ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS

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

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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 2006, North Dakota led the nation in production of spring wheat, durum wheat, barley, canola, all sunflower, oil sunflower, non-oil sunflower, flaxseed, all dry edible beans, pinto beans, navy beans, dry edible peas, lentils, and honey. The state ranks second in production of all wheat and sugarbeets; fourth in potatoes; seventh in oats; and ninth in soybeans. Exports of North Dakota commodities and products are valued at more than $1.8 billion. Crop production is critically important to the economy of the Northern Great Plains. Cash receipts from crops provided more than $3.3 billion to the economic base of North Dakota in 2005. 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 21 percent of total agricultural cash receipts--$989 million in 2005. 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.

In recent years, economic returns from hard red spring wheat, durum wheat and barley have decreased and minor crops have become increasingly important in North Dakota as producers seek to increase returns or incorporate additional crops into rotations. Screening of potential new crops is crucial for identifying those that show potential for future commercialization. This may require years or perhaps even decades in a new region. Such is the history of sunflower, dry bean, soybean, and more recently canola in North Dakota. These were new crops 15 to 40 years ago, but they are now major crops grown in North Dakota and the surrounding region contributing to the states strong agricultural economy. Development of a pilot process for canola biodiesel resulted in it successfully passing key ASTM standards for total and bound glycerine, acid number, sulfated ash content, and flash point. Flaxseed milling represents an excellent opportunity for economic development in North Dakota. Chickpea research has identified that crop density and weed control method were generally the most important factors in achieving higher chickpea yields. The NDSU corn-breeding program has identified and developed five late generation blue corn lines and 31 early generation blue corn lines that are under second-year testing.

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. In 2006, 49.3% (3.45 million acres) of ND wheat acreages were grown to Alsen, Reeder, Steele-ND, Parshall and other NDSU released cultivars.

The recently released HRSW, Dapps and Steele-ND, are grown on significant acreages, replacing old varieties. Glenn, the 2005 NDSU HRSW release is in high demand due to its high resistance to scab, leaf disease, high quality and good grain yield. Howard, a 2006 release will become an important variety which has similar characteristics to Glenn. The impact of the new HRSW cultivars released by this program on the economy of the state and nation is tremendous.

Fusarium head blight (FHB) is the major fungal disease in the spring wheat region, with the disease causing grain shriveling and losses due to the DON mycotoxin. The release of publicly developed resistant varieties and their adoption by North Dakota growers is estimated to have saved growers approximately 25 million dollars over the last several years. NDSU researchers identified three chromosomes from a resistant variety which they quantified as lowering the level of FHB severity and the level of DON in the grain.

The potato continues to be the most important horticultural crop produced in North Dakota. In 2006, North Dakota ranked fourth in U.S. potato production. Potatoes were harvested on more than 39,659 ha in 2006, up 20% from 2005. North Dakota potato growers produced a total of 1.567 million metric tons, with 63% of production russet cultivars, 22% white cultivars, and 15% reds cultivars. Total production was up 24% from 2005 and the average yield per ha was 1.12 metric tons higher than in 2005. In 2006, 6,372 ha were accepted for certification by the North Dakota State Seed Department, up about 1,410 ha from 2005. NDSU cultivar releases, including strains of standards, accounted for more than 38% of the hectarage. Seed hectarage of recent NDSU releases continued to increase, reflecting interest by the processing and tablestock sectors.

The release of Souris, a new oat variety, provides growers with a cultivar with high grain yield potential that provides resistance to the prevalent crown rust races. Souris produces grain with good milling quality that has lower groat oil concentration than HiFi. Lower groat oil concentration is desirable for human food products because of reduced calories per serving. HiFi provides growers with a crown rust resistant, high yielding cultivar with a 30% increase in soluble fiber concentration that increases the human nutritional value of milled oat products.

North Dakota is the primary production area for flax in the U.S. ND produces more than 90% of the flaxseed in the United States. NDSU developed flax varieties that are high- yielding, disease resistant and have high oil and linolenic acid content. The value of the flaxseed crop in ND is estimated at $45 million per year. The demand for flax seed is increasing. Flax production in North Dakota in 2005 was more than 800,000 acres. 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.

Soybean acreage in North Dakota has grown to more than 3 million acres in less than a decade. Iron deficiency chlorosis is a widespread problem in many production areas. Results of chlorosis screening studies are widely used by farmers, seed dealers and agronomists in managing this difficult problem. The annual report of the chlorosis resistance of about 200 soybean varieties has become an essential part of the soybean production system of the state. The screening of future NDSU varieties helps support an alternative to the commercial breeding industry. The variety screening data have been used by other NDSU scientists to identify genetic markers

associated with chlorosis resistance.

North Dakota ranks second in sugar beet acreage, providing 17 percent of the nation's supply. Researchers in North Dakota, Minnesota and Montana are looking at control strategies that integrate disease-resistant crops and timely fungicide applications to manage new and emerging diseases. Better Rhizomania and Fusarium resistant varieties are being developed and quickly used in growers fields. Over 75% of North Dakota/Minnesota growers are now using Rhizomania resistant varieties. Disease control was very effective in 2006 and contributed significantly to the record yields (25.4 tons per acre, 18.2% sugar concentration, 8611 lb recoverable sugar per acre) at American Crystal Sugar Company and at Minn-Dak Farmers cooperative (25.9 tons per acre, 17.1% sugar concentration, 7429 lb sugar per acre). In North Dakota, there was a 38% increase in yield in 2006 compared to 2005. The Roundup Ready event for sugarbeet received full governmental approval for use in sugarbeet in 2005 but the sugarbeet cooperatives in the United States have not allowed sugarbeet growers to utilize the technology. The sugarbeet cooperatives are expected to accept Roundup Ready sugarbeet in 2008 which will greatly simplify weed control in sugarbeet. Roundup Ready sugarbeet research conducted annually since 1996 in eastern North Dakota and Minnesota will provide answers to most sugarbeet grower questions regarding weed control in Roundup Ready sugarbeet.

Weed control is a big part of our scientist's work to improve crop management. Research demonstrated the acceptable application timing for tribenuron use in alfalfa to be 0 to 2 cm of regrowth. Since application outside of this range resulted in 40 to 80% yield loss, widespread adoption of tribenuron in alfalfa for Canada thistle control could have been financially devastating. Identification of such a restricted application timing for tribenuron use in alfalfa prevented loss of forage yield with an estimated value of $24 million annually in North Dakota. Control of broadleaf weeds, especially pigweed species, in flax is very difficult with herbicides because of crop injury. Use of mesotrione should be restricted to preemergence applications because post emergence application caused loss of yield up to 20%. Mesotrione use is more viable in oat because the crop is more tolerant of mesotrione. Producers would benefit because of activity on yellow foxtail, which infests about 20% of North Dakota production acreage. Control of weeds in Kentucky bluegrass is important to increase the value of sod, but weed-free turf also has greater aesthetic value that is realized during the sale of a home or lot. The safety of propoxycarbazone use in bluegrass under cool, wet or hot, dry conditions allows for the removal of quackgrass, a weed that makes sod unsaleable and contributes to lower real estate values.

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 compared with continuous wheat. Producers also are financially benefiting 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. 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

acreages have each decreased by 300,000. This decrease indicates that fewer acres of continuous wheat and barley are being sown. In 2006, some producers planted more acres of wheat and fewer rotational crops. This increased the number of acres of wheat that were grown on wheat. Also drought conditions contributed to lower wheat yields. This provided an opportunity to again emphasize the need to develop and hold to a rotation which controls root pathogens. Producers who kept fields in a rotation to control root disease had an increase of 10 bushel per acre over fields in a monoculture in this drought year resulting in an increase in gross income of $45 per acre.

