathroom stall ads, radio interviews, newspaper columns, brochures, auxiliary labels on prescriptions and peer educators to reach women with information to help prevent future birth defects. Campus promotions were held in cafeterias, libraries, health centers, dorms and sororities. The North Dakota Folic Acid Task Force was nationally recognized for its innovative folic acid education by the March of Dimes.

Impact: Impact was evaluated in several ways: locally, statewide and nationally. Survey results collected by task force members from 1,633 participants in educational displays at health fairs, bridal shows and other events were as follows:

- 88 percent knew that folic acid can help prevent birth defects.
- 60 percent identified leafy green vegetables and multivitamins as good sources of folate/folic acid.
- 68 percent of the survey participants recognized that folic acid is a vitamin.

- 56 percent were able to identify the daily recommendation for folic acid (400 micrograms)
- 65 percent knew that half of pregnancies are unplanned.

A nationwide Gallup Organization random telephone survey with 20,903 adult participants, including 400 in North Dakota, was conducted by the March of Dimes. The results were as follows:
- Awareness of folic acid was higher in North Dakota than nationally. Of the total population, 63 percent of North Dakota adults were aware of folic acid compared to 60 percent of U.S. adults nationally. Among women ages 18-44, 80 percent were aware of folic acid compared to 70 percent of U.S. adults nationally.
- About 33 percent of North Dakota respondents reported taking a vitamin supplement containing folic acid or a folic acid supplement daily compared to 24percent nationally.

As a result of education and fortification of grain-based foods, birth defects have significantly decreased nationwide in the past five years. According to health department data, birth defects have decreased in North Dakota. Only five infants were born with neural tube defects in North Dakota in the past year.

Source of federal funds: Smith-Lever

Scope of Impact: Statewide Extension

Key Theme - Human Nutrition: Expanded Food and Nutrition Education Program
The Expanded Food and Nutrition Education Program (EFNEP) teaches limited-resource audiences how to improve their dietary practices and become more effective managers of available food resources. The nutrition education assistant (NEA) helps families to increase knowledge of the essentials of human nutrition, helps in their ability to select and buy foods that satisfy nutritional needs, and improve practices in food production, preparation and food safety.

Impact: A variety of delivery methods are used to improve nutrition practices in each of the six counties where we reach adults and youth through EFNEP education. Evaluations show 88 percent of homemakers showed improvement in one or more nutrition practices such as plans meals, makes healthy food choices, prepares foods without adding salt, reads nutrition labels or has children eat breakfast.

Source of federal funds: Smith Lever

Scope of impact: Six counties, four of the sites are located at tribal reservations.

Key Theme - Human Nutrition: Food Safety
The EFNEP Program focuses on increasing the ability of families receiving food stamps to make wise use of their food dollars. This is accomplished by providing classes to low-income

audiences on nutrition and meal planning; food purchasing, preparation, and safety; and food resource management.

Impact: Staff received training on the food safety. Participants in the food safety classes received food thermometers to ensure proper cooking temperature of their food. Follow-up evaluations show 57 percent of homemakers showed improvement in one or more of the food safety practices such as thawing and storing foods properly. Also, 61 percent of participants at entry into the EFNEP program demonstrated acceptable food safety practices. At the end of the program, 86 percent of the participates demonstrated acceptable food safety practices.

Source of federal funds: Smith-Lever

Scope of impact: Six counties, four of the sites are located at tribal reservations

Key Theme - Human Nutrition: Food Resource Management
One of the overall goals in the area of food resource management for the past year was to help clients manage their food budget. Staff used the new curriculum developed by the University of Wisconsin entitled "Money for Food."

Classes are often held at a variety of cooperating agencies such as tribal organizations, WIC or Head Start.

Impact: North Dakota residents attended food resource management programming. Participants defined a variety of means to help them effectively manage their limited resources. Surveys show 81 percent of homemakers showed improvement in one or more food resource management practices, such as plans meals, compares prices, does not run out of food or uses a grocery list. Also, 22 percent of the participants at entry level demonstrated acceptable practices of food resource management, compared to 53 percent at the end of their series of classes.

Source of federal funds: Smith-Lever

Scope of impact: Six counties, four of the sites are located at tribal reservations.

Key Theme - Human Health: Childhood Obesity
Obesity is on the rise among children. National data indicates that for youth 6-19 years of age that approximately 15 percent are obese and another 15 percent are overweight (National Health & Nutrition Examination Survey, NHANES). The percentage of children who are above the 95th percentile for BMI has nearly tripled in the past three decades from 4-5 percent in the early 1970s to 15 percent in 1999-2000 (NHANES data). Children who are overweight have an increased incidence of type 2 diabetes and risk factors associated with heart disease such as elevated blood pressure and blood cholesterol.

Data from North Dakota high school students (YRBS 2001) indicated that 12.2 percent were at

risk of becoming overweight; 9.2 percent were overweight; 31.9 percent thought they were overweight; 47.5 percent were trying to lose weight. For 2003 in North Dakota, 82.7 percent of high school students reported eating fewer than five servings of fruits and vegetables and 73.9 percent reported less than three glasses of milk per day. Fifty percent of high school students reported drinking more than 12 ounces of sweetened beverage per day. Almost two-thirds (62.8 percent) of North Dakota high school students in 2003 reported not taking a daily physical education class. More than half (57.3 percent) reported watching television or playing video games for more than 2 hours per day. About one third (37.2 percent) of North Dakota high school students reported not meeting the criteria for a sufficient amount of physical activity (either vigorous or moderate). Vigorous physical activity was defined as activity making you sweat or breathe hard $\geq$ 20 minutes on three of the seven days preceding the survey. Moderate physical activity was defined activity that did not make them sweat or breathe hard $\geq$ 30 minutes on $\geq$5 of the 7 days preceding the survey. New guidelines indicate children need at least 60 minutes of physical activity per day, spaced throughout the day and recommendations discourage extended periods of inactivity during the day (no longer than 2 hours).

Impact: Extension is working with Fargo Public Schools (FPS) to test a method to evaluate changes in food intake and physical activity habits overtime for a Coordinated School Health Grant (Centers for Disease Control and Prevention). This method will potentially help school districts across North Dakota evaluate school-based healthy lifestyle interventions. Food intake and physical activity will be measured for all 6th grade students in FPS by use of an adapted Youth Risk Behavior Survey, Center for Disease Control and Prevention containing only questions related to nutrition and physical activity habits. The survey data will be paired with height, weight, and fitness tests for each student. The fitness tests include: cardiovascular fitness (a timed mile run); muscle endurance (curl-up); muscle strength (push-up), and flexibility (sit and reach). The hypothesis being tested is that sixth grade children in schools having only school lunch (n=350) will demonstrate better food choices than sixth grade students who also have access to less healthy ala carte and vending choices(n=540). Proportions of students meeting recommendations for food choices and physical activity will be determined as well as correlations between food choices, physical activity levels, and fitness scores.

The updated Healthy Weight web site is a resource for community coalitions and health / education professionals in North Dakota (http://www.ag.ndsu.nodak.edu/health.htm)

Source of federal funds: Smith-Lever

Scope of impact: Statewide Extension

Key Theme – Human Health: Diabetes Education

Diabetes is the sixth leading cause of death in the United States. Adults with diabetes have heart disease related death rates 2 to 4 times higher than those without diabetes. The risk of stroke is 2 to 4 higher among those with diabetes. The prevalence rate of diabetes is 6.1 percent of the total adult population of North Dakota rising to greater than 14 percent in the 65- to 74-year-old population (2002, BRFSS, CDC). Diabetes is on the rise in North Dakota from 3.6 percent of the

population in 1994 to 6.1 percent in 2002. National data from the Indian Health Service for 2000 (NIDDK,NIH) indicates that about 15 percent of the American Indians and Alaska Natives have diabetes which is similar to the prevalence rate of diabetes (15.1 percent) among Native Americans in North Dakota. National data from 2002 estimated that diabetes cost the country $132 billion considering both direct medical and indirect expenditures. Medical expenses were estimated to be $13,243 per year for persons with diabetes and $2,560 for those without the disease. There is increasing concern with the rising numbers of persons with pre-diabetes. Progression from the pre-diabetic condition to diabetes can be prevented by lifestyle intervention including a balanced diet and increased exercise. It has been estimated from national data that about 21 percent of adults are pre-diabetic.

Impact: Partnering with the North Dakota Department of Health and the Dakota Diabetes Coalition, NDSU Extension has mapped the location by county in North Dakota of health professionals working in diabetes (dietitians, certified diabetes educators and physicians). Several counties in the southern and the western part of North Dakota have few if any identified health professionals who can provide diabetics with the necessary basic nutrition knowledge and skills to manage their diet and disease. Diet is one of the key areas to assist diabetics with disease management and to help prevent long term complications. A workshop is planned to introduce the curriculum from West Virginia University Extension called "Dining with Diabetes" to North Dakota. Implementation of the curriculum will help fill the gap in diabetes nutrition education for medically underserved rural North Dakota. This curriculum partners local Extension agents with dietitians or certified diabetes educators to present a food-based curriculum to help diabetics make better food choices. Funding to conduct a pilot in four counties has been approved by a local medical foundation: Foster, Grand Forks, Richland, and Walsh.

Source of federal funds: Smith-Lever

Scope of impact: Statewide Extension

Key Theme – Human Health: Agriculture to Health (Dakota Diet)

The Dakota Diet concept suggests that foods produced in the Dakotas and Northern Plains, when incorporated into the framework of the Food Guide Pyramid, will promote health and reduce chronic disease. Some crops produced on the Northern Plains are known to contain nutrients or phyto-chemicals that may reduce the risk of chronic disease. For example, the omega 3 fatty acids and lignan in flaxseed have been demonstrated to provide certain health benefits such as the following: helps reduce the risk of heart disease; provides anti-inflammatory effects which may benefit auto-immune diseases such as rheumatoid arthritis; provides relief from some menopausal symptoms; etc. A number of healthy plant oils such as canola, flax, soybean, sunflower, and others are produced in this area. The Northern Plains are major producers of legumes such as beans, peas, and lentils which have many health promoting qualities. Whole grains have been implicated in reducing the risk of chronic diseases such as diabetes and heart disease.

Impact: Flaxseed was featured for the first lesson of the "Agriculture to Health" series which promotes the research-based health benefits of regional foods produced in North Dakota and the northern plains. Educational materials (handout, powerpoint, and leader's guide), which promoted the health qualities of flaxseed, were developed under the leadership of the NDSU extension specialist in the Department of Health, Nutrition, and Exercise Sciences, in collaboration with the NDSU Department of Plant Sciences and with the USDA-ARS Grand Forks Human Nutrition Research Center. NDSU Extension agents in human development received training in May 2003 and delivered lessons to adult audiences across the state during 2003-04. A pre/post-evaluation was obtained from 245 participants, both men and women, from 18 counties in North Dakota. Of the participants, 68 percent indicated they had never consumed flaxseed prior to the lesson, with 15 percent indicating that they consumed ground flaxseed nearly every day. About 7 percent indicated daily ingestion of flaxseed oil capsules. Post-lesson evaluation indicated that 45 percent of the audience indicated a desire to add flaxseed to their diet with 25 percent indicating daily consumption as their goal. Increased awareness, knowledge, and intent to add flaxseed to the diet was evidenced by a pre/post evaluation of the lesson. The "Agriculture to Health" concept will be utilized for development of a series of Extension educational materials about the health benefits of foods produced in North Dakota: beans in 2004-05; healthy oils in 2005-06; and whole grains in 2006-07.

Source of federal funds: Smith-Lever

Scope of impact: Statewide Extension

Key Theme- Human Health: Women's Health

One in ten women in the United States ages 45 to 64 years of age has some form of heart disease. For women over 65 years of age, one in four have some form of heart disease. Heart disease is the number one killer of women in North Dakota. Each year, North Dakota loses an average of 1,113 women to heart disease and stroke. The risk factors for heart disease include cigarette smoking, high blood pressure, high blood cholesterol, overweight, physical inactivity, and having diabetes. Adults with diabetes have death rates from heart disease that are two to four times higher than for the general population. The rate of heart disease is two to three times higher for postmenopausal women compared to those who are pre-menopausal. The risk of heart disease and stroke can be greatly reduced by lifestyle changes including modification of dietary intake and increased physical activity.

Impact: The Fifth annual Women's Overall Wellness Retreat occurred at the Assumption Abbey in Richardton, N.D., during September 2004 as a collaborative effort between the NDSU Extension Service and the West River Medical Center in Hettinger, N.D. The goal of the annual retreat is to empower rural women to take leadership roles for women's health issues both for themselves and their rural communities. The original retreat in 2000, called "Healthy at Every size" addressed issues of size sensitivity. In 2002, the name of the third retreat was changed to "Women's Overall Wellness" to heighten awareness of the broader focus of health issues for women. At the 2004 Retreat, participants completed an assessment of the "Seven Dimensions of Wellness" which indicated that behaviors related to "physical wellness" were causing the most

difficulty for participants (maintaining healthy weight; getting recommended amount of exercise; managing stress; consuming moderate amounts of caffeine). A total of about 200 women have participated over the past five years. Forty-two women responded to a five-year follow-up questionnaire. Of those responding, about two-thirds were middle-aged or older living in households with incomes of $30,000 or higher primarily from the rural area in southwestern North Dakota. More than half of respondents report that since attending the conference they have been successful in making positive lifestyle changes which has resulted in a perceived improvement in their quality of life. About 90 percent would recommend the retreat to others.