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 production and profitability roadblocks. Dairy families monitor and measure the impact of decisions formulated by their self-selected advisory board with the help of a facilitator. Since the inception of this program, more than 19 percent of North Dakota dairy farms have participated in the program. Gross annual economic impacts in 2006 ranged from $80,000 to $428,610. Demands for expertise in livestock development are escalating with the explosion of interest in investment for alternative fuels production. Thirteen land sites have been pre-permitted for dairy use and are near established rural communities who welcome new dairy farm families.

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 followed by 140 producers in 2004, and 157 producers in 2005. In 2006, 159 producers were enrolled in the program and of these 124 were beef, and 35 were dairy herds. It should be noted that one of the beef herds was a demonstration herd funded by USDA:APHIS to study modes of transmission and attack rates by age cohort and type of environment.

In 2005, more than 500 animals were lost to anthrax in North Dakota. In conjunction with regulatory, public health and Extension veterinarians in Manitoba, Minnesota, North Dakota, and South Dakota, North Dakota State University entered into a regional program to assess the current knowledge about anthrax and develop recommendations for a unified anthrax education and control program for the region. A regional meeting of regulatory, public health and Extension veterinarians along with international anthrax experts was convened in October 2005. Subsequent to this meeting, NDSU extension personnel received funding from the ND State Board of Agricultural Research and Extension to study the anthrax outbreak of 2005 from which recommendations can be made to this regional consortium for a unified anthrax education and control program. In the summer and fall of 2006, only 5 cases of anthrax on 4 premises were reported after an intensive media campaign was conducted in the spring of 2006.

The NDSU Extension Service showed that it cost up to 3 cents less per pound to finish cattle in North Dakota compared with an out-of-state feedlot. Cattle producers are participating in feedout projects where they commingle groups of 3 to 6 cattle per consignor at a university feedlot for finishing. While cattle returns over expenses have averaged more than $100 per head for spring marketed calves during the past fours, the range between the most profitable group

and the least is more than $200 per head. More than 525 producers attended Extension feedlot schools in the last six 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. Privately owned custom feedyards are being built in a response to increased education and public funds for improving water quality with reduced manure runoff.

Animal feed utilization studies have focused primarily on productivity realized by traditional, co-product and new feed regimens. Recently, considerable attention has been directed at the impact of various feeds on beef composition. Flax is an oilseed crop produced in the northern Great Plains. It contains high levels of n-3 fatty acids, making it a unique source of nutrients for livestock. Feeding 8% flax to feedlot heifers increased gain and efficiency, and processing flax increased available energy and resulted in increased efficiency of gain. Feeding 8% flax also increased levels of n-3 fatty acids in fresh beef.

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.

Screening of new crop oilseed species was conducted near Prosper, ND. Oilseed species included borage, calendula, camelina, coriander, cuphea, echium, evening primrose, lesquerella, and lunaria. Borage, cuphea, echium, evening primrose, and lesquerella exhibited agronomic deficiencies such as poor emergence, plant lodging, late and prolonged flowering and maturity, seed shatter, and low yield. Camelina and coriander produced moderate yields with fewer agronomic concerns. Yield improvement for cuphea requires plant breeding improvements to reduce agronomic deficiencies associated with seed shatter and indeterminate growth. Cuphea seed treatments containing Apron showed the greatest seedling emergence in field when the previous crop was sugarbeet. Oilseed crops have the potential to provide industrial, edible, nutritional, cosmetic, and pharmaceutical products.

Impact: Development of a pilot process for canola biodiesel resulted in production of 1020 liters of canola biodiesel that was used in field equipment demonstrations. This biodiesel

successfully passed key ASTM standards for total and bound glycerine, acid number, sulfated ash content, and flash point. Flaxseed milling represents an excellent opportunity for economic development in North Dakota. Milling technology is relatively accessible to small businesses, even businesses based in rural areas. North Dakota based research on spearmint N requirements indicates that recommends that N rates may be reduced by more than 60% relative to the current recommendations that are derived from Montana or Oregon. Spearmint growers will realize a significant savings in fertility input costs due to these revised guidelines. Chickpea research has identified that crop density and weed control method were generally the most important factors in achieving higher chickpea yields. The NDSU corn-breeding program has identified and developed five late generation blue corn lines and 31 early generation blue corn lines that are under second-year testing. The current high demand for blue corn hybrids makes NDSU an essential player with recognized breeding capacity. Sensory evaluation of fermented chickpea fortified breads showed that a 5% addition to the bread formula did not impact the sensory characteristics when compared to the control. A supplement of low-grade chickpeas for use in a higher value food product would increase the value back to farmers.

Screening of potential new crops is crucial for identifying those that show potential for future commercialization. This may require years or perhaps even decades in a new region. Such is the history of sunflower, dry bean, soybean, and more recently canola in North Dakota. These were new crops 15 to 40 years ago, but they are now major crops grown in North Dakota and the surrounding region contributing to the states strong agricultural economy.

Source of Federal Funds: Smith-Lever and Hatch

Scope of Impact: Multi-state

Key Theme - Plant Production Efficiency: Develop Management Strategies to Sustain Crop Productivity

Many nutrition-related constraints to crop production remain in North Dakota. One example is iron deficiency chlorosis of soybeans, a micronutrient deficiency related to poorly-drained soils. It is a common and destructive problem for soybean production in North Dakota. Iron deficiency chlorosis causes stunting early in the growing season, and severely reduced yields. Chlorosis is related to the presence of $CaCO_3$ in the topsoil, elevated salinity in the soil, and wet conditions in general. Studies are being performed in the greenhouse and field in several aspects of this disorder. Soybean varieties are screened for resistance to chlorosis, and greenhouse studies are being performed to clarify the effects of different forms of salinity on chlorosis. Information from our studies is also being used to help identify genetic markers for resistance to chlorosis. Iron fertilizers are also evaluated.

Impact: Soybean acreage in North Dakota has grown from about 600,000 acres to over 3 million acres in less than a decade. Iron deficiency chlorosis is a widespread problem in many production areas of the state. The results of our chlorosis screening studies are widely used by farmers, seed dealers, and agronomists, in managing this difficult problem. Our annual report of the chlorosis resistance of about 200 soybean varieties has become an essential part of the soybean production system of the state. Our screening of future NDSU varieties helps support an

alternative to the commercial breeding industry. Our variety screening data have been used by other NDSU scientists to identify genetic markers associated with chlorosis resistance. Our work with the chelate FeEDDHA has contributed to increased interest in the fertilizer industry in providing lower-cost sources of this material for the correction of chlorosis in soybeans.

The Roundup Ready event for sugarbeet received full governmental approval for use in sugarbeet in 2005 but the sugarbeet cooperatives in the United States have not allowed sugarbeet growers to utilize the technology. The sugarbeet cooperatives are expected to accept Roundup Ready sugarbeet in 2008 which will greatly simplify weed control in sugarbeet. Roundup Ready sugarbeet research conducted annually since 1996 in eastern North Dakota and Minnesota will provide answers to most sugarbeet grower questions regarding weed control in Roundup Ready sugarbeet.