Source of federal funds: Smith-Lever

Scope of impact: Statewide Extension

Allocated Resources ($ x $1,000)		**FYO4**
1862 Extension ($)	Smith-Lever	588
	State	882
	FTE	21
1862 Research ($)	Hatch	0
	State	0
	FTE	0

Goal 4: Greater Harmony Between Agriculture and the Environment

Overview: *Agricultural pollution primarily from non-irrigated crop land, grazing land and feedlots presents a significant threat to North Dakota's surface waters. According to the North Dakota Department of Health, in 2004 58 percent of the state's assessed river and stream miles and about 56 percent of the assessed lakes and reservoirs are either threatened or impaired for aquatic life use. The primary reasons for impairment of stream and rivers were total fecal coliforms, physical habitat alterations, and sedimentation. The main sources for these impairments were riparian grazing, animal feeding operations, crop production, and loss of riparian habitat impairments. The primary reasons for impairment lakes and reservoirs were oxygen depletion, elevated temperatures, and elevated nutrients. When known the most common impairment was flow regulation or modification. Agriculture also threatens ground water. Over-application of fertilizer and runoff from farm fields can result in degradation of ground and surface water. Livestock waste has been identified as an important source of pollutants. The area occupied by feedlots and other concentrated production units is currently relatively small; however, the proximity of animal operations to surface water resources and/or aquifers makes them a possible source for pollution.*

Extension programs on site-specific management reached thousands of producers in the region. In studies using zone management of N in sugarbeets, economic advantages when there is sufficient variability of N range from $10-$100/acre. A recent American Crystal survey based on harvest receipts and grower practices showed a $45/acre advantage over conventional soil testing based on zone management and zone management with a $20/acre advantage over grid sampling. On wheat and sunflowers, net returns are in the range of $5-$15/acre when field N variability exists, which would roughly double profit margins in these crops. Comparison of site-specific N management with an adjacent grower field, showed 60 lb N per acre less leaching on the site-specifically managed corn compared to a conventionally managed field.

The NDSU Soil Testing Laboratory analyzed more than 17,025 samples for farmers, agricultural producers, researchers and homeowners from North Dakota and Minnesota. Soil tests and fertilizer recommendations by the Soil Testing Laboratory are recognized as the standard for crop nutrient recommendations in western Minnesota, North Dakota, northeastern South Dakota and eastern Montana. Accurate results and recommendations assure producers that crop nutrient needs are being met efficiently while environmental quality is maintained. Soil testing is the most practical way of evaluating the fertility status of soils. The number of soil tests performed for homeowners is increasing thanks to a "Garden Solutions" program designed to help minimize the amount of excess fertilization to home lawns and gardens.

NDSU Research on potato planting configurations shows promise for significant yield improvements and water conservation. Additional research on evapotranspiration in high-value crops will provide information that could lead to the expansion of irrigation in the state and improved methods of managing existing water resources.

The NDSU Extension Livestock Waste Technical Information and Assistance program addresses address manure nutrient utilization, livestock feeding, housing, and management impacts on livestock waste and defines and delineates the non-point pollution rules and the economics of proper livestock waste management. As a result of programs and publications, 56 North Dakota producers have requested financial assistance to bring their livestock feeding operations into environmental compliance. These 56 facilities account for more than 60,000 head of cattle.

Before NDSU launched research and extension programs on controlling leafy spurge, the number of acres infested with the weed was doubling every decade. If left unchecked, the current infestation would be about 3.8 million acres in North Dakota alone. However, since the introduction of this program, the present infestation is about 1.2 million acres which has held steady or declined in the last eight years. Herbicide treatments incorporated with the Aphthona spp. biocontrol agents have provided much better long-term control than either method used alone. Grazing with sheep or goats followed by a fall herbicide treatment has resulted in greater forage utilization by sheep, goats, and cattle and reduced the leafy spurge infestation to near zero. Combinations of herbicides with different modes of action have provided long-term reduction of leafy spurge with less input costs and less pesticide in the environment. Competitive grass and forb species have been introduced to replace leafy spurge once the weed was controlled.

Key Theme - Natural Resource Management: Insect Management to Preserve Tallgrass Prairie

Less than 1 percent of the original native tallgrass prairie still exists, and much of the remaining prairies are highly fragmented. Not only is it important to acquire more land to preserve as natural prairies, but it is imperative to manage existing prairies properly. Traditionally, native tallgrass prairies have been managed by periodic burning (every three to five years), and this seemed to be a sound method (from data gathered on vertebrates and the flora). But recent studies have indicated that fire may not be the best type of management for at least some of the invertebrates. Our research is investigating the effects of burning, haying and grazing on a variety of tallgrass prairie invertebrates.

Impact: This project will produce data that will aid natural area stewards in making the best decisions on how to manage their lands. We are also documenting the invertebrate fauna for our research sites, indicating new distribution records, range extensions and the discovery of rare or endangered taxa, all of which will give researchers, conservationists and the general public a greater awareness of the importance of the tallgrass prairie invertebrate fauna.

Source of Federal Funds: Hatch

Scope of Impact: This research will directly benefit tallgrass prairies which occur throughout much of the Upper Great Plains. Our techniques and ideas may also have some indirect applicability to other prairie areas, and perhaps to conservation in general.

Key Theme - Water Quality: Nutrient Management

Extension specialists and experiment station researchers are developing methods to compare various types of zone delineation methods, which will increase the effectiveness of soil testing and nitrogen fertilization efficiency. Techniques being evaluated include a combine protein sensor, aerial photography, satellite imagery, soil EC sensor measurements, Order 1 soil survey, topography and yield monitor data. Each technique is being evaluated individually. They are then being combined to evaluate the effectiveness of possible synergistic relationships with residual soil nitrate patterns. Sugarbeet growers in the Red River Valley use satellite imagery and aerial photography to map 150,000 areas of sugarbeet fields and then give an N credit or adjustment for subsequent crops based on relative canopy N content. Wheat and sunflower growers in central and western North Dakota are using topography, satellite imagery, multiple-year yield maps and electrical conductivity sensors to locate homogeneous zones within fields. These zonal boundaries are used as guides for soil sampling. The move to site-specific approaches is progressing west of the Red River Valley with about 120,000 acres involved.

Impact: In 2004, programs focusing on site-specific management totaled about 1,000 attendees at various presentations around North Dakota. In addition, site-specific soil testing has been woven into nearly all presentations given, amounting to about 2,500 other attendees. News releases on radio and in the press have been provided for people who do not attend meetings. Four circulars were printed in 1999 to provide general site-specific information regarding sampling, fertility, concepts and environmental benefits. These have been well-received by

growers and received a national award from the American Society of Agronomy in 2000. It is estimated that an additional 20,000 growers were reached indirectly about some aspect of site-specific farming/N management in 2004. In studies using zone management of N in sugarbeets, economic advantages when there is sufficient variability of N range from $10-$100/acre. A recent American Crystal survey based on harvest receipts and grower practices showed a $45/acre advantage over conventional soil testing based on zone management and zone management with a $20/acre advantage over grid sampling. On wheat and sunflowers, net returns are in the range of $5-$15/acre when field N variability exists, which would roughly double profit margins in these crops. In addition, the use of some form of zone N sampling reduces the need for "insurance" rates of N, which are often 40-50 lb. N/acre ($10-$16/acre current price). Comparison of site- specific N management with an adjacent grower field, showed 60 lb N per acre less leaching on the site-specifically managed corn compared to a conventionally managed field.

Source of Federal Funds: Smith-Lever and Hatch, USDA-ARS IFAFS

Scope of Impact: Multi-state research and extension, MN and MT, MN and SD

Key Theme - Nutrient Management: NDSU Soil Testing Laboratory

From July 1, 2002 to June 30, 2003, the Soil Testing Laboratory analyzed 17,025 samples. Of those, 11,777 samples were from various research projects on campus and the various Research Centers in North Dakota. Another 5,248 samples were submitted by farmers for fertilizer recommendations. The Soil Testing Laboratory offers free soil analysis of one soil sample to students enrolled in agricultural courses in North Dakota and Minnesota. In conjunction with soil analysis the testing lab also conducts educational tours for schools. The amount of fertilizers used on lawns and gardens is often much greater than necessary for optimum growth and health of plants. In an effort to promote wiser use of fertilizers, we have initiated a project to encourage homeowners and gardeners to test their soils before planting. The benefit of this is a more efficient use of fertilizers and reductions of the potential for pollution. The project, 'Garden Solutions', offers homeowners in the metro area a soil sampling service for a fee as well as our usual soil testing program. The number of samples tested has increased annually, with 127 garden samples tested this year.

Impact: Soil tests and fertilizer recommendations by the Soil Testing Laboratory are recognized as the standard for crop nutrient recommendations in western Minnesota, North Dakota, northeastern South Dakota and eastern Montana. Soil testing is the most practical way of evaluating the fertility status of soils. Used in this way it has great economic benefits to farmers and homeowners in increasing yields, using resources where they will do the most good and in reducing pollution. If routine soil testing and environmental soil and water sampling becomes a more common practice, our state's economy and environment would be greatly improved.

Source of Federal Funds: Hatch

Scope of Impact: Multistate research and extension, ND, MN, MT and SD

Key Theme - Water Quality: Irrigation Technical Information and Assistance
Effective irrigation water management requires accurate daily crop water use estimates. Since 1995, the NDSU Extension Service has had a Web site that displays the crop water use for the 10 major irrigated crops in North Dakota. The water use for each crop is calculated using data from the 67 automated weather stations on the North Dakota Agricultural Weather Network (NDAWN). During the growing season, the crop water use data is updated daily. The user can view the daily water use of each crop as color-coded maps or as numerical tables. To use the maps for irrigation management purposes, the irrigator or crop consultant selects both the crop and the nearest emergence date.

Every year since 1995, additional features have been added to help the irrigator or crop consultant make better, more informed irrigation decisions. For instance, a color-coded map showing the cumulative rainfall measured at each NDAWN station was added in 2001. Because of the drought conditions in the southern part of the state during the 2002 season, a color-coded map showing the difference between the crop water use and rainfall was added. This map clearly showed the areas of the state with deficit water conditions as the growing season progressed.

Since 1977, extension has had a bulletin on irrigation scheduling by the Checkbook method. This bulletin has been very popular with growers. In 2000 a computerized version of the checkbook was developed in cooperation with the Minnesota Extension Service. The program was revised in 2001 and has been distributed throughout both states. In 2003, a version of the checkbook program was developed that would run on a Palm Pilot.

Impact: The crop water use maps and numerical tables are used extensively for irrigation scheduling. For example, during June, July, August and September of the 2003 growing season, the crop water use Web site handled more than 50,000 successful requests for pages. The average daily requests were more than 450. The busiest day of the week was Monday with more than 18,000 requests during the growing season. The Web site was accessed the most in August (over 16,000 requests), which is not surprising since it was the hottest and driest month. Over 850 distinct computers accessed the Web site. The crop water use numerical tables were requested about ten times more often than the crop water use maps. There are about 1,500 irrigators in North Dakota. Many contract with crop consultants for information services. Most consultants working with irrigators access the Web site at least twice per week and increase the impact of the irrigation water management information by providing a multiplier effect.

Every year since 1977, between 500 and 800 of the Irrigation Scheduling by the Checkbook Method (AE-792) bulletins have been distributed. Over the years, this bulletin has been copied by the extension services of other states. Since development of the computerized version, more than 100 copies have been distributed in North Dakota and Minnesota.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Natural Resources Management: Irrigation Research for High-Value Crop Production and Water Resource Protection
Researchers at NDSU are developing improved water and cultural management information and tools for the production of high-value crops in North Dakota. We are also beginning a watershed-scale study of evapotranspiration for water resources management.

Impact: Our previous research on potato planting configurations has recently attracted private funding for trials in growers' fields and for a fertilizer management and seed spacing trial. The potato planting configuration research shows promise for significant yield improvements and water conservation in drought-sensitive situations and may be applicable to other crops. The evapotranspiration research is expected to provide information regarding possible expansion of irrigation in the state as well as information useful for the management of existing water resources.

Source of federal funds: Hatch

Scope of impact: Statewide research

Key Theme - Land Use: Benefits and Costs of Resource Policies Affecting Private and Public Land
NDSU researchers have developed a database of agricultural land sales in North Dakota and are using it to evaluate the accuracy of USDA-NASS land value surveys, and the impact of both hunting and recreation based sales as well as conservation program activities (USFWS wetland easements) on land values.

Impact: Federal (USDA-NASS) land surveys appear to be most accurate in counties with relatively homogenous soil productivity. As much as 10 percent of recent land sales have been to out-of state buyers and most of these are for hunting/recreation purposes. Each additional acre of permanent (wet) USFWS wetland easements decrease average land values by $321 (-79%). Non-eased permanent wetlands reduced land values by $161/acre, and the implicit price specific to an easement is therefore $160/acre (-39%) which is 6 percent below historical easement payment values.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research: ND, SD, MN.

Key Theme - Integrated Pest Management: Pest and Disease Information for Producers
The statewide IPM crop and pest survey has evolved into a more comprehensive program for obtaining crop and pest information. Beginning in 2002, the survey was expanded to include five crops and their key pests. In 2003, the state was divided into five regions. Six crops and their key pests were surveyed from the last week of May until the end of August. The survey was limited to five crops again for 2004. A total of 2,362 fields were visited from late May until the end of

August. Information from these surveys is summarized in geo-referenced maps for use in newsletters, reports, and web information. The survey can be found at: http://www.ag.ndsu.nodak.edu/aginfo/ndipm/. The maps summarizing the sampling data were used to graphically illustrate where pest problems were developing in the region. Crops include wheat, barley, soybean, sunflower, and canola. Pests include grasshoppers, cereal aphids, cereal leaf rust, *Fusarium* head blight, soybean aphid, flea beetles, white mold/sclerotinia, and many, many more that are specific to the crops. This survey program has evolved during the past five seasons, incorporating the geo-referencing of data, mapping, to expansion of crops and focus of pest issues.

Regional surveys for detection of overwintering larvae of the orange wheat blossom midge have been conducted for nine years. These surveys identify locations of high populations of overwintering midge and are used by growers and managers to help plan for the up coming season. The project has been funded through the North Dakota Wheat Commission since 1995. Members of the commission continue to support the effort and have expressed a desire to continue funding the project. Funds were reduced beginning with the 2002 survey, limiting the scope to counties only in the northern half of the state where midge risk is greatest.

North Dakota is currently part of the North Central Pest Management Center. In cooperation with other state contacts, the regional wheat PMSP for ND, SD, and Nebraska was completed and posted in May 2004. The document can be found at: http://pestdata.ncsu.edu/pmsp/pdf/NorthernWheatPMSP.pdf. A regional pesticide use survey for corn production was planned and implemented in ND, SD, NE, and KS under the leadership of the Kansas state contact. The ND state contact consulted with Minnesota Department of Agriculture staff on the development and implementation of a Minnesota field crop pesticide use survey. The final survey instrument and implementation was modeled after the successful North Dakota surveys. This report was just published and can be accessed at: http://www.mda.state.mn.us/appd/pesticides/pesticideuse2003.pdf.

Funding was secured for conducting the 2004 North Dakota Pesticide Use and Pest Management Practices Survey. The comprehensive, enterprise level survey continues the four-year schedule for acquiring pesticide use data and information on pest management practices for N.D. field crop production. Multiple meetings were held in the fall with the North Dakota Agricultural Statistics Service (NDASS) staff to finalize plans for implementing the survey. The survey instrument was reviewed and revised. New information for the survey was a section for on-farm management of stored grain. This information has not been collected in previous surveys, but has become a recent issue relating to grain exports, particularly to Asia. The survey is scheduled for implementation in February 2005.

Impact: The crop and pest surveys have provided valuable information about current crop and pest situations as they develop in the region. With the survey information, extension specialists have been able to develop programming needs to address the issues that were being faced by agriculture in a proactive fashion rather than after the fact. The proactive programming provides the tools to make timely management decisions that produce economic return during the current production season.

The pesticide and pest management practices survey has been conducted on a four- or five-year cycle since 1978. This will be the seventh, statewide survey. Its usefulness in reporting reliable estimates of pesticide use have been realized during the recent EPA pesticide registration reassessments.

Source of Federal Funds: Smith-Lever

Scope of Impact: State Specific

Key Theme - Conservation of Biodiversity: Evaluation of Transgenic Corn
Transgenic corn varieties that produce insect-toxic proteins for the protection of plants from pest feeding injury have been developed by commercial seed companies in the United States. One particular transgenic event expresses a beetle-specific protein (Cry3Bb) that is toxic to corn rootworms. An investigation is being carried out to determine whether this material is likely to pose a threat to abundance or species diversity of non-target Coccinellidae (Lady beetles), Anthocoridae (minute pirate bugs), or Chrysopidae (green lacewings) common to Midwestern corn field habitats.

Impact: The potential effects of this new Cry protein on non-target insect taxa, especially those with evolutionary histories similar to corn rootworms, are not well understood. This information will be helpful in understanding the overall environmental impact of this promising pest management strategy on important beneficial organisms. Knowledge of negative effects would aid in the design of use patterns to avoid deleterious impacts on species diversity. Alternatively, major reductions in the prophylactic use of soil insecticides for rootworm control are likely to occur if Cry3Bb-expressing corn is found to pose no major threat to non-target organisms.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state integrated research and extension. The insects are widely distributed from the central plains between Texas and North Dakota to the northeastern seaboard. Currently, more pounds of insecticide material are applied for control of corn rootworms than for any other insect pest in the United States. Transgenic technology has the potential for allowing major reductions in use of conventional insecticides for this key pest of corn.

Key Theme - Integrated Pest Management: Invasive Weeds
Invasive weeds are one of the greatest threats to croplands, rangelands, and wildlands, not only in the region, but in the United States. Leafy spurge alone currently infests more than 4 million acres in the Northern Great Plains and Intermountain West and causes an estimated $195 million annual loss due to decreases in forage and livestock production, wildland- and wildlife-associated recreation, and soil and water conservation. Leafy spurge can be successfully controlled with herbicides; however, treating leafy spurge with herbicides is not always cost-effective. In fact, approximately 40 percent of the leafy spurge infested-rangeland has a

carrying capacity value below the herbicide cost break-even point. Biological control is an economic alternative to herbicides in managing leafy spurge on rangeland habitats. To date, 15 species of insects have been released in North Dakota for control of leafy spurge, and the Aphthona spp. flea beetles have become the most successful. Leafy spurge control with flea beetles has ranged from zero to over 95 percent stem reduction with approximately 30 percent of the releases considered successful. Other tools developed for leafy spurge control include grazing by sheep or goats and planting competitive species. Multiple approaches are needed since no single method will control leafy spurge in all the environments in which the plant is found.

Impact: Prior to this program, leafy spurge was doubling in acreage every 10 years. If left unchecked, the current infestation would be about 3.8 million acres in North Dakota alone. However, since the introduction of this program, the present infestation is about 1.2 million acres which has held steady or declined in the last 8 years. This integrated research and teaching program included personnel from several federal agencies, five states, and many counties in the region. A variety of integrated methods was developed to control and reduce leafy spurge and the resulting technology was brought to the public in a variety of methods including meetings, publications, and electronic media. Herbicide treatments incorporated with the Aphthona spp. biocontrol agents have provided much better long-term control than either method used alone. Grazing with sheep or goats followed by a fall herbicide treatment has resulted in greater forage utilization by sheep, goats, and cattle and reduced the leafy spurge infestation to near zero. Combinations of herbicides with different modes of action have provided long-term reduction of leafy spurge with less input costs and less pesticide in the environment. Competitive grass and forb species have been introduced to replace leafy spurge once the weed was controlled. The incorporation of herbicide treatment with biological control agents has successfully controlled leafy spurge in the habitat of the western prairie fringed orchid, an endangered species, without harming the orchid. This was the first time an herbicide was allowed to be used over an endangered plant species. Leafy spurge is no longer the most feared noxious weed in the region because land managers now have a variety of effective tools available to control the weed.

Source of Federal Funds: Smith-Lever and Hatch, federal grants

Scope of Impact: Multi-state in the North Central and Rocky Mountain Regions

Key Theme - Integrated Pest Management: Characterizing Weed Population Variability for Improved Weed Management Decision Support Systems to Reduce Herbicide Use

Weed management decision-making is complex, requiring integration of weed biology, environmental risks, labor needs, crop yield potential, efficacy of a given control measure, and economics. Researchers are working to better understand: variability from weed competition studies for development of a decision support system; the basis and relative importance of spatial, temporal, and biological variability in weed/crop competition; and the spatial, temporal, and biological variability of weed seed in the soil seedbank and it's impact on weed/crop competition.

Two experiments were conducted in the summer of 2004 to understand the basis and relative importance of spatial, temporal, and biological variability in weed/crop competition. The studies were designed to determine corn and soybean grain yield loss associated with four cohorts of a multi-species community. These data are to be used as validation data sets for the weed management decision support system. Glyphosate-resistant corn was seeded on May 6 at a density of 79,000 seeds ha-1 in rows spaced 76 cm apart, and glyphosate-resistant soybean was seeded on May 20 at a density of 500,000 seeds ha-1 in rows spaced 18 cm apart. The major weed species in the studies were: common lambsquarters, common ragweed, redroot pigweed, Venice mallow, wild buckwheat, wild mustard, and yellow foxtail. Glyphosate was applied at the V2, V4, and V6 growth stages of corn and at the VC, V1, and V3 growth stages of soybean. Weed-free and weedy treatments were included in each study. Subsequent to each application weed escapes were monitored weekly in four 0.1 m2 quadrats per plot. Weed biomass was harvested from each quadrat when crops reached physiological maturity, dried, and biomass production determined. The center two rows of each plot were harvested on Oct. 12 (soybean) and Nov. 15 (corn). In corn, when glyphosate was applied at the V2 to V6 stages of corn growth, average weed biomass production was 24 kg ha-1 and no statistical differences were detected among the glyphosate and weed-free treatments. Similarly, average corn yield was 6,012 kg ha-1 among the glyphosate treatments and was equivalent to the weed-free treatment. Weed biomass production and corn yield in the weedy treatment was 251 and 2,180 kg ha-1, respectively. In soybean, no weeds were present at physiological maturity of soybean. Soybean yield was similar among all treatments and averaged 2,180 kg ha-1. The months of June and July were unusually cool, consequently weed emergence and growth were affected.

Impact: Understanding how weed escapes impact crop yield will help improve estimates of yield loss. It is anticipated that this research will provide more precise information on the fecundity of weed escapes which will help in developing more efficient management systems. This research will also allow us to determine the degree of spatial variability within a field and between fields with various cropping systems and soils for weed species of agronomic importance in the north central region.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Integrated Pest Management: Biological Control in Pest Management Systems of Plants

Although chemical pesticides have had a beneficial impact on agriculture, their attendant side-effects, such as target pest resurgence, secondary pest outbreaks, pest resistance, and environmental contamination, demand that more ecologically sound methods of pest suppression, such as integrated pest management (IPM), be developed. The mission of this regional project is to facilitate research and implementation activities among the participating institutions and organizations in applied biological control. Objectives are to evaluate natural enemy efficacy and study ecological/physiological basis for interactions; identify and assess factors potentially disruptive to biological control and implement and evaluate habitat

modification, horticultural practices and pest suppression tactics to conserve natural enemy activity.

Aphthona population development and leafy spurge stem density when the flea beetles are combined with herbicide and competitive grass species: although the adult Aphthona flea beetle population is substantially higher in the insect only and insect plus competitive grass species treatments, the leafy spurge stem density is substantially lower in the treatments with a fall herbicide application. Aphthona flea beetle species overwintering success and leafy spurge stand density in ground cover versus no ground cover treatments: Snow cover may not provide sufficient protection for the overwintering Aphthona larvae when the mean winter soil temperature drops below approximately 4^{o} C. The overwintering success of the Aphthona larvae was not different among snow-covered treatment plots with or without a grass debris covering. The leafy spurge stand density was not significantly different among the ground cover treatments. Aphthona flea beetle species distribution among ecological habitats fourteen years afer their release: The flea beetle population was uniformly distributed among different habitats in a pasture consisting of high prairie, mid prairie, thicket, tree, and wetland. In a second pasture, a significantly higher number of beetles occurred in the mid prairie habitat compared to the high prairie, tree and wetland habitats.

Impact: The success of biological control in IPM systems for leafy spurge control will allow land managers to reduce production costs and increase production values of land infested with leafy spurge. Reduced herbicide use will enhance the environmental quality of the natural lands through reduction in herbicide contamination of ground and surface water and reduced effects on nontarget organism. A reduction in leafy spurge infestation will reduce the detrimental impact of this invasive species on the native plant species. A better understanding of the ecological and environmental mechanisms that effect the habitat distribution, establishment, and population development of Aphthona flea beetle species is important in improving the success rate of these biological control agents for leafy spurge control.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Natural Resource Management: Renewable Resources
An integrated extension and research program was developed to improve rangeland management across the state. Key components of the effort included:

Extension

- Development and publication of the second edition “Rancher’s Guide to Grassland Management II". Book encompasses 26 chapters including sections on plant identification, noxious weed identification and control, poisonous plants, grazing management, riparian grazing management, forage and pasture development, and drought management.
- Cow/calf and 12-month grazing and forage planning workshop (two- and three-day):

Two intensive grazing, forage and livestock management sessions were held in Steele and Dickinson for livestock producers. Ranchers learned to improve their rangeland management skills, develop year-long forage use strategies, and improve overall management of their beef herd.

- One-day range management and/or natural resource workshops were conducted at 17 locations in North Dakota, including 2 via the polycom video system. These one-day programs are designed to introduce ranchers, farmers, conservationists, and youth range management principles that can enhance grazing management, conservation programs, and economic efficiency.
- Educating youth on the importance of the range resource: A four-day range youth camp was conducted in western North Dakota for youth interested in the range resource and range judging. Youth learned the importance of range to livestock producers, the environmental community, and wildlife enthusiasts. They learned basic fundamental range management practices and how to judge the resource for health and value for forage and wildlife habitat.
- Conduct one to two-day natural resource management programs on tribal lands in North and South Dakota: These programs were conducted at Fort Berthold and Sitting Bull, N.D., and Pine Ridge, S.D., and concentrated on local ranchers and farmers, professionals in the region, and students at the colleges.
- Conduct 1 three-day in-service training sessions for North and South Dakota extension agents/educators and North and South Dakota Natural Resource Conservation Service conservationists. Thirty-six educational professionals (Extension agents and NRCS Staff) in North and South Dakota were taught using class room and field activities under a sustainable agricultural program for western rangeland.

Impact: The first edition of "Rancher's Guide to Grassland Management" was published in January 2003 and out of print by March, distributing over 400 copies to eastern North Dakota and western Minnesota farmers and ranchers, and natural resource professionals. The second edition of "Rancher's Guide to Grassland Management"in June 2004 with 1,960 copies distributed through North Dakota, eastern Minnesota, and southeastern South Dakota, and out-of-print by August, 2004. Over 2,450 land managers and ranchers received this book for educational and hands-on use to impact an estimated 2,695,000 acres of land. Thirty-eight ranchers participated in the cow/calf and 12-month forage planning workshops. These two workshops impacted over 125,000 acres of native rangeland, pastureland, and hayland and 10,963 animal units of livestock. More than 90 percent of the participants were planning to add new range improvement practices or cattle nutritional programs.

One-day range and forage management workshops and schools were conducted for 766 participant in North Dakota, bordering counties of South Dakota and Montana, Wyoming, and Manitoba, Canada. These programs were designed to introduce and teach ranchers, farmers, land managers, and youth the proper resource management tools and management strategies to improve efficiencies of the land base. The producers were then introduced to the more intensive two- or three-day workshops that would concentrate on their land base.