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 our research project are to develop white, specialty, and sawfly resistant wheat varieties for North Dakota and the surrounding region. There remains substantial interest in the production of specialty wheats, and both domestic and export end-users especially desire the development of high protein hard white spring wheat varieties. Fusarium head blight (FHB) research involved combining two sources of FHB resistance - one derived from Sumai-3 and another derived from *Triticum dicoccoides*. We have used molecular markers to identify lines with two different sources of resistance to FHB, and we quantified that these lines exhibit a lower level of scab severity and grain deoxynivalenol (DON) content compared with lines having a single source of resistance. Using reciprocal backcross disomic lines, we also quantified a lower level of FHB severity and DON in the grain of disomic lines due to Frontana spring wheat chromosomes 3A, 6A, and 4D. We tested the effectiveness of various methods of selecting varieties for high grain protein content by using molecular markers compared with near infra-red reflectance (NIR) technology. Selecting for high grain protein was more effective using NIR technology. A low-amylose experimental wheat line was commercially tested for the production of a biodegradable pet litter product and modified starch products, and tests demonstrated that this line performed favorably in both products. We are preparing for pre-release of this line. We tested experimental wheat lines for resistance to wheat stem sawfly and demonstrated that one solid-stem experimental line exhibited superior resistance to sawfly larval infestation. We are preparing for prerelease of this line as well. We tested experimental hard white wheat lines for agronomic performance in the region and identified several lines as being competitive for grain yield and end-use quality with existing red spring wheat varieties.

Impact: FHB is the major fungal disease in the spring wheat region, with the disease causing grain shriveling and losses due to the DON mycotoxin. The release of publicly developed resistant varieties and their adoption by North Dakota growers is estimated to have saved growers approximately 25 million dollars over the last several years. We identified three chromosomes from a resistant variety which we quantified as lowering the level of FHB severity and the level of DON in the grain. Resistance to FHB might be increased by combining different sources of genes for resistance. We measured a lower level of FHB severity and DON concentration in plants and grain from a single wheat genotype in which we combined two genes for resistance. High grain protein is a main quality component of spring wheat, and spring wheat farmers are paid premiums for high grain protein. We measured the effectiveness of selecting varieties for high grain protein content by using molecular markers compared with near infra-red reflectance (NIR) technology. Generally, selecting for high grain protein was more effective using NIR technology. Low-amylose spring (waxy) wheat has the potential to be used to positively impact the making of a biodegradable regional pet litter product as well as modified food starches. We tested seed and demonstrated that the seed from a completely low-amylose or waxy wheat genotype could be used to produce a quality biodegradable pet litter product. Additional tests may indicate its usefulness in the production of modified food starches. Since it has a positive impact on flour milling yield and final product color/taste, hard white spring wheat is in high demand by millers and bakers of bread, noodle, and tortilla products both domestically and internationally. We measured the agronomic performance of advanced hard white spring wheat breeding lines and commercial white wheat varieties in comparison to red spring wheat varieties. Hard white spring wheat breeding lines and commercial varieties were identified which exhibited higher agronomic performance than red spring wheat lines under the same environmental test conditions.

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 glutograph, gluten index, and mixograph as predictors of durum wheat quality for pasta will be explored.

Research was conducted to determine the deposition of carotenoid pigments in durum wheat during grain fill. During kernel development, carotenoid pigment content/kernel increased until physiological maturity, after which it declined. Lutein and zeaxanthin were the main carotenoids found in durum wheat. Preliminary results indicate that lutein and zeaxanthin concentrations/kernel peaked just before physiological maturity. Lutein content declined 38% while zeaxanthin remained relatively constant during kernel desiccation. Moist conditions after kernel desiccation generally resulted in decreased pigment content and increased levels of free fatty acid and conjugated dienes, which indicates lipid oxidation.

Quality of durum wheat harvested in 2006 from Montana and North Dakota was determined from 219 samples. The average crop grade was U.S. No. 2 hard amber durum, with 78.0 kg/hl test weight, 2.0% total defects, and 90% vitreous kernel content. The 2006 crop averaged 15.1% protein and 1.53% ash for grain at 12% mb. Research to evaluate the relative suitability of mixograph, gluten index, and glutograph as predictors of durum wheat quality for pasta was continued. Data indicate that the glutograph test related better to pasta processing properties of semolina than did the mixograph or gluten index.

Impact: Information regarding the deposition of lutein and zeaxanthin during grain development of durum wheat genotypes will be useful in developing cultivars with enhanced carotenoid pigment content. Carotenoid pigments are antioxidants that can protect fatty acids, proteins, and DNA from oxidation. Consumption of lutein has been shown to protect human beings against age degenerative diseases such as macular degeneration, cataracts, and certain cancers. Thus, enhanced carotenoid pigment content will improve the aesthetic and healthful qualities of durum wheat produced in the US. The knowledge gained by this research will contribute to increased economic opportunities for producers and food manufacturers by improving quality and increasing value of durum wheat and its end-use products.

Information on crop quality is important for marketing durum wheat to domestic and foreign buyers. The ability to predict processing properties of semolina is of economic interest to the pasta processing industry.

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. This program has trained more than 25,000 commercial and private applicators.

Several methods of information dissemination are used, including radio, television, magazines and newspapers, the Internet, consumer service and printed material. In addition, faculty and staff who are directly accessible receive numerous phone calls.

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. USDA scientists provide basic genetic information and, in some cases develop and provide germplasm to assist the NDSU breeding programs. In some crops, 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.

In 2006, 49.3% (3.45 million acres) of ND wheat acreages were grown to Alsen, Reeder, Steele-

ND, Parshall and other NDSU released cultivars. In addition, other acreages in neighboring states (MN, SD, and MT) were grown to these NDSU cultivars. The recently released HRSW, Dapps and Steele-ND, are grown on significant acreages, replacing old varieties. Glenn, the 2005 NDSU HRSW release is in high demand due to its high resistance to scab, leaf disease, high quality and good grain yield. Howard, a 2006 release will become an important variety which has similar characteristics to Glenn. Therefore, the impact of the new HRSW cultivars released by this program on the economy of the state and nation is tremendous. The release of new improved HRSW cultivars with high quality enhances ND wheat production and market ability 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.

Fusarium head blight (FHB) is a fungal disease of small-grain crops that causes yield loss and poor grain quality. NDSU is developing durum, barley, 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' crops with new commercial applications for increased premiums.

In 2005, North Dakota ranked fourth in US potato production. In 2005, 48% of the crop was planted to russets, 32% to white, and 20% to red skinned cultivars. Predominant cultivars included Russet Burbank, Red Norland, Frito-Lay varieties, Shepody and Dakota Pearl. Norland and Dakota Pearl are ND releases. Packing of reds for the table stock market in the 2004-05 season was a very strong segment for the ND industry. It is expected that Dakota Jewel, a 2004 release with excellent storage qualities, will make significant contributions to this effort that early in the 2005-06 marketing season appears to be repeating itself. In 2005, 4,962 ha were accepted for certification by the North Dakota State Seed Department, making ND the third largest seed producer in the US behind Idaho and Colorado. Potato production for all market types and uses exceeded $153 million in 2004; the potato continues to be the most important horticultural crop produced in North Dakota. National and regional chip manufacturers for large-scale use are evaluating Dakota Crisp (2005) and Dakota Diamond (2006), two white skinned varieties for chipping and culinary use.

The release of oat variety Souris provides growers with a cultivar resistant to the prevalent stem rust race. The variety HiFi provides growers with a crown rust resistant, high yielding cultivar with a 30% increase in soluble fiber concentration that increases the human nutritional value of milled oat products. Souris, a 2006 release, is a high quality line adapted to all of North Dakota.

North Dakota is the primary production area for flax in the United States and has developed flax varieties that are higher yielding with disease resistance high oil content, and high linolenic acid content. The demand for flax seed is increasing. Production of flax in North Dakota in 2005 was over 800,000 acres.