Twenty-one youth ages 13-18 participated in the four-day range camp and 102 participated in the

State Range Judging Contest. Seven other educational programs were taught to youth ages 10 through 18 and undergraduate college students, totaling 198 students. We believe any involvement of youth in the importance of the range resource and fundamental needs for managing these lands will create a better-rounded adult.

Twelve and 169 people participated in the two natural resource educational programs associated with tribal lands on Fort Berthold in North Dakota and Pine Ridge Reservation in South Dakota. These programs were developed to help guide us in developing educational programs, demonstration projects, and research projects on tribal lands in North and South Dakota. Results from previous needs assessments indicate a need for natural resource educational material and programs to enhance use for small and mid-size ranchers and farmers. A need to be more sustainable on the Tribal lands and using their commodity products within the Tribal areas more effectively. A better understanding and marketability of bison and the natural resources well addressed as well.

Thirty-six county agents/educators and Natural Resource Conservation Service staff participated in a one-day sustainable agricultural programs. This program is part of a four phase grant to help educate professionals on range management, livestock nutritional needs, range habitat assessment, and mentor development. By teaching the sustainable range management to professionals that are the key contact personnel in a county, we can provide educational tools and materials to potentially thousands of land managers impacting hundreds of thousand acres in North and South Dakota. This program is part a 2-year project that will finish in 2006 and funded by the NCC SARE program.

Research

- Effects of sheep grazing using a multi-species and single-species grazing approach on leafy spurge infested rangeland: NDSU Extension Service, in cooperation with the Animal and Range Sciences Department and Hettinger Research Extension Center have conducted grazing trials on leafy spurge infested rangeland throughout North Dakota.

Impact: Sheep effectively controlled leafy spurge after one year using a single species grazing approach and after three years using a multi-species grazing approach. Leafy spurge stem densities were reduced by 98 percent and 96 percent on single-species and multi-species grazing treatments, respectively, after eight years. Season long grazing using a multi-species approach provided a quicker, more efficient grazing of leafy spurge than rotational grazing; however, both reduced leafy spurge stem densities by 99 percent and 75 percent, respectively, after eight years. The research provides new options for North Dakota livestock producers who want to control this invasive weed. Chemical control on large patches of the weed is seldom cost effective. The research shows that sheep can provide some financial return while providing control.

- Effects of dormant season grazing on native rangeland in western North and South Dakota: NDSU Extension Service, in cooperation with the Animal and Range Sciences Department and Hettinger Research Extension Center has conducted grazing trials on western rangelands in North and South Dakota.

Impact: Dormant season grazing (mid November through mid January) at moderate and full use did not effect herbage production the following compared to standard full use summer grazing (June 1 through November 1). Double use of two weeks grazing in mid June followed by dormant season grazing from mid November through mid January enhance subsequent years herbage production by 0 to 26 percent. These results are from years 1, 2, 3 and 4 of a projected 10-year study. Initial results would indicate ranchers and land managers could graze their winter pastures for two weeks in June at 50 percent use of standing herbage and fully graze (50 percent) the dormant season forage and enhance subsequent year's growth.

- Impacts of dormant season prescribed fall fire on herbage production and plant community dynamics of native rangeland managed using seasonlong or twice-over rotation grazing and nonuse in western North Dakota: NDSU Extension Service, in cooperation with the Animal and Range Sciences Department and USDA Forest Service has conducted this trial in western rangelands of North Dakota.

Impact: Nine months post prescribed October dormant season fire decreased herbage production on the seasonlong grazing treatment; however, no significant reductions occurred on the twice-over rotation grazing system or nonuse treatment. Twenty-one months post fire showed full recovery of herbage production on all treatments. Almost a 100 percent kill of club moss occurred from the prescribed fire at 9 and 21 months post fire, irrelevant of treatment.

Source of Federal Funds: Hatch and Smith-Lever

Scope of Impact: Multi-state research and extension

Key Theme - Water Quality: Livestock Waste Technical Information and Assistance
Educational programs are being developed to address manure nutrient utilization, livestock feeding, housing, and management impacts on livestock waste, defining and delineating the non-point pollution rules and the economics of proper livestock waste management. Educational workshops were held across the state. Locations included Ellendale, Crosby, Fessenden, Carrington, Park River, Mandan, Devils Lake, Jamestown, Washburn, Bismarck, Lisbon, Fargo, Manning, Beulah, Carson, Minot, and New Salem. More than 500 individuals were reached at these meetings. Audiences included producers, crop consultants, industry representatives, NRCS, SCD, NDSU Extension personnel and research personnel. The objective of each workshop varied slightly, but all presentations included a general discussion of the principles of nutrient management and non-point regulations affecting animal feeding operations.

Impact: In the past year this program has provided education to producers, NRCS employees, 319 Watershed Coordinators, County Extension Agents, commodity association members and policy makers through 23 workshops, 22 on-farm producer consultations, and development and distribution of seven new Extension publications. A reflection of these educational efforts can be quantified by the fact that 56 North Dakota producers have requested financial assistance to bring their livestock feeding operations into environmental compliance. These 56 facilities account for more than 60,000 head of cattle.

Source of Federal Funds: Smith-Lever and EPA

Scope of Impact: State specific

Allocated Resources ($ x $1,000)		**FYO4**
1862 Extension ($)	Smith-Lever	378
	State	567
	FTE	13.5
1862 Research ($)	Hatch	272
	State	400
	FTE	8

Goal 5: Enhanced Economic Opportunity and Quality of Life for Americans

Overview. *The Great Plains has struggled with rural population loss for decades. Nearly two-thirds of the counties in the region have a smaller population base than they did in 1950. In the last half century, the overall loss in rural counties has been more than 34 percent – more than a half million people. Significantly, the largest loss of population has been those in their twenties and early thirties, reducing the proportion of youth and increasing the proportion of the elderly remaining. In North Dakota counties, 35 of 53 counties lost young adults at rates that exceeded 50 percent. In the 21st century, shaping forces will include information technology, agricultural technology, changes in federal policies, and international trade policy. Major changes in the rural landscape are causing great stress as well as creating new opportunities.*

Economic development also has been a long-standing concern for North Dakota policymakers. Farming, once the backbone of the rural economy, has dwindled in economic strength. Nearly 90 percent of total income earned by farm households comes from off-farm sources. Nationwide, fewer than one of eight rural counties have agriculture as their rural sector. In North Dakota, the service industry accounts for the largest share of the gross state product at 19 percent. Government follows at 16 percent and Finance, insurance and real estate at 15 percent. Agriculture generates just over 5 percent.

Research suggests that economic developers and policy makers need to focus on innovated approaches to economic development focused on retaining and expanding existing businesses and creating new businesses that take advantage of the area's assets.

At the same time, the state's youth need opportunities to be meaningfully involved in family, school, and community in order to develop skills and confidence to become productive, caring

adults who contribute positively to society. Experiential learning in areas relating to healthy lifestyles, preparing for careers, developing communication, social skills, leadership and community involvement can provide the education and development of these life skills.

The Business Retention and Expansion visitation program helps interested community leaders identify existing business issues and needs. Research specialists analyze and present the data to community leaders. Fourteen county and city based programs have been conducted since 1995. Eleven of the first 13 program coordinators responded to a follow-up survey conducted in this program the first survey year. Results included: of the 176 projects planned, 43 percent or 75 projects were in progress, 23 percent or 41 projects had been completed.

Approximately 450 people participated in 12 NDSU Extension agritainment workshops. Of those participating, 99 percent gave the program an overall rating of useful to very useful; 114 people indicated that the workshop did help them to make a decision as to whether or not they would pursue starting a recreation business. Businesses started as a direct result of attending the workshops include a pumpkin and corn maze business, lake cabins and fishing guide, bed and breakfasts. Numerous business owners have contributed increased success of their business to what was learned in the workshop. NDSU Extension specialists were instrumental in establishing a state tourism association for rural and nature based tourism businesses and organizations and provided leadership for the second annual Marketplace for Entrepreneurs preconference nature and rural tourism event.

Seven e-business classes were offered in 2003 and 2004. The hands-on, computer-based workshop helped 68 individuals determine their need for a Web presence and the vast majority of participants reported plans to either start a website, begin to participate in online auctions, or participate in other portal-type sites to market and sell their product. A six-month follow-up survey showed development of business Web sites and increased research on products and supplies because of the course.

NDSU specialists helped develop a strategic plan for establishing a biomaterials industry in North Dakota. Initial efforts will be focused on economic and technical requirements for commercializing technology to produce bio-based cellulose nanowhiskers, which will be key feedstocks for production of next-generation nanocomposites. Technologies identified, developed, demonstrated, and transferred to commercial application under this program may use a variety of renewable resources such as wheat straw and other grasses to produce higher value products while generating little or no waste. The development of a biomaterials industry could offer an additional income source for North Dakota wheat producers, as well as new jobs in the processing activity and general economic stimulus for rural areas of the state.

Developing skills to prepare youth for the workforce is one of the underlying goals of many 4-H activities. The 4-H Youth Range Camp develops a sense of teamwork and cooperation, an understanding of rangeland resources, a level of proficiency in skill development important to range resources. As of 2004, 1,610 students in 36 North Dakota schools completed the High School Financial Planning Program. Nationally, students in the program show significant improvement in their ability to set aside money for the future and in distinguishing the difference

between needs and wants. Technology team members and 4-H Ambassadors partnered with the North Dakota Insurance Department's Senior Health Insurance Counseling Program to assist senior citizens to find out how to save money on prescriptions through internet searches. Students in 4-H also provided train the trainer opportunities with Global Positioning System technology. On the Ft. Berthold Indian Reservation, 4-H programs used technology learning experiences as an after-school program and found resurgence in youth participation interested in learning how to use technology in a practical, applicable manner.

Key Theme - Community Development: Rural Economic Development
The Extension specialist co-developed a comprehensive Business Retention and Expansion visitation program to help interested community leaders identify existing business issues and needs. Research specialists in the NDSU Department of Agribusiness and Applied Economics analyze and present the data to community leaders. The NDSU Institute for Business and Industry Development follows up with individual requests from manufacturers. Annual progress surveys are conducted.

Partners: Local Economic Development and Chamber of Commerce Staff, State Department of Economic Development and Finance, NDSU - IBID and local county or city economic development groups and chambers of commerce.

Impact: Fourteen county and city based programs have been conducted since 1995. Eleven of the first 13 program coordinators responded to a follow-up survey conducted in this program the first survey year. Results included: of the 176 projects planned, 43 percent or 75 projects were in progress, 23 percent or 41 projects had been completed, 11 percent or 20 projects were dropped, and 23 percent or 40 projects had no indication as to progress. The last county conducting the BR&E visitation program completed its program in January of 2001. A survey conducted after three months indicated that of the fifteen action items that were identified in four major issue areas, only six items had no action while three had already had substantial progress or already implemented. The other items were in the process of being worked on. A six month evaluation of progress for implementation resulted in an overall lower degree of implementation. This would seem to go against logic but upon further questioning of participants it was felt that some of the momentum had been lost resulting in lower scores. Follow-up evaluation of participating counties shows that most have either completed their plans of work as outlined in their original plan and/or are continuing to work on items that are ongoing. Approximately 52 percent of the projects identified were completed.

A targeted industry BR&E project has been conducted to determine higher education educational programs and workforce skill needs. Results of this survey are being compiled by ND Job Service. The study was conducted under the ND Workforce Development Council of which extension played a critical role in organizing and training in the BR&E process and took leadership for the state industry visioning session.

Source of Federal Funds: Smith-Lever and CSREES Fed. Admin.

Scope of Impact: Integrated Research and Extension

Key Theme - Impact of Change on Rural Communities: Strategic Planning
The Extension specialist chaired a committee consisting of multiple agencies and organizations to develop and deliver a statewide curriculum and program for community strategic planning. Extension specialists also provided facilitation training for staff from the following agencies and organizations: USDA Rural Development, USDA Rural Development Council, State Department of Economic Development and Finance, State Department of Community Services, Governor's Office Regional Planning Councils, North Dakota State Department of Health and local economic development professionals.

Impact: In two two-day workshops, 102 facilitators were trained for the strategic planning process. Of those facilitators, 72 attended another one-day session for pilot program updating and specific facilitator skills training. Ninety-three communities are currently in the process or have concluded conducting strategic planning programs with the assistance of the trained facilitators. An additional 15 communities were identified and participated as three member teams in a Heartland Center training sponsored by Federal Land Bank. If you calculated the total of volunteer time dedicated to the strategic planning process in the ninety-three communities by taking an average of 15 hours per steering committee member times 12 or the average size of a committee times $17.19 (value of one hour of volunteer time according to Independent Sector) times 93 communities you would get $287,760.60 total value of volunteer time spent on strategic planning in ND communities. A new survey will be conducted in 2005 to determine future planning and updating of planning needs.

Source of Federal Funds: Smith-Lever and CSREES Fed. Admin.

Scope of Impact: State Specific

Key Theme - Supplemental Income Strategies: Rural Economic Development
Extension specialists and county extension agents conducted educational agritainment workshops in areas of the state. The goal of the program was to provide information to help families decide if a recreation business was feasible for their individual location and operation. Partners: Local economic development staff, Southwest Area REAP board, North Dakota Department of Tourism.

Impact: Approximately 450 people participated in 12 agritainment workshops. Of those participating, 197 completed the post-workshop evaluations. Results include: 99 percent gave the program an overall rating of useful to very useful; 114 people indicated that the workshop did help them to make a decision as to whether or not they would pursue starting a recreation business, 33 percent were already in business; 90 participants plan to start a business; of those already established 31 indicated that they would make changes in their current operation because of what was learned. Samples of businesses started as a direct result of attending the workshops include a pumpkin and corn maze business, lake cabins and fishing guide, bed and breakfasts

plus numerous business owners have contributed increased success of their business to what was learned in the workshop.