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: Oat Cultivar Improvement
North Dakota (ND) produced 86,750 metric tons of oats from 48,600 ha harvested for grain during 2006. Much of the remaining 170,000 ha planted area was harvested as oat forage due to the extreme shortage of feed in many areas. Selected parents were used in 460 hybrid combinations involving parental lines with effective resistance to virulence prevalent in the crown rust and stem rust populations in ND. 300 $F_{2:3}$ populations were advanced via single seed descent accompanied by seedling crown rust and stem rust screening to eliminate plants susceptible to critical races from the populations. Nearly 15,000 F_3 - F_5 lines were evaluated in hill plots for disease resistance and agronomic characteristics and individual panicles were harvested from selected hills. 8,500 F_5 and 2,200 F_6 lines were evaluated in unreplicated augmented trials at one location. 380 lines were evaluated in replicated preliminary yield trials at 2 locations. 136 lines were evaluated at 4 locations in advanced yield trials. Ten lines were entered in the Tri-State Oat Nursery, 11 elite experimental lines were evaluated at 10 ND locations in Oat Variety Trials (OVT), and 6 lines were entered in the Uniform Midseason Oat Performance Nursery (UMOPN). 'Morton' and 'HiFi', released in 2001 continued to perform very well in 2006 field production. 'Killdeer', released in 2000 produced among the highest grain yield of any genotype tested in ND OVT. 'Beach', released in 2004, continued to produce high grain yield with large white kernels and high stable test weight. 'Maida', released in 2005 has resistance to stem rust race NA67 and produces grain yield and quality superior to 'AC Assiniboia'. ND961161 was released as 'Souris' in 2006 and produced very high grain yield and test weight in 3 years of variety trials at 10 locations.

Impact: Release of 'Souris', provides growers with a cultivar with high grain yield potential that provides resistance to the prevalent crown rust races. Souris produces grain with good milling quality that has lower groat oil concentration than 'HiFi'. Lower groat oil concentration is desirable for human food products because of reduced calories per serving. HiFi provides growers with a crown rust resistant, high yielding cultivar with a 30% increase in soluble fiber concentration that increases the human nutritional value of milled oat products. 'Beach', released in 2004 is providing growers with a cultivar that will produce high test weight grain under drought stress conditions. Lines were developed that all combining crown rust resistance from 'Morton' with a source of resistance to problematic races of stem rust. The stem rust resistance and crown rust resistance in this material are inherited as a single unit so that selection for one recovers both types of resistance. This material is providing a basis for development of cultivars with broad resistance to both stem rust and crown rust which are the two most important oat diseases in the upper Midwest.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Plant Germplasm: Corn (Zea Mays L.) Breeding in the Northern Corn Belt
North Dakota (ND) corn production keeps moving north and west within the U.S. North Central Region. In 2006, ND farmers planted over 1.7 million acres of corn placing corn as the number three state crop commodity economically. Genetic improvement is the main reason corn is becoming adapted to these once considered marginal areas. However, even though the ethanol

industry is expanding in these areas corn is still limited in its extension to the west due to significant environmental challenges mainly drought.

The main economic benefit to the farmer and industry in this area continues to be the current availability of productive early-maturing lines with high starch under abiotic stresses, a priority within the NDSU corn breeding program. We have initiated efforts to understand the mechanisms of polygenic effects involved in drought tolerance by testing over 3,000 genotypes through non-transgenic approaches, a complementary approach to industry. This has been possible increasing our drought management in winter nurseries and extending our testing efforts in western ND. Following an award from the state Agricultural Products Utilization Commission (APUC) we have continued and increased the screening of our germplasm for grain quality traits for the development of corn hybrids specific for ethanol utilization. Currently, 20% of our program is being evaluated for grain quality with a long-term target to evaluate 100% of it depending on funding. Our corn breeding program has continued its focus on the development of very early-maturing inbred lines reducing the risks associated with late planting, early frost, and low grain quality. We have evidence of producing early-maturing hybrids (in cooperation with certain industries) that are similar in grain yield and lodging performance, above average test weight (~3 lb/Bu) and below average grain moisture at harvest (~40 g kg-1) compared to dominant commercial corn hybrids available in the ND market based on 2005 data across 15 locations. The NDSU corn breeding program has grown to a record of 20,000 plots across locations and our products have extensively been requested by industry. Adaptation and germplasm improvement efforts have continued due to our long-term cooperation with the USDAGEM program since 2000 and our efforts on intra and inter-population recurrent selection programs. We currently have four full-sib reciprocal recurrent selection programs that address the creation of new heterotic patterns for the region and are a consequence of the extensive testing performed for choice of germplasm during 1999-2004.

Impact: The NDSU corn breeding program has been in existence for 75 years and it is the most northern public breeding program in North America. Its focus is on early maturity, grain quality, and abiotic stress tolerance since these traits are as evident as yield in ND environments. We develop elite populations, inbreds, and their respective hybrids. We had about 40 requests for germplasm from other public and private programs last year, mainly inbred lines due to fast dry down, early maturity, good performance and quality, and because of new sources of genetic diversity within early maturing germplasm. As a consequence, commercial hybrids are becoming earlier with higher test weight. Ethanol plants will only utilize ND corn hybrids if they are early maturing with above average drought tolerant, grain quality, and stand ability. The impact of public corn breeding programs is very large even though confidentiality does not clearly show it. Plant breeding should continue to become a priority across state leadership and federal granting agencies.

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 that is preferred for "eye appeal."

The regional flax nursery was seeded at six locations in ND, with both early and late seeding at Fargo, for yield and other agronomic evaluations. A nursery was planted and evaluated on historic 'Plot 30' for wilt tolerance. N0010 was named 'Carter' and released in 2004. Initial grower feedback suggests an undesirable yellow seed coat color. Additional observations will be made to compare the seed coat color of Omega and Carter under the same growing conditions. In 1998 the USDA-ARS discontinued research in flax, regional responsibility for coordinating an advance variety trial for the North Central Region (including Canada) was transferred to my leadership. The project of the effect of latitude on oil content and oil quality has been completed. A new program to evaluate the potential of increasing the ALA content of flaxseed has been initiated.

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. The demand for flax seed is increasing. Production of flax in North Dakota in recent years has been over 800,000 acres.

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.

Chromosome asynapsis and hybrid sterility are major obstacles to alien gene transfer, and genes affecting nuclear-cytoplasmic (NC) interactions are directly or indirectly involved. A detailed analysis of two genes involved in NC interaction scs (species cytoplasm specific) located on

chromosomes 1A and 1D using recombination based and radiation hybrid based mapping approaches, respectively is underway. We now have markers within 1 cM of 1A locus and BAC clones to initiate chromosome walking toward this gene. Radiation hybrid mapping approach resulted in map resolution of ~199kb which is much higher than any previously reported in wheat and will lead us to the locus on 1D. We have also initiated experiments to identify mitochondrial genes differentially expressed in these and other alloplasmic stocks. Fusarium head blight (FHB) is a fungal disease of small-grain crops that causes yield loss and poor grain quality. We used molecular markers to introgress the linked region from resistant species/cultivars into cultivated durum and hexaploid wheat. Additionally, we are rapidly mapping new sources of resistance by modified pedigree-association mapping analysis.

Impact: This project is aimed at developing durum and bread wheat lines better adapted to North Dakota growing environment and tolerant to prevalent diseases. The ultimate aim is to provide North Dakota growers with durum and bread wheat crop having improved resistance and 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

Approximately 60% of Northern Plains potato production is used for frozen processing and dehydration. Potatoes are also produced for tablestock and for certified seed, in addition to several alternative end uses. Disease and insect pests continue to challenge producers and require chemical inputs, as commercially acceptable cultivars are not available. Stress resistance and quality continue to be important issues for producers, processors, and consumers. Our research efforts 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.