The extension service and partners were instrumental in the organizational phase of establishing a state tourism association for rural and nature based tourism businesses and organizations. The organization began taking memberships in 2004. This is a great accomplishment and a huge step forward for our fledgling rural and nature based tourism industry. Extension provided leadership for the second annual Marketplace for Entrepreneurs preconference nature and rural tourism event. Approximately 150 people attended.

Source of Federal Funds: Smith-Lever and CSREES Fed. Admin.

Scope of Impact: Multi-state Extension - ND and MT

Key Theme - Promoting Business Programs: E-Commerce for Small Business

Information technology holds the promise of reducing the disadvantages of distance and low population density that have long held back rural communities relative to their urban counterparts. Survival of rural enterprises and communities depends greatly on how rural people are prepared to deal the Information Technology revolution, where services are available 24 hours a day, 7 days a week. Rural residents must develop the necessary skills for employability of entrepreneurship in an evolving industry. They also need the skills to market their products in a competitive area.

Impact: Five classes were offered in 2003 in Fessenden, Hettinger, Watford City, Devils Lake and Langdon. Two additional classes were held in 2004 in Oakes and Ellendale. The hands-on, computer-based workshop was offered as a one-day workshop from 9 - 5 instead of as a multi-date program as has been done elsewhere. This day-long program has been received by 68 individuals since its inception in October of 2003 with 37 individuals participating in Access North Dakota Mainstreet in 2004. The course is designed to help people determine their need for a Web presence and a large majority of participants reported plans to either start a website, begin to participate in online auctions, or participate in other portal-type sites to market and sell their product. A six-month follow-up survey was done in March and April for all participants that had taken the course in the fall of 2003. Participants have reported the development of business websites and increased research on products and supplies because of the course.

Source of Federal Funds: Smith-Lever and Dept. of Commerce

Scope of Impact: State

Key Theme - Agricultural Financial Management: Benefits and Costs of Natural Resources Policies Affecting Public and Private Lands

It is not known whether various land and water conservation programs on agricultural lands provide economic benefits that exceed costs to both society and individual farmers. This study

will help landowners and local, state, and federal governments evaluate the benefits and costs of conservation programs focused on agricultural lands in North Dakota.

Estimates of average tract land values surrounding wetland easements in the Fish and Wildlife Service Small Wetland Acquisition Program were found to increase significantly when published county level land value data was used in place of appraisals: by 11 percent in North and South Dakota, and 22 percent in Minnesota. These differences are smallest among easement tracts dominated by pastureland versus cropland. Using of county land value data would also increase wetland easement payments by 9 percent in North Dakota (1990-1999), 11 percent in South Dakota (1995-1999), and 22 percent in Minnesota (1993-1999). 2) It was determined that a five-foot reduction in water levels at Lake Sakakawea between 2002 and 2003 due to drought conditions and USACE management of the Missouri River, reduced the economic value of recreational fishing to the State by $2.6 million, or 6.6 percent of pre-drought values. Consumer surplus losses estimated with a travel cost model were approximately twice as large as reduced daily expenditures adjusted for site-substitution effects. Future (2004-2011) reductions in economic values are expected to be $90.2 million, or $11.2 million per year.

Impact: The use of alternative land value data for calculating Fish and Wildlife Service wetland easement payment values in North Dakota will save the agency (and taxpayers) time and money. The improved understanding of the economic impacts of low water levels in Lake Sakakawea will enable the U.S. Army Corps of Engineers to more optimally manage Missouri River water levels in the coming years.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Impact of Change on Rural Communities: Rural Tourism

This study examined and analyzed existing agricultural and natural resource-based tourism enterprises in the state, assessed their market demand and estimated their local and statewide economic impacts. This was accomplished through a comprehensive survey of existing agricultural and natural resource-based tourism enterprises in North Dakota. The research team first assembled a list of known enterprises, based on sources such as the North Dakota Game and Fish Department (listing of licensed hunting and fishing guides and outfitters), the North Dakota Tourism Department, local convention and visitors bureaus, Internet listings, and persons attending NDSU Extension agritainment workshops. The intent was to include a broad spectrum of enterprises, including farm- and ranch-based activities (e.g., horseback riding, branding, and cattle drives), hunting, fishing, birding and other wildlife viewing, lodging, hiking, biking, snowmobiling, and similar activities. A survey mailed to these businesses during the summer of 2003 elicited information regarding services provided, business characteristics (e.g., year established, number of employees, months of operation, subcontracting, revenues and expenditures), customer characteristics, marketing/advertising, and interest in information and technical assistance. A report summarizing survey findings was the first major product from the program.

A series of focus group discussions were conducted in Southwestern North Dakota to further explore areas with potential for expansion and issues of concern to tourism businesses in that region and gain insights about areas where cooperative action or state initiatives might be useful. Findings have been summarized in a departmental report.

Results from the research clearly indicate that the state's outdoor recreation and nature tourism sector is still a fledgling industry. Most of the firms responding were relatively new (85 percent started since 1990) and relatively small (half reported 90 or fewer customer days in 2002). Most of the businesses provided only supplemental income for their operators (three-fourths of respondents reported that their business provided less than 25 percent of annual household income). On the other hand, most operators were optimistic about demand for the type of services they provide and the potential for growth, both for their own business and for the industry as a whole.

Impact: Tourism is the fastest growing component of North Dakota's economic base. In 2002, tourism (expenditures by out-of-state visitors) was estimated at $3.1 billion (almost 20 percent of the state's total sales for final demand, a.k.a. economic base). Hunting and angling alone have become a billion-dollar industry in North Dakota. During the 2001-02 season, hunters and anglers accounted for an estimated $469 million of direct expenditures and $545 million in secondary impacts, for a total economic contribution of more than $1 billion. Nonresident sportsmen accounted for $66 million of the direct expenditures and a total economic contribution of $150 million

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research

Key Theme - Impact of Change on Rural Communities: Regional Center for Rural Development in North Dakota-2003 Special Grant

Rural communties in the Great Plains need to diversify their economic development options. This project explores the value of two economic development opportunities for rural communities in the Great Plains, specifically natural resource-based tourism and informal caregiving for the elderly.

Data from a statewide survey of outdoor recreation, nature-based, and agricultural tourism businesses have been analyzed and the results have been published in two research reports. The data indicate that tourism as an economic industry has grown over 50%, an increase of $74.5 million, in the Southwest region of North Dakota since 1998. This places tourism ($223.6 million) at the same level as agriculture ($226.1 million) with regard to its contribution to the region's economic base. Analysis of survey data of informal caregiving has been completed. The data indicate that 6.5% of the households in the state have informal caregivers. Estimates of the national contribution of informal caregiving top $196 billion in longterm care services.

Impact: This research will increase the information available to policy makers regarding the

economic contribution of natural resource-based tourism and informal caregiving.

Source of Federal Funds: CSREES Grant

Scope of Impact: Statewide

Key Theme - Impact of Change on Rural Communities: Regional Center for Rural Development in North Dakota-2004 Special Grant
Rural communities, especially those in the Great Plains, need to explore new economic development strategies. This project examines the viability of two economic development opportunities for rural communities in the Great Plains.

Intercept surveys were conducted at the Potholes and Prairie Birding Festival, held in Jamestown in June, 2004. Findings indicate that attendees were largely non-local area residents (76%). They spent an average of 3.1 nights in connection with the event and, on average, $160 per person. The total direct economic impact for the event was estimated at $26,000 and overall economic impact, including indirect impact was $64,000. Census data are being analyzed regarding shifts in elderly populations and their corresponding economic impacts.

Impact: It is expected that this project will increase economic information available to numerous decision makers concerning economic trends in the state and the impacts of various agricultural and resource development activities along with demographic shifts on the state economy.

Source of Federal Funds: CSREES Grant

Scope of Impact: Statewide

Key Theme - Promoting Business Programs: Developing a Nanocomposite-Based Biomaterials Industry in North Dakota
There is a growing interest in the use of natural fibers as reinforcements for composites. Natural fibers not only have the functional capability to substitute for glass fibers used in the industry today, but also have advantages such as low cost, low density and affinity for polar polymer matrices. The use of wheat straw as a source of biomaterials represents an important opportunity in supplying bio-based reinforcements for composites and ultimately biocomposites. The development of a biomaterials industry not only offers the prospect of replacing current materials with a superior, biodegradable product derived from renewable resources, but also could provide an additional income source for North Dakota farmers, as well as new jobs and economic stimulus for rural areas of the state. This type of economic stimulus is urgently sought in rural areas of North Dakota, where the predominate trends over the past two decades have been ones of depressed farm incomes, dwindling farm numbers, out-migration, and population decline. The goal of this project is to develop a strategic plan for establishing a biomaterials industry in North Dakota. Initial efforts will be focused on economic and technical requirements

for commercializing technology to produce bio-based cellulose nanowhiskers, which will be key feedstocks for production of next-generation nanocomposites.

Initial work on this project has included analysis of wheat straw availability and cost. Data was assembled on wheat acreage, yields, and estimated straw production for all North Dakota counties over the past 20 years. During that period, estimated straw production ranged from 4.4 million tons to 20 million tons. Evaluation of market prices for baled straw, together with transportation costs, resulted in an estimated cost for straw delivered to the plant of $34 per ton.

Impact: Technologies identified, developed, demonstrated, and transferred to commercial application under this program may be expected to use a variety of renewable resources such as wheat straw and other grasses to produce higher value products while generating little or no waste. By adding value to what is now basically a waste material (wheat straw), the development of a biomaterials industry could offer an additional income source for North Dakota wheat producers, as well as new jobs in the processing activity and general economic stimulus for rural areas of the state.

Source of Federal Funds: CSREES Grant

Scope of Impact: Statewide

Key Theme - Promoting Business Programs: Food Entrepreneurship

Food safety is a topic of concern in the United States. Because food-related businesses are a growing sector in the North Dakota economy, the NDSU Extension Service has developed materials and partnered with other agencies to help ensure the safety of North Dakota-produced foods. A resource binder, "Starting Your Food Business in North Dakota," was developed by the NDSU Extension Service and the Institute for Business and Industry Development in partnership with the North Dakota Department of Agriculture. Available in all county extension service offices, the resource binder includes information on food industry rules and regulations regarding food safety and quality control. A Web site, "Food Entrepreneur: Guide to the Food Industry," is regularly updated with information on food safety, testing/labeling and other issues. The address is http://www.ag.ndsu.nodak.edu/cdfs/foodent/entrpnr.htm. Workshops on "Acidified Foods Regulations" and "HACCP" (Hazard Analysis Critical Control Point) in partnership with the Food and Drug Administration (FDA) and U.S. Department of Agriculture have been provided for food entrepreneurs and regulators.

Impact: More than 170 food products have been tested for acidity and water activity for compliance to federal regulatory standards. Several did not meet the federal government standards for safe pH level and/or had not filled out the appropriate registration forms. The products were re-formulated for safety. "Nutrition Facts" labels for incorporation on food labels have been developed for over 350 North Dakota food products currently on the market.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Consumer Management: Improving Decision-Making Among Consumers
North Dakota consumers are faced with increased decision-making responsibilities regarding new products and services, new ways of purchasing, and new ways of receiving product and service information and support. Understanding these trends and providing unbiased information to assist consumers in making these decisions requires continuous development and dissemination of research and fact-based educational materials and delivery formats. Such information has been historically sought from land-grant institutions, such as NDSU.

Extension specialists, faculty and extension agents are instrumental in providing this resource to citizens. Educational programs and materials on topics such as choosing long-distance phone service, shopping from home, financial services and identity theft are only a few of NDSU's recent consumer education resources. Other agencies, such as the Consumer Protection Division of the North Dakota Attorney General's office will collaborate to provide a comprehensive source of consumer information. The goal is to help consumers make informed choices in the market place, understand their redress options, and improve their overall quality of life. A challenge for NDSU Extension is to help citizens be able to determine the validity and reliability of consumer information in an information-rich society.

Impact: Through these programs and relationships, North Dakota consumers will understand their rights and responsibilities as consumers. Collaborative relationships with other consumer education organizations will be strengthened and consumers will improve their decision-making skills. While all consumers in North Dakota will benefit, certain audiences will be targeted, such as limited resource audiences which are prone to predatory lending practices. In addition, the elderly population is growing in the state and special efforts will be made to provide information for their needs, and for the people who work with, and care for them.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Estate Planning: Financial Security Later in Life
As North Dakota's population ages, individuals and families have increased need to prepare for financial security in later life. The national CSREES initiative, "Financial Security in Later Life," has been developed to address these issues. North Dakota Extension family economics programming for the next several years will complement this initiative. The research-based framework provides a solid conceptual foundation on which to build needed educational resources. A review of the protective factors identified in the existing literature suggests that there are three key "stops" involved in achieving financial security in later life. Consumers who plan, act, and evaluate are more likely to achieve a financially secure later life.

A Roadmap to Financial Security in Later Life curriculum was developed in 2001 to introduce

consumers to the importance of achieving financial security for themselves and others and what critical stops they must make along that road. In addition, packaged programs have been developed annually to present the information in a logical order using user friendly format. "Money Attitudes, Values and Goals" and "Communicating About Money" were developed and taught state-wide using a train-the-trainer format in 2001-2002. In 2002-2003, "North Dakota Saves," "The Basics of Bonds", and "Saving and Investing" were developed and taught. "Welcome to Wall Street," "Mutual Fundamentals" and "Starting an Investment Club" were developed and taught in 2003-2004. Programs being developed for 2004-2005 are: "Planning for Long-Term Care,." "Post Secondary Education Planning,", and "Forecasting Retirement Income and Expense."