In 2006, 570 new families were created in the greenhouse, and 101,472 seedlings from true botanical seed grown in summer and fall crops. Primary focus for breeding continues to be cold processing ability, late blight, Colorado Potato Beetle, sugar end, pink rot and *Pythium* leak, and aphid resistance, with emerging areas including *Verticillium* wilt, PVY and *Fusarium* resistance, as well as enhanced nutritional quality. Of the 101,472 seedlings, 33.6% had one or both parents possessing cold sweetening resistance, 46.3% had one or both parents possessing late blight resistance, and 29.6% had one or both parents possessing Colorado potato beetle resistance breeding. At Langdon, 80,317 ND seedlings, representing 428 families were evaluated; 1,015 were retained. Unselected seedling tubers, totaling about 100,000, were shared with the breeding programs in CO, ID, MN, TX and WI. Approximately 1,254 second and 436 third year and older selections were evaluated in the field at Absaraka and Wyndmere; 184 second year and 303 third year and older genotypes were retained. Yield and evaluation trials were grown at five locations, three irrigated and two non-irrigated sites. One hundred thirty-one advancing selections and named cultivars were evaluated in replicated yield trials at Hoople, including the

North Dakota state red and chip trials, North Central Regional, and Quad State trials. Irrigated sites were at Park Rapids, MN, Larimore and Tappen, ND, with 24, 28 and 199 genotypes evaluated, respectively, in the replicated trials. Yields were generally good to excellent with highs of more than 60 metric tons per ha. ND submitted ten entries in the quad state trial and six entries in the North Central Regional trials. The heat and drought conditions in late June and July resulted in quality issues including higher sugar content, reduced levels of dry matter, and an increased level of hollow heart. Fifty-one families (nearly 5100 individual genotypes) were evaluated for resistance to late blight (US8) using a detached leaf assay in the greenhouse; families ranged from 0 to 58% resistance. All resistant selections were retained for field evaluation in 2007. In collaborative cultivar development trials 20 selections were evaluated for disease reaction to bacterial ring rot in the field. Two did not express typical foliar symptoms and one did not display tuber symptoms; symptom expression was impacted by the hot, dry production conditions and all will be retested in 2007. Eight ND advanced selections and cultivars were evaluated for sensitivity to metribuzin; ND6095-1, ND4659-5R, ND5002-3R and ND7192-1 exhibited some sensitivity. Twenty-one advanced selections were subjected to a transient water stress at tuberization, for the detection of susceptibility to the sugar end disorder. Thirty clones were evaluated for resistance to pink rot and *Pythium* leak. An important breeding line for resistance to Colorado Potato Beetle, ND2858-1, was identified along with others, as possessing moderate to high resistance to these two important diseases. One parent of ND2858-1 is *Solanum chacoense*. ND submitted entries in cooperative trials in FL, MI, MN, NC, TX and WI amongst others. Promising advanced selections include ND4659-5R, ND5002-3R, ND8555-8R, ND7818-1Y, AOND95249-1Russ, AOND95292-3Russ, ND8229-3, ND7882b-7Russ, ND5775-3, ND8304-2, and ND8305-1. Three of these may be considered for release in late 2007 or 2008.

Impact: The potato continues to be the most important horticultural crop produced in North Dakota. Potatoes were harvested on more than 39,659 ha in 2006, up 20% from 2005 (North Dakota Agriculture Department, 2006). North Dakota potato growers produced a total of 1.567 million metric tons, with 63% of production russet cultivars, 22% white cultivars, and 15% reds cultivars. Total production was up 24% from 2005 and the average yield per ha was 1.12 metric tons higher than in 2005. In 2006, 6,372 ha were accepted for certification by the North Dakota State Seed Department, up about 1,410 ha from 2005. NDSU cultivar releases, including strains of standards, accounted for more than 38% of the hectarage. Seed hectarage of recent NDSU releases continued to increase, reflecting interest by the processing and tablestock sectors. Dakota Crisp increased 26.6 ha, Dakota Diamond 5.5 ha, Dakota Jewel held about steady and Dakota Pearl was up by more than 116 ha. Several advancing selections are being increased by certified seed producers in North Dakota and Minnesota. Dakota Crisp and Dakota Diamond, both released in 2005 with cold chipping properties are being evaluated by national and regional chip manufacturers for large scale adoption.

The seed increase procedures for the potato breeding program continue to be improved and in 2006 included increases in minituber production, nuclear seed in the field, and larger increases of experimental (breeders seed) lots. These efforts are permitting enhanced participation in in-state and out-of-state cooperative trials and evaluation by potato producers and industry representatives.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Plant Germplasm: Improving Hard Red Spring Wheat (HRSW) Germplasm and Cultivars

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 the spring wheat region. This project aims to develop and provide wheat growers in North Dakota and neighboring states in the North Central region with new adapted HRSW cultivars that will meet their needs and the wheat industry and the export market requirements.

Elite and improved germplasm generated by NDSU HRSW breeding program 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. Classical breeding methodologies and modern tools such as molecular markers will be used to achieve the targeted goal. Studies to understand the genetics of most valuable and economic traits will be conducted to generate powerful tool to achieve efficiently the development of improved wheat germplasm. Recently developed transgenic wheats (genetically modified wheat) for specific traits are being studied within the HRSW breeding program for eventual use to face the endless challenges for wheat productivity and endues.

Impact: The NDSU-released hard red spring wheat (HRSW) cultivars have been historically, hallmark cultivars in the wheat industry. They still continue to dominate the overall acreage grown to wheat in North Dakota and expand to neighboring states. During the last five years, more than 50 percent of N.D. acreage was grown to NDSU HRSW wheat cultivars. This includes Alsen, Reeder, Steele-ND, Parshall, and Dapps. Steele-ND and Glenn released in 2005 and 2006 are steadily gaining acreage. In 2006, these two cultivars were grown on more than 9 and 2% of ND acreages, respectively. Howard released in 2006 is still in the seed increase phase. 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 scab disease. Steele-ND is a high yielding cultivar with very good quality and good scab resistance. Steele-ND's resistance to scab is different from the one included in Alsen, which is a very important from the standpoint of breeding strategy to diseases resistance. Glenn may expand in most HRSW growing area where scab disease is a threat replacing mainly Alsen and Parshall. The reasons why this may happen is because Glenn combines both Aslen and Steele-ND resistance for scab; has higher yield than grown cultivars; has better resistance to foliar disease; and most importantly, it has excellent milling and baking characteristics. Glenn is now the wheat industry standard replacing Parshall. In 2006, a new HRSW cultivar 'Howard' was released. Howard has good quality and higher yield than Reeder, Alsen, and Parshall. It has similar level resistance to scab than Steele-ND. It is expected that Howard and Steele-ND will be grown mostly in the North Dakota Western areas

where Reeder is a dominant cultivar. 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. In summary, the HRSW wheat breeding program impact on both ND and national economy is immense.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme - Ornamental/Green Agriculture: Woody Ornamental Evaluation
Climate and certain soil conditions present a challenge in growing landscape plants in the northern plains. Only a small % of genotypes may perform satisfactorily due to insufficient winter hardiness, pest susceptibility, lack of resistance to drought, desiccating winds and unfavorable soil conditions; e.g., alkaline (pH) and saline soils. Resistance to insect or disease attack should be a major consideration in woody plant improvement and planting decisions. There is a real need to breed, evaluate and introduce adapted woody plants for this region to avoid monoculture disasters in the future.

Two superior winterhardy woody plants were named and introduced. Spring Welcome(TM) Magnolia (*Magnolia x loebneri* 'Ruth') is a seedling selection with proven winter hardiness in USDA zone 3 for 17 years. Foliage is dark green, narrowly obovate, leathery and of high quality. Plants are densely ovate in form and may be grown single or multi-trunked. Flowers are pink in bud, open to clear white with 11-13 tepals, and 7.6-11.4 cm. in diameter. This introduction could extend the range for planting magnolias 240-320 kms further north in the upper midwest. Northern Tribute(TM) River Birch (*Betula nigra* 'Dickinson') is a seedling selection from a 40-year old large tree growing in Dickinson, ND. Compared to various seed sources of this species, this selection performs well in rather compacted, dry and alkaline soil conditions in USDA zone 3. Bark is ivory colored with contrasting coppery-bronzy exfoliating layers, becoming more uniformly tannish-brown with age. This selection exhibits superior adaptation to environmental stress in the Northern Plains. Commercial nursery production of these introductions has begun as well as production of two releases in 2005, Prairie Spirit(TM) Juniper and Prairie Stature(TM) Hybrid Oak. A U.S. plant patent was issued for *Syringa pekinensis* 'SunDak' and U.S. Trademark Registrations were granted for Copper Curls(R) Pekin Lilac, Prairie Expedition(R) American Elm and Prairie Reflection(R) Laurel Willow. The NDSU Research Foundation licensed numerous nurseries to commercially propagate NDSU woody plant introductions. Field evaluations of a hardier Eastern Redbud selection, plus five other woody selections, were begun at six N.D. research sites. Several hybrid honeysuckle selections resistant to Russian aphid are in the process of introduction. Our entire Birch, Magnolia and Maple collections were inventoried. New Sargent Cherry, Callery Pear and elm cultivars are promising in hardiness. One, 5 and 10-year NC-7 reports were submitted and 5 new accessions planted. Evaluation reports were submitted to nursery collaborators on over 175 cultivars. New accessions obtained for trial totaled 186.

Impact: Evaluation recommendations for woody plants are making a significant impact on a large clientele who use landscape plants in the Northern Plains. With the introduction of 32 superior plants from this project, the inventory of hardy plants for production and sale in the nursery industry and use by landscape architects/designers, developers, city arborists, foresters, horticulturists, parks and sports facilities, conservationists, and public consumers has been markedly increased. NDSU's woody plant improvement program is recognized in North Dakota, the Northern Plains states/provinces, the Midwest, and nationally.

Source of Federal Funds: McIntire-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 local information on soybeans and small grain varieties, and corn hybrids, staff work with area groups and establish variety plots. The corn comparison trials started in 2005 was continued in 2006, staff worked county seed corn dealers in the 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 invites 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, Allied Agronomy Kulm, National Sunflower Association, North Dakota Soybean Council, soybean and corn 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 Kerry and Karl Ketterling of Marion, Dennis & Roger Feiken of LaMoure and Tom Kiecker of Edgeley.

Impact: With more favorable prices and reduced problems with insects and disease, many producers were looking to switch from sunflower and 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. In 2006, soybean acreage had increased to more than 230,000 acres, corn for grain production to just over 80,000 acres and hard red spring wheat acres had decreased to 104,000 and sunflower acres to

5400 acres. Not only have soybean and corn acres increased, so have yields. In 1994 county average soybean yields were 26.8 bushels per acre, in 2006 the county average increased to 41.3 bushels per acre. Corn yields have also improved from a county average of 83.4 bushels per acre in 1994 to 146.6 bushels per acre in 2006.

The economic impact from this change in 2006 was approximately $5.1 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%, in 2005 65% of the wheat grown in southwestern North Dakota was grown on wheat, barley or durum stubble. In 2006, some producers planted more acres of wheat and fewer rotational crops. This increased the number of acres of wheat that were grown on wheat. Also drought conditions

contributed to lower wheat yields. This provided an opportunity to again emphasize the need to develop and hold to a rotation which controls root pathogens. Producers who kept fields in a rotation to control root disease had an increase of 10 bushel per acre over fields in a monoculture in this drought year resulting in an increase in gross income of $45 per acre.

Source of Federal Funds: Smith-Lever

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

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.

Fall harvest of alfalfa produced 3.75 tons/acre more forage during the seeding and 2 subsequent years than no fall harvest and is the 7th yr a fall harvest was taken without major winter injury/winter kill. Harvest during the fall should occur only when the plant is "ready", which has been 40 to 50% bloom or regrowth initiating (about 3 inches in height). Stands harvested for 5 yr in fall were very similar in forage yield to stands not harvested in the fall previously. Forage quality was enhanced by fall harvest by removal of the residue from the first-harvest forage (residue RFV was 50). Sulfur fertilization at 40 lb S/acre increased alfalfa-orchardgrass yields by 1.35 tons/acre in a dry yr. Five locations have now been documented with S deficiency. Phosphorus fertilization of alfalfa at 60 lb/a phosphate increased forage yields 79% on a soil testing 2 ppm. Max-In, a micronutrient mix, did not increase forage yields in either P or S experiment and did not affect forage quality in 4 harvests. Lime increased forage yields at Valley City location. Hays barley had a higher IVDMD, lower ADL, and average forage yield compared with 12 other barley genotypes over 2 yr. Bestford was the highest yielding cultivar and second in IVDMD, a good alternative. Incorporating the orange lemma character into Hays or Bestford might reduce their lignin content and increase the forage quality. Two Roundup Ready alfalfa cultivars were lower yielding (average 85%) than Vernal in the seeding year. Traffic reduced forage yield of 12 or 8 varieties by only 6.3 and 6.8% in this dry year. Forage yields of Roundup Ready alfalfa seeded at 5, 7.5, 10, 15, and 20 lb/a were not significantly different with only 0.31 tons/a difference between the 5 and 15 lb/a seeding rate. BMR sorghum sudangrass was equal in yield to a check variety.

Impact: Fall harvest of alfalfa can increase forage yield by 0.75 tons/acre, which if adopted on 25% of the acreage could increase alfalfa production by 280,000 tons or 17 million dollars. Sulfur fertilization on only the 5 documented locations increased returns by $58,000 in this dry year. Selection of Hays barley for half of the 50,000 acres grown in North Dakota or selection of the BMR sudangrass/sorghum will add value to the livestock industry. Seeding Roundup Ready alfalfa at 6 to 8 lb/a on well prepared seedbeds could save $25/acre on every acre seeded.

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 were NDSU Extension Service, NDSU plant pest diagnostician, extension service plant pathologist, extension service entomologist and participating area extension specialists.

Impact: Sawfly in 2006 was identified in eight different samples submitted for analysis at the Dickinson Research Extension Center. These samples represented approximately 1,600 acres. Control measures for the next control session were discussed and could save producers 8 bushel per acre in loss grain yields in the next year. Mites were identified in three samples thought to contain wheat streak mosaic virus. Producers contacted their crop insurance adjuster and then terminated these winter wheat crops and seed an alternative crop. Sunflower flea beetle was identified occurring in one sunflower field after the insect was identified. An insecticide was recommended and then applied by the producer. This reduced plant loss and injury from these insects and producer in a drought year was able to produce a 1,250 per acre seed yield worth $182 per acre.

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 at the Dickinson Research Extension Center developed two PowerPoint presentations in cooperation with the extension agronomist at the Carrington Research Extension Center on no-till system practices. Another PowerPoint presentation on terminating alfalfa/grass hay and establishing an annual forage crop was developed for the state agent program CD. A Chapter on no-till was written for the Minnesota-North Dakota Small Grains Handbook in 2005. Provided pictures of a demonstration to an author for inclusion in a book on no-till commissioned by the Food and Agriculture Organization, United Nations. The book is scheduled for publication in spring 2006.

In 2006 an auto-downforce unit was added to the demonstration drill at the Dickinson Research Extension Center. Since all openers are controlled individually with hydraulic rams the addition of such a system provides real time adjustment to maintain consistency of opener penetration and seed placement without the operator needing to touch drill settings. This permits even germination and emergence of crops in highly structured no-till soils.