Impact: Implementing this program will increase the number of North Dakota residents who:
- engage in activities which increase their financial literacy related to later life issues,
- utilize recommended practices in managing their use of credit in light of long-term goals for later life,
- initiate contributions to a retirement savings plan or increase contributions to retirement plans,
- determine retirement income needs and/or future income needs,
- develop a plan to achieve retirement and/or future income goals,
- establish or revise investment goals,
- participate in employer-provided retirement plans,
- increase their contributions to employer-provided retirement plans,
- increase their knowledge of risks, costs and financing options for health, including long-term care,
- develop a plan for managing long-term health care needs, and
- develop an integrated plan for accumulating, protecting, and distributing/transferring assets.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Family Resource Management: Helping Families become Money Wise

Most Americans are not satisfied with their current economic situation and do not feel in control of their personal finances. Many rely on sales-oriented information to make decisions concerning significant resources or have unwise credit use practices. Others let compulsive behaviors interfere with their financial goals.

North Dakota's economy has depended traditionally on agriculture and energy and these two sectors have been depressed in recent years. In addition, agriculture is undergoing considerable change. Farm families, as well as other families within the state, need to adjust and adapt to these rapid changes that are occurring throughout the state, nation, and world. Educational programs are needed to help individuals, farmers, ranchers and families develop competencies to remain financially secure members of North Dakota's economy.

Recent studies have documented a lack of financial literacy among youth and adults of all ages

in our country: increased personal debt, bankruptcies, lack of emergency savings, and failure to attain financial goals such as an economically secure retirement are a threat to our state's financial well-being. In addition, productivity in the workplace is affected when workers are experiencing financial stress and lack of work/family options.

Impact: Implementing this program will increase the number of North Dakota citizens who:
- engage in activities which increase their financial literacy,
- utilize recommended practices in managing their use of credit,
- establish or revise investment goals,
- increase their knowledge of risks, costs and financing options for health care, and
- increase their knowledge of risks, costs and financial options for insuring property and automobiles.

While the program will provide useful information for all individuals and families, various programs and activities will have targeted audiences. For example, the High School Financial Planning Program will target high school students and educators, and the Becoming Money Wise will target limited resource audiences.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Parenting: Father Involvement and the Dakota Fatherhood Initiative
Three out of four people in America believe father absence is one of the most significant social problems facing our country. Twenty-five million American children (34%) live apart from their biological fathers and may experience negative outcomes associated with this reality. In 1997, the National Center for Children in Poverty located at Columbia University began to track the activities of all 50 U.S. states regarding the challenge of addressing social problems associated with father absence or low father involvement. By the year 1999, at the time of its second report, only one state reported implementing only one of the five possible strategies–North Dakota. The Dakota Fatherhood Initiative was developed in the year 2002 to begin addressing ways to support responsible fathering and organizations interested in promoting involved fathering.

A series of intensive regional conferences were planned to provide training and resources related to father involvement, the Dakota Fatherhood Summits. The first summits were held in Bismarck, N.D. (April 2002), and Pierre, S.D. (October 2002), with respective attendance of 100-125 individuals at each conference. Partners in the planning, design, and implementation of the Dakota Fatherhood Summit 3 Conference included the NDSU Extension Service and North Dakota State University, the Dakota Fatherhood Initiative, the North Dakota Head Start - State Collaboration Office, and the Denver Region VII Office of the Administration for Children and Families, U.S. Department of Health and Human Services.

Impact: A post-conference evaluation was administered to assess the impact of the conference

training and materials. Participation in the Dakota Fatherhood Summit III conference involved attendance by approximately 180 individuals from at least six states. Most participants came from North Dakota, South Dakota and Minnesota, with others attending from Wyoming, Montana, and Washington. A sizeable number of participants attended with support from local Head Start or Early Head Start programs, and between 30 and 40 percent of participants were from Native American communities across the region. Of those reporting, 98 percent stated the conference training as a whole on father involvement and resources was significantly or very useful in their work. And, 93 percent of the participants also indicated that the specific conference presentations and materials provided were significantly or very useful to them. Among the conference participants, 95.2 percent reported that they were much to very much more interested and motivated to work on issues related to father involvement with families. 81.4 percent of the respondents noted that they were much to very much more knowledgeable about specific issues related to father involvement with families. Additionally, 95.3 percent of participants said that they were much or very much planning to access or use resources and strategies they had learned about through the training in their own efforts. These results suggest a positive outcome for the participants regarding their knowledge about father involvement and their likelihood of making new efforts to strengthen father involvement in meaningful ways in their communities.

Source of Federal Funds: Smith-Lever

Source of Impact: Multi-state extension and research

Key Theme - Parenting: Family Life Education - NDSU Extension Parent Resource Centers

The NDSU Extension Service supports and operates four regional Parent Resource Centers in Fargo, Grand Forks, Mandan, and Dickinson. These centers provide quality educational resources on parenting and family life, delivering educational programs, and building collaborative partnerships. Collaboration with the North Dakota Department of Human Services, Children and Family Services Division, targets some funding for program activities designed to prevent child abuse and neglect and promote healthy parenting skills. This profile highlights selected activities and impacts at two of the Extension Parent Resource Centers in North Dakota.

Impact: The Region IV Parent Resource Center in Grand Forks provides parenting resources and educational programs in a 4-county region of northeast North Dakota (Grand Forks, Nelson, Pembina, and Walsh). Among its varied activities, the Parent Resource Center provides a regular newsletter to community professionals, parents, and others in the community to share parenting information and furnish updates on parent education events and opportunities. A survey evaluation showed the following impacts of this effort:

- 91.4 percent of respondents indicated that the newsletters are a valuable resource to them in their parenting or their professional work.
- 61.1 percent of respondents stated that they their knowledge of healthy parenting had increased a lot or very much as a result of reading the newsletter.
- 54.1 percent of respondents stated that they had significantly changed behavior to use

more positive guidance and discipline with a child as a result of reading the newsletter.

Based in Dickinson, the West Dakota Parent & Family Resource Center is a collaborative project between Dickinson Public Schools and the NDSU Extension Service to provide parent education and resources to residents of eight counties in southwest North Dakota (Adams, Bowman, Dunn, Golden Valley, Hettinger, Slope, and Stark/Billings). This center offers the Children of Divorce program at multiple times throughout the year for parents who are divorced or those that are contemplating divorce. Recent evaluations with class participants indicated the following results:

- 57 percent of participants think the workshop should be mandatory for all divorcing parents.
- 79 percent of participants agreed that the session helped them to understand how children are affected by divorce.
- 93 percent indicated that the information presented will have an influence on the decisions they will make regarding their children.
- 78 percent of participants planned to make a stronger effort to work with an ex-spouse for the children's sake.

These impact examples illustrate the strength and importance of the resources, educational programs, and partnerships developed through the Extension Parent Resource Centers to work toward creating a better life and future for North Dakota's children, families and communities.

Source of Federal Funds: Smith-Lever

Source of Impact: State specific extension

Key Theme - Parenting: Parent Involvement - The Father Times Newsletter

Father involvement in family life is a major need for the healthy development of young children. To aid families in encouraging parent involvement, a parenting newsletter series for fathers and father figures of young children was developed and implemented in specific sites in North Dakota. The NDSU Extension Service partnered with an urban kindergarten program, Eagles Kindergarten Center, to implement and evaluate the Father Times parenting newsletter series.

Impact: 430 families in Fargo, N.D., at the Eagles Kindergarten Center received issues of the Father Times parenting newsletter each week during a two-month period. A survey was conducted to determine impacts of the newsletter. The findings showed that:

- 89 percent of fathers and father figures reported reading a significant portion or all of the Father Times parenting newsletter when they received it.
- 97.5 percent of fathers and father figures reported that the Father Times parenting newsletter was easy to read and understand.
- 89 percent of fathers and father figures agreed or strongly agreed that the Father Times parenting newsletter was useful in their everyday parenting.
- 77.3 percent of fathers and father figures indicated they had increased understanding about their children's needs for growth and development as a result of reading the Father Times parenting newsletter.

- 75.7 percent of fathers and father figures stated they were more attentive to the needs of their children as a result of reading the Father Times parenting newsletter.
- 76.6 percent of fathers and father figures reported they had increased knowledge of good parenting as a father due to reading the Father Times parenting newsletter.
- 72.2 percent of fathers and father figures reported changing their behavior to use more postive guidance or discipline with their child as a result of reading the Father Times parenting newsletter.
- 68.7 percent of fathers and father figures said they had done some of the father-child activities from the Father Times newsletter with their own child.
- 66.6 percent of fathers and father figures indicated they had read more to or with their child as a result of reading the Father Times parenting newsletter.

These findings suggest the value of educational resources that meet the needs of specific audiences and encourage a focus on child and family well-being.

Source of Federal Funds: Smith-Lever

Source of Impact: State specific extension

Key Theme - Youth Development/4-H: Career Readiness/Workforce Preparation
Youth in North Dakota can benefit from opportunities to explore career possibilities, to view education as a tool to success, and learn the attitudes, skills, and work habits valued by employers and needed by entrepreneurs. Youth need to know what to expect in the workplace.

Science and information technology affect the career opportunities for youth. Science and information technology education will affect decisions relating to future education and careers. The 4-H program can supplement and enhance science and technology education now offered in schools for youth and adults.

The effort to complete a project, planning and organization skills, respect for others when a young person works on a project or competes in an activity are all characteristics that will help the individual in the world of work. Employees need specific subject matter knowledge and skills, but the real successful employees have the skills to follow through on commitment, and have the ability to communicate and get along with others.

Impact: Service projects are a significant part of the 4-H experience. North Dakota ambassadors donated more than 1100 hours to communities around the state between the summer of 2003 through the fall of 2004. In addition, as reported by 16 counties, more than 70 percent of clubs in those counties participated in one or more community service projects in 2004.

Developing skills to prepare youth for the workforce is one of the underlying goals of many 4-H activities. Youth Range Camp objectives are to develop a sense of teamwork and cooperation, an understanding of rangeland resources, a level of proficiency in skill development important to

range resources. Skills learned in range camp are transferable to the work place. Evaluations of the camp showed scores of 4.35 on a 5 point skill for skill development and 4.39 for a measurement of teamwork and cooperation.

Management of financial resources is an important aspect of work force readiness and skills needed by youth as they move into adult life. In 2004, 1,610 students in 36 North Dakota schools completed The High School Financial Planning Program. Nationally, students in the program have shown significant improvement in their ability to set aside money for future needs and wants and in distinguishing the difference between needs and wants.

Technology skills are an important aspect of career readiness and work force preparation. Technology team members and 4-H Ambassadors partnered with the State Insurance Department's Senior Health Insurance Counseling Program to help senior citizens learn how to save money on prescriptions through internet search on www.medicare.gov.

They also provided train-the-trainer opportunities with Global Positioning System technology, including the Marketplace for Kids Region 3 event, helping to develop entrepreneurs in North Dakota. Other areas became involved with the Favorite Places project.

At the Ft. Berthold Indian Reservation, 4-H programs used technology learning experiences as an after-school program and found resurgence in youth participation interested in learning how to use technology in a practical, applicable manner.

Using an electronic discussion process to allow free flowing discussion of a teen audience, teens identify issues having impact on teens growing up in North Dakota. Surveys of participants in the Governor's School program during six years from 1999-2004 have identified trends. Alcohol use by teens was the number one issue throughout the entire process, Teen sexuality and a theme of self image, mental health and acceptance by peers ranked as the 2nd and 3rd significant issues. A total of 331 Governor's school teens indicated they now have a better understanding of issues affecting them as a group and how there are similarities and differences for teens growing up in both rural and urban settings.

Youth involved in conference judging interviews, judging contests, local club meetings, and communication arts events are developing communication skills in both one-to-one and group situations.

The ability to follow through and complete tasks is evident by the completion of a project as demonstrated by more than 11,000 exhibits at the North Dakota State Fair by youth enrolled in 4-H programs. In addition, 112 youth participated in the project expo at the North Dakota State Fair. This involved sharing information from their projects or research and practicing communication skills with the public as wells as officials of the event.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Youth Development/4-H: Mini-Society
Youth have a strong interest in entrepreneurship or starting their own business. National Gallup surveys (sponsored by the Ewing Marion Kauffman Foundation) in 1994, 1995 and 1999 concluded that six out of ten young people wanted to start a business. When students were asked to rate their knowledge and understanding of starting a business most (76 percent) rated themselves fair to very poor. Youth recognized the importance of education for preparation of starting a business. The predominant response that significantly outweighed all others was "education in school." (Source: "The E Generation" by Marilyn Kourilshy and William Walstad, 2000) Mini-Society®, or the entrepreneurship course that we implement in North Dakota is designed for 3-7th grades.

Impact: Four hundred twenty-four young people participated in 30 hours each of entrepreneurship "hands on" learning in 2004 in 56 classroom, after school programs and 4-H clubs in North Dakota. There was a definite decline in the use of the program with the "No Child Left Behind Act," so we are currently pursuing ways in which to incorporate the lessons from program into the North Dakota academic standards. Current train-the-trainer programs do incorporate the standards. The value of volunteer hours given to this program is more than $1 million when $17.19 is used as the value for one hour. This number does not include preparation and other time spent outside the classroom on the program.

We have received a grant from the Ewing Marion Kauffman Foundation to conduct surveys in two high schools with students who participated in our program in grade school to see if there is any retention of what they learned and whether participants have a different attitude toward entrepreneurship.

Three high schools were surveyed to determine the retention of entrepreneurial concepts and attitude toward owning a business. All three schools were located in rural communities with two in non-reservation and one in a reservation area. One hundred students made up the total sample size with the mean age of 15. Sixty-six of the students reported that they were white, 20 Native American, 10 mixed race, 2 black and 2 Asian. Chi square analyses revealed a significant statistical difference between male and female students in terms of having their own business in the future. Male students were more likely to indicate that they would like to have their own business in the future, compared with female students. No differences could be found in age, grade level, and ethnicity. There was no difference in whether or not the student participated in Mini-Society in grade school as to whether they wanted to start their own business. However, these results should be interpreted with caution for numerous reasons. The sample of 100 students is very small to make any generalizations. Additionally, even though participation in Mini-Society did not seem to influence attitudes about entrepreneurship or increase knowledge about certain economic concepts, do not overlook the fat that participating students were in grades 9 and 10 when they filled out this survey, and had at least two more years of high school to attend. Therefore, the exploration about future careers might not be a high priority at this time. Furthermore, the lessons were taught in 3rd and 4th grade. We would be interested to see if there would be a difference when surveying 12th grade students when career choices are more important to them.

Source of Federal Funds: Smith-Lever and Ewing Marion Kauffman Foundation

Scope of Impact: State

Key Theme - Youth Development/4-H: CYFAR New Community Project
Standing Rock: Since February approximately 124 participants (adults, adolescents, and children) on the Standing Rock Indian Reservation have been involved in the parent education and programs focusing on positive youth development are provided. Preliminary evaluation of the adult program indicated the following:

85 percent of parents/caregivers found the information useful—all the time.
13 percent of parents/caregivers found the information useful—most of the time.
2 percent of parent/caregivers found the information useful—most of the time.
25 percent of children/adolescents stated that the information was useful—all the time.
75 percent of children adolescents stated that the information was useful—most of the time.

Impact: Parents/caregivers indicated that as a result of this program they increased the time they spend with their children, became more patient with their children, and became more aware of their children needs. Youth indicated that they enjoyed the projects they were involved with. Additionally, youth stated that they learned how to work in groups, to be calm, how to solve problems, and how to better manage their emotions.

Home on the Range: Approximately 131 children and adolescents have been involved in a youth program on Home on the Range, an in-home youth facility.

46 percent reported that the information/activities were useful—all the time.
38 percent reported that the information activities were useful—most of the time.
15 percent reported that the information/activities were useful—sometimes.
1 percent reported that the information/activities were never useful.

Impact: Youth indicated that as a result of programming they learned: how to work with others, learned new 'things,' leadership skills, dropping out of school does not get me anywhere, to stop drugs, and to get closer to family.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Youth Development/4-H: 4-H Survey Project
In 24 North Dakota counties, 372 4-H youth participants (age 12 and older) were involved in this survey project. The preliminary findings indicated a large majority of youth participating in 4-H reported the following:

- 4-H provides physiological and psychological safety

- 4-H provided an appropriate structure
- 4-H provided supportive relationships with adults
- 4-H provided the opportunities to belong
- 4-H provided support for efficacy
- 4-H provided support for skill-building
- 4-H provided integration between families and communities

Impact: All these above principles have been outlined to be promoting positive youth development and are characteristics of features and settings that promote youth development.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Allocated Resources ($ x $1,000)		**FYO4**
1862 Extension ($)	Smith-Lever	798
	State	1,197
	FTE	28.5
1862 Research ($)	Hatch	34
	State	50
	FTE	1

B. STAKEHOLDER INPUT PROCESS

Building linkages with the public enable us to discover information about community/county/district/state assets and needs. Various methods for stakeholder input are utilized on an on-going basis. The input from stakeholders plus input from the general public and from targeted audiences is used to develop our long range four year plans of work along with adjustments to the plan based on crisis situations that may develop in the state (drought, flood, insect infestations, plant diseases, high-risk issues of youth, food borne illnesses, security issues). Using several methods to collect data insure that high priority issues are identified, people that have a self-interest in the issue are brought to the planning meetings, and an educational design is developed to address the issue using a variety of delivery methods. The following are examples of stakeholder groups or organizations that inputs are solicited from and utilized for programming direction.

State Board For Agricultural Research and Education (SBARE)

Duties of the State Board of Agricultural Research and Education are to:

- determine the causes of any adverse economic impacts on crops and livestock produced in this state;

- develop ongoing strategies for the provision of research solutions to negate adverse economic impacts on crops and livestock produced in this state;
- develop ongoing strategies for the dissemination of research information through the Extension Service;
- annually evaluate the results of research and extension activities and expenditures and report the findings to the Legislative Council and the State Board of Higher Education;

SBARE holds monthly meetings during the fiscal year that include attendance by agriculture department chairs and research/extension center directors. The meetings focuses on assessing current programs and identifying issues and needs for new programs. The purpose of SBARE is to determine how Experiment Station and Extension budget dollars are allocated for programming. Individual citizens and commodity group representatives provided direct input. Membership is composed of the President of North Dakota State University; five persons appointed by the state Ag Coalition; five persons appointed by the Extension Service's multi-county program units; two members of the legislative assembly appointed by the chair of the legislative council (one member from each political faction); North Dakota Agriculture Commissioner (serves as a nonvoting member); Vice president for the College of Agriculture, Food Systems, and Natural Resources (serves in a nonvoting capacity); Director of the N.D. Agricultural Experiment Station (serves in a nonvoting capacity); and, Director of the NDSU Extension Service (serves in a nonvoting capacity).

Citizens' Support Group for Nutrition, Youth and Family Science

The Citizens' Support Group for Nutrition, Youth and Family Science meets quarterly. The group meets face-to-face twice a year and by conference call or other technology twice a year. The membership of this group is based on the following criteria: state geographic representation, diversity, content expertise, and leadership roles. Current citizens, Extension agents, Extension specialists, and others place names in nomination for a three year term on the advisory group. The role of this group is to:

- identify emerging areas of research and educational program needs for North Dakota individuals and families;
- disseminate and promote information focusing on cutting-edge research, recent initiatives, and Extension programs in the areas of nutrition and health, family financial management, family living and parenting, policy education, leadership and community development, and youth development, and;
- serve as advocates for research and educational programs in Nutrition, Youth and Family Science; and, share with decision makers the impact of these programs at the local and state levels.

Members of the Citizens' Support Group represent the following areas: 4-H youth development, economic development, elementary and secondary education, youth, faith communities, legislators, grant consultants, government officials, health professions, housing authority, military, value-added agriculture, violence prevention, and the legal professions. The Extension Director, Dean of the College of Human Development and Education, Chair for the Center of 4-H Youth Development, and the Assistant Director for Nutrition, Youth and Family Science are ex-officio to the advisory group. Extension specialists and agents provide periodic updates to the

advisory group using North Dakota data. Members testify before the legislature for funding support for Extension Service programs in Nutrition, Youth and Family Science programs. We have one member of the Citizens' Support Group for Nutrition, Youth and Family Science who also serves on the State Board for Agriculture Research and Education.

County Government Oversight
County commissioners actively participate in county extension program reviews. The county extension budgeting process also results in strong engagement from county government. This arrangement helps assure that extension programs are grass roots driven and are focused on local issues and needs.

Research Extension Center Advisory Committees
The seven research extension centers (RECs) hold winter meetings with their citizens advisory boards that focused on issue identification for both research and extension programming. REC staff not only used this input to set program direction for the center but also conveyed it to main station researchers and to SBARE.

Livestock Commodity Organizations
NDSU faculty and administration meet on a regular basis with the North Dakota Stockmen's Association, the Lamb and Wool Growers, Milk Producers, and Pork Producers. This interaction is used to reaffirm that livestock program priorities are addressing the needs of North Dakota livestock producers.

North Dakota Nutrition Council
North Dakota Nutrition Council, established in 1980, has more than 180 members who identify nutrition education needs. The council has representation from several agencies and organizations, each with a specific nutrition focus. North Dakota nutrition issues are identified by the membership and directed to the appropriate agency or organization for action. NDSU Extension Service specialists and agents have taken the lead educational role in addressing several nutrition issues identified by the council.

Family Life Education Committee
In 1992, the North Dakota Department of Human Services and NDSU Extension Service were legislated by the North Dakota state legislature to form a statewide Family Life Education Committee. The purpose of this committee is to provide guidance for the parenting education needs and support of individuals at all points within the family life cycle. The committee is composed of state legislators, an Extension specialist, an Extension Human Development Agent, citizens with a parenting self-interest, two administrators from the Child Division of the State Department of Human Services and the Extension Assistant Director, Nutrition, Youth and Family Science. The committee meets six times per year to identify issues, plan, implement, and evaluate parenting education programs.

The NDSU Extension Service is the primary source of direction for the parenting education programs and outreach to the state. The NDSU Extension Service partially funds three area Parenting Resource Coordinator positions. The three professionals meet with local people,

develop a program based on grass roots needs, and deliver the program using various methods acceptable to a parenting audience and report to the Family Life Education Committee.

As a result of this partnership, the state Department of Human Services provides funding opportunities to six state family life education centers through a request for proposal process. The availability of designated funds also directs the focus of the parenting education programs provided through the six family life education center coordinators. The six family life education coordinators provide evaluation feedback to the Family Life Education Committee of the state Department of Human Services on program impacts. These impacts are then shared with state legislators.

C. PROGRAM REVIEW PROCESS

No significant change in program review processes since five-year Plan of Work.

D. EVALUATION OF THE SUCCESS OF MULTI AND JOINT ACTIVITIES

The issues addressed in most "multi and joint" activities were identified by county and multicounty program unit advisory councils, specific boards and groups like SBARE, and our own extension staff. The targeted audiences for these programs were inclusive of all people with a vested interest in the issue. Many programs are on-going or multiple year in length; however, specific impacts were noted where applicable. Most of these activities resulted in time efficiencies for the extension educator, and they provided a complete educational experience for the end user. The following is a partial listing of multi-state and multi-institution activities undertaken.

Great Plains States Collaboration

Extension program leaders from North Dakota, South Dakota, Nebraska and Kansas continually interact on programming and staff development issues that address needs in all four states. The logic model continues to be utilized as a program planning/ program performance indicator in all four states. Areas that have been identified are cropping systems and public policy.

Cropping systems specialists and agents from the four Great Plains states have hosted an in-service workshop designed to foster multi-staff program collaboration and subject matter training for agents. These have alternated between the four states utilizing the host state researchers as new presenters on new topics. These workshops have fostered the development of on-going communications linkages, the sharing of educational resources and the exchange of programming ideas.

The four Great Plains states are also collaborating on public issue education. Recent demands on extension personnel to get involved in public issues prompted the four states to hold a conference in the fall of 2004. Topic covered were water issues, livestock waste, obesity, and aging. Most of the follow up training is still in the planning stages but will ultimately result in

enhanced awareness for extension agents.

Parenting - Father Involvement

A series of intensive regional conferences were planned to provide training and resources related to father involvement, the Dakota Fatherhood Summits. Summits were held in Bismarck, N.D. and Pierre, S.D. with respective attendance of 100-125 individuals at each conference. Partners in the planning, design, and implementation of the Dakota Fatherhood Summit 3 Conference included the NDSU Extension Service and North Dakota State University, the Dakota Fatherhood Initiative, the North Dakota Head Start - State Collaboration Office, and the Denver Region VII Office of the Administration for Children and Families, U.S. Department of Health and Human Services.

Three out of four people in America believe father absence is one of the most significant social problems facing our country. Twenty-five million American children (34%) live apart from their biological fathers and may experience negative outcomes associated with this reality. In 1997, the National Center for Children in Poverty located at Columbia University began to track the activities of all 50 U.S. states regarding the challenge of addressing social problems associated with father absence or low father involvement. By the year 1999, at the time of its second report, only one state reported implementing only one of the five possible strategies–North Dakota. The Dakota Fatherhood Initiative was developed in the year 2002 to begin addressing ways to support responsible fathering and organizations interested in promoting involved fathering.

A post-conference evaluation was administered to assess the impact of the conference training and materials. Participation in the Dakota Fatherhood Summit III conference involved attendance by approximately 180 individuals from at least six states. Most participants came from North Dakota, South Dakota and Minnesota, with others attending from Wyoming, Montana, and Washington. A sizeable number of participants attended with support from local Head Start or Early Head Start programs, and between 30 and 40 percent of participants were from Native American communities across the region. Of those reporting, 98 percent stated the conference training as a whole on father involvement and resources was significantly or very useful in their work. And, 93 percent of the participants also indicated that the specific conference presentations and materials provided were significantly or very useful to them. Additionally, 95.3 percent of participants said that they were much or very much planning to access or use resources and strategies they had learned about through the training in their own efforts. These results suggest a positive outcome for the participants regarding their knowledge about father involvement and their likelihood of making new efforts to strengthen father involvement in meaningful ways in their communities.

Northern Plains Sustainable Agriculture Society and Organic Agriculture

The Northern Plains Sustainable Agriculture society (NPSAS) contains members from North Dakota, South Dakota, Montana, Nebraska, Minnesota and Canada. The group's goal is to promote sustainable food production systems in agriculture. While many of the members are organic producers, it welcomes all those interested in producing food in sustainable systems. NDSU Extension Service staff have been active in developing educational programs for NPSAS.

More than five years ago NDSU extension was instrumental in developing the beginning organic farming program for NPSAS. It started out with 10 new producers and now annually draws a crowd of over 60 producers from surrounding states. The NDSU Extension Service has also developed an organic crop budget and a bulletin on switching to organic production that is widely used in both North and South Dakota. New organic farmers have used the beginning organic farming tract and the bulletin on switching to organic production to help successful transition into organic production. Organic producers from North and South Dakota have used the crop budgets for financial planning and getting loans for their operation from lenders who are not familiar with organic farming. Current work is focused on facilitating a dialogue on the coexistence of GMO, non-GMO and organic crop production.

National Farmers Market Association
An Extension Specialist from North Dakota worked with Extension Specialists, Direct Marketers and Farmers Market managers to start a national Farmers Market association. The new group was formed at a breakout session (full day) that was held during the North American Farmers Direct Marketing Association meeting held in Charlotte, North Carolina. Over $20,000 was raised from 14 states in attendance. In 2004, the Extension Specialist worked with the Department of Agriculture to start a Farmers Market and Growers Association in ND. The first annual meeting was just held in February of 2005. Eighty people registered with the two-day session. Farmers markets are being established in the larger cities in North Dakota, providing an outlet for producers to sell.