Cooperating institutions and organizations were 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 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. The no-till alfalfa/grass termination program was used with four county agriculture improvement meetings where 125 producers viewed the program. Eleven producers indicated that they were interested in using the methods described in the program on their farms in spring 2006. The 2005 seminar on no-till drew 180 producers from North Dakota, Montana, South Dakota, Nebraska, and Canada. The 2005 Field Day drew 56 producers interested in forage production. In 2006 a reduced seeding rate (3 pounds per acre) of alfalfa was successfully demonstrated to producers in Dunn County using no-till methods. Newsletters, an article in the paper and discussion at the Dunn County Ag Improvement Meeting informed producers on how low-disturbance no-till seeding can reduce costs and improve yields for establishing alfalfa. Information on no-till seeding wheat and no-till seeding corn was presented at the Best of the Best programs in western North Dakota. About 120 producers listened to the program on wheat in Williston and 210 producers listened to the corn program at three locations in southwest ND. Twenty-eight producers during the year expressed additional interests in no-till equipment and learned more about function and performance of various styles of openers.

Source of Federal Funds: Smith-Lever

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

Key Theme - Innovative Farming Techniques: Spatially Managed Farms
The area extension cropping systems specialist along with county agents from Adams, Golden Valley, Slope, and Stark Counties as well as the extension geospatial technology specialist, area farm management specialist initiated a program involving five southwest North Dakota producers to compare spatially managed variable rate application fields with whole field management systems and to improve the understanding of the economic and environmental factors important to farms who adopt geospatial technologies to produce agricultural crops. This interdisciplinary research, extension and education project will compare at least 160 acres on each of five farms. The program was initiated in March 2005.

Four producers in a four county area were selected with the assistance of the county agents. Producers were provided geographical information systems software specifically designed for agricultural uses along with personal digital assistants with global positioning systems hardware and software for capturing data in the field on pest and other notable agronomic problems. Producers were required to have yield monitors, GPS, data loggers the interest in maintaining the extra records needed for program analysis. One field was selected and split for spatial and variable fertilizer rate practices to compare to a field managed with traditional whole field

management practices. Both fields had the same crop and previous crop history.

Impact: The first year, 2005, of the project proved to be challenging in developing producer skills in using both the software and the hardware required in the project. One producer was able to get all of the equipment and software working correctly, so the comparison could be made. A comparison of yield points and input costs between the two fields showed the variable rate field net return was $9.00 to $15.00 per acre more for spatially managed fields compared to the traditional whole field management system.

The second year, 2006, of the project all producers participating demonstrated at least a beginning level of skill and understanding of operating equipment and software for applying variable rates of nitrogen fertilizer. One producer exhibited a high level of understanding in operating equipment and software for variable rating applications of fertilizer. That producer is planning to increase use of the equipment from an initial 160 acres to 1,200 acres and feels that he will not need additional assistance in developing prescription maps but will continue to participate in meetings. One producer indicated he did not have the time to develop the proficiency needed to operate the equipment and software and has hired a company to prepare prescription maps and variable rate apply fertilizer to his fields in addition to his initial spatially managed field. Two other producers participating indicated they need additional help in developing management zones and prescription maps for their demonstration fields. They indicated interest in applying what they learned to additional acres they farm. A comparison of yield points and input costs between all demonstration fields indicated no benefit for variable rating fertilizer in 2006. Drought was severe enough at all locations that no matter what level of fertilizer was applied, a difference in crop growth was limited by more by water than by fertilizer levels. A Veris Machine for measuring electrical conductivity in soils was used in the fall of 2006 to help improve the delineation of management zones in all demonstration fields. Results from the use of this additional information will not be known until 2007.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Plant Health: **Improved Sampling Procedures and Economic Injury Levels**
Methods were developed to sample banded sunflower moth populations in the field. The new technique improves on the previous methods by being simpler, requiring less time, improving accuracy, and providing more lead time before a control tactic needs to be implemented. Eggs need to be sampled along the field margins only. Using supplied tables or a spreadsheet, growers can determine portions of a field that may have populations expected to exceed the economic injury level. By limiting treatment growers can reduce their pest management expenses and beneficial insects such as pollinators and natural enemies are conserved.

Impact: The techniques for sampling banded sunflower moth eggs along field margins will reduce management costs by increasing sampling efficiency and will increase decision-making accuracy. In addition, by mapping fields into treat and no-treat areas input costs in terms of insecticide and application costs will be reduced.

Source of Federal Funds: Hatch

Scope of Impact: Statewide

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

Diseases limit productivity of dry beans in North Dakota. New pathogens are being detected in North Dakota. This project evaluates novel approaches to manage these diseases and works to improve screening techniques to identify resistant germplasm. This project studies pathogenicity of newly introduced organisms and evaluates screening techniques to help identify resistant germplasm.

The most important disease affecting dry bean production in North Dakota is white mold. The fungus Sclerotinia sclerotiorum causes white mold. In 2006, guar (Cyamopsis tetragonoloba) was identified as a new host for this pathogen. Guar is being evaluated as a potential new crop for North Dakota agriculture. This is the first report of a plant species from the genus Cyamopsis that is identified as susceptible to S. sclerotiorum. A journal article has been submitted, but will be published in 2007. The identification of alternate hosts of this pathogen is crucial to determine what kind of crops could be used in rotations with dry bean. A model that associates weather conditions to white mold development was produced with data collected from field surveys conducted in the previous three years. This model identified precipitation in the first halves of June and August as having significant impact on final disease incidence. In light of this finding, the efficacy and economics of post-flowering fungicide applications should be evaluated; previous efforts have characterized the impact of fungicides applied only during the flowering period. Studies on biological control of S. sclerotiorum continued in 2006. Several isolates of Sporidesmium sclerotivorum were successfully retrieved from North Dakota soils and are being cultured in artificial medium. The efficacy of these isolates as biocontrol agents will be evaluated in 2007. S. sclerotivorum is an aggressive biological control agent that has proved to be effective in controlling sclerotia of S. sclerotiorum in other states.

Impact: A forecasting model for white mold has been developed, but needs to be validated. This model could help growers make better informed decisions on whether to spray or not for white mold control and could potentially save several hundred thousand dollars in unnecessary fungicide applications. The identification of new alternate hosts for S. sclerotiorum will help extension agents and crop consultants advise growers on the type of crop rotations that could be used with dry beans. Results of the surveys published in 2006 will be helpful in steering breeding programs as well as serving as a base line for future evaluation of the impact of cultural practices and weather conditions on incidence of diseases affecting dry bean production in North Dakota.

Source of Federal Funds: Hatch

Scope of Impact: Statewide

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

Soybean at 4 million acres is the most important row crop in North Dakota. Soybean diseases 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.

There is emphasis on the development of disease-resistant soybean cultivars especially for resistance to soybean cyst nematode (SCN) and Phytophthora root rot through cooperation with the soybean breeder. Because of the discovery of SCN in ND in 2003, there was a major emphasis on SCN research. Studies have been initiated on the effect of crop rotation on egg densities and the reproduction of SCN on resistant and susceptible soybean and on other crops grown in rotation with soybean. Rotation to non-host crops for two years substantially reduces egg densities, but at high egg densities a two year rotation will not reduce egg levels to below the threshold for susceptible soybean. Cultivars reported as resistant to SCN were evaluated in naturally infested fields. Significant differences in resistance were found between cultivars. The impact of dry beans on SCN reproduction was investigated due to the large dry bean acreage in ND. Eight pinto and navy bean and four black and kidney bean cultivars were compared to Lee74 soybean for reproduction of SCN HG type 0 in the greenhouse within a 30 day period. SCN reproduced on all bean cultivars. Female indices (number of females on bean cultivar/number on Lee74) on cultivars in the four bean classes ranged as follows: pinto 25-50, navy 25-48; black 8-27; and kidney 75-100. Kidney beans appear to be highly susceptible to SCN while navy and pinto bean are moderately susceptible and blacks are more resistant. Research also continued on Phytophthora root rot of soybean. A method of quantifying partial resistance was investigated. Three soybean cultivars, Conrad, Sloan and OX 20-8 (high, moderate and low levels of partial resistance, respectively), were grown in the presence of a virulent isolate using the inoculum layer test. The roots of three week old plants were harvested and root volume and length were analyzed using WinRhizo software and scanner. Conrad had significantly greater root volume and length than the other two cultivars and results were consistent over experiments. These results indicate that WinRhizo root scanning software in conjunction with the inoculum layer test is a reliable method to identify and quantify partial resistance to Phytophthora root rot in soybean. Because of the high number of soybean aphids and bean leaf beetles found in ND soybean fields in 2006 we conducted a survey for soybean viruses in Richland and Cass counties, two counties with the greatest soybean acreage. Leaves from 65 soybean fields were tested for Soybean Mosaic Virus and Bean Pod Mottle Virus. All samples were negative for both viruses while known controls were positive. As of September 2006, there has not been a confirmed report of any soybean virus in ND.