4-H Cooperative Curriculum System
A North Dakota 4-H Extension specialist chairs one of the development work team for the CCS system. The individual participates in at least two monthly phone calls, reviews curriculum proposals and prepares materials for review by a development team. This work amounts to about 30 percent of this individual's time. We have adjusted this person’s role so they can contribute to the Cooperative Curriculum System. Our state has committed three years of this specialist’s time to manage the national development work team.

Several North Dakota extension agents also have their time committed to the Cooperative Curriculum System. There are three agents serving on curriculum design teams for beef, leadership, and geospatial literacy. Each design team includes members from at least six states. This work involves attending workshops on writing curriculum and leading efforts to write, revise, review, and pilot curriculum pieces. All of the Cooperative Curriculum is reviewed every five years.

Minnesota/North Dakota Extension Partnership for Curriculum Revision
Family Life and Child/Adolescent Development Extension Specialists, from Minnesota and North Dakota respectively, have partnered to research and rewrite the Children of Divorce curriculum. The two states shared resources by providing half the funding and the faculty expertise to accomplish the project.

Two research symposiums have been held to update staff and faculty on the latest research in this field. Curriculum materials are now being revised. In the fall 2005, training and educational

materials will be provided offered to agents who in turn will use the curriculum for programming at the county level.

E. MULTISTATE EXTENSION ACTIVITIES

Sugarbeet Program

* North Dakota ranks second in the production of sugarbeets, providing 17 percent of the nation's supply. In 1998, sugarbeet growers in North Dakota and Minnesota lost $113 million to a Cercospora leaf spot epidemic. Isolates of Cercospora were found to be resistant and/or tolerant to the benzimidazole and triphenyltin hydroxide (TPTH) fungicides. From 1999 through 2004, the EPA has granted our sugarbeet extension specialist request to use Eminent, a tetraconazole fungicide, to control Cercospora leaf spot. The average number of fungicide applications applied per acre was reduced from 3.74 in 1998 to 2.06 in 2004, and Cercospora control was good to excellent in most fields. Rhizomania, Rhizoctonia and Fusarium are also becoming more severe in sugarbeet fields. Management strategies are being developed to better manage these diseases using resistant varieties and fungicides where applicable.

Impact: Testing different fungicides to control Cercospora including resistant and/or tolerant strains has led to the full registration of two new effective strobilurin fungicides, Headline and Gem. Efforts are still in place to have a full label for Eminent to be used in an alternation program with the strobilurins to control Cercospora and manage fungicide resistance. Growers are now successfully controlling Cercospora leaf spot without losing millions of dollars as they did in 1998. The use of Eminent and the strobilurins fungicides in an alternation program with TPTH has resulted in improved efficacy of TPTH, and *Cercospora beticola* populations that are more sensitive to TPTH.

* Postemergence herbicides are an expensive but necessary practice for the 3,300 sugarbeet growers in the Red River Valley of northwestern Minnesota and eastern North Dakota. Looking to help growers cut costs while continuing to provide weed control in sugarbeet, the Extension Sugarbeet Specialist developed a micro-rate application plan of postemergence herbicides combined with a seed oil additive. Applications are made two to three times during the season. The end result is a reduction in herbicide costs to the producers and reduced amounts of total herbicide use, resulting in a more environmentally friendly agricultural production system.

Impact: The micro-rate system has been widely accepted by sugarbeet growers in North Dakota and Minnesota and shows potential for use in other cropping systems. Average savings per acre of micro-rate application in sugarbeet was $20 with a total industry cost savings of $39 million. In addition, the micro-rate can save fields in adverse weather conditions. Although the active ingredient of the herbicides is not harmful to human health or to the environment when used according to the label, public perception is that using lesser amounts of any herbicide is better for the environment. Therefore, the micro-rate may help to reassure the public by demonstrating that lower amounts of herbicides are being used.

Agronomy Program
The area extension cropping systems specialist, state extension plant pathologist and county agents in southwestern North Dakota developed a demonstration using a soil fumigant to show producers yield and quality losses that can be expected in continuous wheat, wheat every other year and when at least a two-year break occurs between wheat crops. Also, nitrate levels in the root zone were compared between fumigated and non-fumigated soils to illustrate the potential environmental impact that continuous wheat may have should nitrates leach below the root zone. Cooperating institutions and organizations were North Dakota State University Extension Service, Montana State University Extension Service, Dickinson Research Extension Center, and the Hettinger Research Extension Center.

Impact: Producers who are including a two-year break in their crop rotation increased gross income $36 per acre when wheat is grown in comparison to continuous wheat. Producers are also financially benefitting from alternative and specialty crops planted during the two years between wheat crops. Some producers have reported up to $40 per acre return on specialty crops grown. Producers have also learned they can produce yields comparable to and sometimes greater than those from fallow.

Value-Added Programs
This effort focuses on three phases of value added agriculture development. The first is to assist producers, industry, etc., identify the strengths and opportunities in the region. The second is to educate clients on constraints and requirements to develop an identified value-added venture. The third is to serve as a resource for implementing identified value added agriculture opportunities.

Impact: Several events aimed at educating the public on the strengths and identified opportunities for the region are held during the year. These events include: MonDak Ag Open, MonDak Value Added Ag Conference, Research Extension Center field days, Wheat Show, MonDak Pulse Day, Sidney Ag Days and Gateway of Opportunities in Glendive, MT. Interest in value-added agriculture is high. The outcome of these efforts included identification of areas that participants felt had the best opportunity for success. These included: potential for high value crop development with the vast irrigation resources in the region (potatoes, onions, and alfalfa were singled out); developing niche crops to be used in rotation with high value crops (malting barley, soybeans and corn were identified); attracting food/ag processing firms for better markets; and the development of higher value dryland crops (chickpeas, other legumes, and oilseed crops have seen dramatic acreage increases in the past three years).

Impact in North Dakota and neighboring states is demonstrated by the changes in acreage. In North Dakota, lentil acreage increased from about 2,500 acres in 1993 to more than 100,000 acres in 2004. Dry peas have increased from about 2,000 acres to more than 300,000 acres during the same period. Canola increased from 20,000 acres to 780,000 acres. Potato is the highest volume vegetable crop grown in the North Central region. With over 100,000 acres of legume crops (chickpeas, field peas, lentil, etc.) and over 2 million oilseed acres (canola, mustard, flax, etc.) many new processing facilities have developed. In the region, there was one processor in 1995, now there is 5 processing/marketing facilities.

Busch Ag, Cargill and Coors have implemented a malting barley increase program. Acreage of selected varieties of malting barley under contract has gone from a limited number of acres in 1998 to over 50,000 acres now. Busch Ag constructed an elevator in the region that became operational in 2003. Their goal is to market five to seven million bushels of malting barley. The three companies would like to contract well over 100,000 acres of malting barley in the future.

Livestock: Two surveys and a focus group were conducted for Dakota Heritage Beef, a group of southwestern North Dakota and northwestern South Dakota ranchers. The purpose of the first survey was to determine consumer interest and potential for a test market in a branded beef product. The second survey was to gauge consumer satisfaction of their purchase. Important findings included: Consumers indicated they were interested in buying locally produced beef (64.3 percent would pay a premium). Quality was more important than price as the determining factor in buying beef (85.8 percent). More than 77 percent of the survey respondents found the product through in-store promotions. And more than 91 percent were interested in future purchases.

Impact: Consumer willingness to pay for locally produced food products is an important element in determining the feasibility of value-added ventures. Impacts of the survey indicate further analysis is warranted in determining the feasibility of facilities for producing branded beef product.

U.S. Department of Agriculture
Cooperative State Research, Education and Extension Service
Supplement to the Annual Report of Accomplishments and Results
Multistate Extension Activities and Integrated Activities

Institution: NDSU

State: North Dakota

Check one:

X Multistate Extension Activities
__ Integrated Activities (Hatch Act Funds)
__ Integrated Activities (Smith-Lever Act Funds)

Title of Planned Program/Activity	Actual Expenditures FY 2004
Sugar Beet Program	56,000
Agronomy Program	21,000
Value Added Programs	26,000
Total:	103,000

F. INTEGRATED RESEARCH AND EXTENSION ACTIVITIES

Renewable Resources
An integrated extension and research program was developed to improve rangeland management across the state. Key components of the effort included research on the effects of dormant season grazing on native rangeland in western North and South Dakota and the impacts of dormant season prescribed fall fire on herbage production and plant community dynamics of native rangeland managed using seasonlong or twice-over rotation grazing.

Impact: Dormant season grazing (mid November through mid January) at moderate and full use did not effect herbage production the following compared to standard full use summer grazing (June 1 through November 1). Double use of two weeks grazing in mid June followed by dormant season grazing from mid November through mid January enhance subsequent years herbage production by 0 to 26 percent. Nine months post prescribed October dormant season fire decreased herbage production on the seasonlong grazing treatment; however, no significant reductions occurred on the twice-over rotation grazing system or nonuse treatment. Twenty-one months post fire showed full recovery of herbage production on all treatments.

Distribution of these results were accomplished thru different means. The second edition of "Rancher's Guide to Grassland Management" was published in June of 2004 with 1,960 copies distributed through North Dakota, eastern Minnesota, and southeastern South Dakota. It was out-of-print by August, 2004. Over 2,450 land managers and ranchers received this book for educational and hands-on use to impact an estimated 2,695,000 acres of land. Thirty-eight ranchers participated in the cow/calf and 12-month forage planning workshops. These two workshops impacted over 125,000 acres of native rangeland, pastureland, and hayland and 10,963 animal units of livestock. More than 90 percent of the participants were planning to add new range improvement practices.

Beef Education
Animal feed utilization studies have focused primarily on cattle. In addition to productivity realized by traditional, co-product and new feed regimens, considerable attention has been directed at sources, intake, and fates of metabolizable protein.

Impact: Processing barley finer in backgrounding diets increased feed efficiency when total mixed rations were fed to growing steers. No differences in average daily gain were noted as barley was processed finer. No benefits were noted when corn was ground finer in similar backgrounding rations. Field peas can be used as a portion of creep feeds for nursing calves with no negative effects on forage digestibility or forage intake. Processing flax by grinding or rolling improved cattle performance compared to feeding whole flax. Cattle fed flax had increased levels of alpha-linolenic acid (ALA) in the resulting meat products compared to cattle not fed flax. Flax-fed cattle may produce beef that can be a source of ALA in the human diet. No

negative effects on palatability of the resulting meat products were noted. Canola seed can be used as a protein supplement for cattle fed low quality forage. However, canola must be processed, either by rolling or grinding, to improve digestibility prior to feeding.

Scientists and extension personnel at North Dakota State University have used this information extensively in producer meetings throughout the state.

Entomology Education

* Trap cropping is being evaluated as a cultural strategy for protection of fields from yield losses associated with sugarbeet root maggot feeding injury. Essentially, the concept involves planting sugarbeet, the insect's preferred host, in previous-year sugarbeet fields (root maggot overwintering sites) to delay or prevent their colonization of current-year sugarbeets in neighboring fields.

Impact: The available body of literature suggests that the sugarbeet root maggot is capable of causing yield losses of between 40 and 100 percent in the absence of control measures. Chemical insecticides are under frequent regulatory and public scrutiny and some have been shown to cause harmful impacts to non-target and beneficial organisms in crop production habitats. Thus, the development of cultural strategies for management of agricultural pests is a worthy endeavor.

* Farmers growing wheat in North Dakota face many challenges, two of which are the wheat midge and Hessian fly. As well as being a pest and causing yield and quality losses to North Dakota farmers, the wheat midge may play a role in the spread of wheat scab. The Hessian fly appeared in North Dakota wheat during the summer of 2003.

Impact: In the last decade, the wheat midge and Hessian fly have emerged as serious pests of durum and hard red spring wheat grown in North Dakota. Management practices including planting dates, scouting, and insecticide treatments, have mitigated the impact of these pests. When scouting reveals infestation, producers spend an estimated $10 per acre to control the wheat midge. For the Hessian fly, insecticides can again be used to kill the pest; however, by the time the pest is found in the crop, it is usually too late to reduce crop losses.

The Extension statewide IPM pest survey has evolved into a very comprehensive program for obtaining pest information. In 2003, the state was divided into five regions. Six crops and their key pests were surveyed from the last week of May until the end of August. The survey was limited to five crops again for 2004. A total of 2,362 fields were visited from late May until the end of August. Information from these surveys are summarized in geo-referenced maps for use in newsletters, reports, and web information. The maps summarizing the sampling data were are to graphically illustrate where pest problems are developing in the region. Crops include wheat, barley, soybean, sunflower, and canola.

Funding was secured for conducting the 2004 North Dakota Pesticide Use and Pest Management Practices Survey. The comprehensive, enterprise level survey continues the four-year schedule for acquiring pesticide use data and information on pest management practices for N.D. field crop production. Multiple meetings were held in the fall with the North Dakota Agricultural

Statistics Service (NDASS) staff to finalize plans for implementing the survey.

Impact: The pest surveys have provided valuable information about current crop and pest situations as they develop in the region. With the survey information, extension specialists have been able to develop programming needs to address the issues that were being faced by agriculture in a proactive fashion rather than after the fact. The proactive programming provides the tools to make timely management decisions that produce economic return during the current production season. In addition, researchers get a heads up on pest activity and where research should be focused.

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Multistate Extension Activities and Integrated Activities

Institution: NDSU

State: North Dakota

Check one:

__ Multistate Extension Activities
__ Integrated Activities (Hatch Act Funds)
X Integrated Activities (Smith-Lever Act Funds)

Title of Planned Program/Activity	**Actual Expenditures FY 2004**
Renewable Resources	11,000
Beef Education	18,000
Entomology Education	15,500
Total:	44,500

Check one:

__ Multistate Extension Activities
X Integrated Activities (Hatch Act Funds)
__ Integrated Activities (Smith-Lever Act Funds)

Title of Planned	**Actual Expenditures FY 2004**

Program/Activity	
Renewable Resources	19,600
Beef Education	25,000
Entomology Education	6,200
Total:	50,800

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