Impact: Soybean cyst nematode is becoming an important soybean disease in ND. Management of this pathogen will require information on all aspects of the pathogen. Crop rotation is an important tool for reducing egg densities in infested fields. Understanding the reproduction of SCN on crops in rotation with soybean will help design rotation schedules for managing this pathogen. Phytophthora root of soybean is also an important disease. Tools to identify and quantify partial resistance will assist in our efforts to utilize resistance as one of the management tools for this disease. Identifying new soybean pathogens such as viruses aids our efforts to develop disease management methods growers need to maximize yields.

Source of Federal Funds: Hatch

Scope of Impact: Statewide and Region wide

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. Breeder's lines and commercial cultivars of durum and hard red spring wheat were planted in three nurseries around North Dakota. Leaf rust (caused by *Puccinia triticinia*) failed to develop in two nurseries (Fargo and Carrington) because of drought conditions in the state during June and July. The Langdon nursery had a normal amount of leaf rust pressure. At that site, 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 Faller, ND Steele, Glenn, and Howard appear to possess excellent resistance against the T races. Greenhouse and field experiments suggest that several advanced breeding lines appear to possess this gene. One hundred sixty-four CIMMYT wheat lines were screened in the greenhouse for reaction to races 1 and 5 of the tan spot fungus. Thirty-three lines were resistant to race 1, the most prominent form of the fungus in North Dakota; all but four lines were resistant to race 5. These lines may possess new sources of genetic resistance for the North Dakota wheat breeding programs. In other experiments, 126 hard red spring wheat cultivars and advanced breeding lines were evaluated in the field for reaction to tan spot. The plots were inoculated with races 2, 3, and 5 of the fungus. The same lines were also evaluated in greenhouse inoculations with the same races. Of these 126 lines, 17 were resistant to race 2, 76 to race 3, and 40 to race 5. Data collected were used to support variety release decisions at NDSU.

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
Glyphosate-resistant alfalfa was not injured by glyphosate tank-mixes, including 24 oz ae/A glyphosate applied twice. Weed control was not improved for treatments applied at the first trifoliolate stage compared to the third trifoliolate stage, but alfalfa was more vigorous in plots that received earlier treatment.

Mesotrione at 1.5 to 6 oz ai/A applied preemergence caused less injury, 13%, than when applied post emergence, 30%, but plants recovered by June 26. MCPA reduced initial symptom expression, but injury of 20% was recorded 14 days after application. Mesotrione preemergence or post emergence provided 90% control or better of pigweed and wild mustard and gave 65 to 85% control of yellow foxtail, but only post emergence mesotrione provided 89 to 96% control

of wild buckwheat.

Mesotrione at rates of 1.5 to 6 oz/A did not cause injury to oat when applied preemergence, but post emergence application at 3 oz/A caused 10% injury. Bromoxynil increased injury to 17%, but MCPA tended to reduce the amount of injury. Mesotrione provided 90% control or better of pigweed. Control of lambsquarters and foxtail was greater with mesotrione applied preemergence, 75 to 85%, than when applied post emergence, less than 25%.

Kentucky bluegrass was very tolerant of propoxycarbazone applied at rates up to 4 oz ai/A in May. Propoxycarbazone applied at the end of June caused discoloration and stunting that was not discernible until August, 10%. Application spray volume up to 80 gpa did not contribute to bluegrass injury with propoxycarbazone at 0.25 to 1 oz/A. The inclusion of herbicides for control of broadleaf weeds did not result in injury to Kentucky bluegrass with propoxycarbazone at 0.5 oz/A.

Impact: Research demonstrated the acceptable application timing for tribenuron use in alfalfa to be 0 to 2 cm of regrowth. Since application outside of this range resulted in 40 to 80% yield loss, widespread adoption of tribenuron in alfalfa for Canada thistle control could have been financially devastating. Identification of such a restricted application timing for tribenuron use in alfalfa prevented loss of forage yield with an estimated value of $24 million annually in North Dakota.

Establishment of alfalfa stand is important for determining the longevity, as well as the annual productivity, of alfalfa forage. Weed removal with two applications of glyphosate in seedling glyphosate-resistant alfalfa benefited alfalfa vigor and subsequent biomass production, which resulted in greater forage yield in the year of establishment compared with conventional treatments.

Control of broadleaf weeds, especially pigweed species, in flax is very difficult with herbicides because of crop injury. Use of mesotrione should be restricted to preemergence applications because post emergence application caused loss of yield up to 20%. Mesotrione use is more viable in oat because the crop is more tolerant of mesotrione. Producers would benefit because of activity on yellow foxtail, which infests about 20% of North Dakota production acreage.

Control of weeds in Kentucky bluegrass is important to increase the value of sod, but weed-free turf also has greater aesthetic value that is realized during the sale of a home or lot. The safety of propoxycarbazone use in bluegrass under cool, wet or hot, dry conditions allows for the removal of quackgrass, a weed that makes sod unsaleable and contributes to lower real estate values.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state

Key Theme – Emerging Infectious Diseases: Sugarbeet Disease Research
North Dakota ranks second in sugarbeet acreage, 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. EPA provided a full label for Eminent in 2005. In 2006, another triazole, Enable received full label for use on sugarbeet. The average number of fungicide applications applied per acre was reduced from 3.74 in 1998 to 2.08 in 2006, and 92% of surveyed respondents indicated good to excellent disease control. Rhizoctonia, Rhizomania and Fusarium are also becoming more severe in sugarbeet fields. Management strategies are being developed to better understand and manage these diseases by determining the specific species causing disease and 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 effective strobilurin fungicides, Headline and Gem, and the triazoles Eminent and Enable. The use of triazole 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. As a result, growers have a wider array of effective fungicides available at competitive price for controlling Cercospora. Specialists have also determined that azoxystrobin should be applied when the temperature at the four inch soil depth is between 62 and 73ºF for best control of Rhizoctonia crown and root rot. 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. Better Rhizomania and Fusarium resistant varieties are being developed and quickly used in growers fields. Over 75% of our growers are now using Rhizomania resistant varieties. Disease control was very effective in 2006 and contributed significantly to the record yields (25.4 tons per acre, 18.2% sugar concentration, 8611 lb recoverable sugar per acre) at American Crystal Sugar Company and at Minn-Dak Farmers cooperative (25.9 tons per acre, 17.1% sugar concentration, 7429 lb sugar per acre). In North Dakota, there was a 38% increase in yield in 2006 compared to 2005.

Source of Federal Funds: Hatch and Smith-Lever

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

Program 2: Competitive and Profitable Animal Production

Key Theme - Agricultural Profitability: North Dakota Dairy Diagnostic Program
Dairy business challenges include more than high feed costs or low milk prices. Important whole farm business decisions affect the typical North Dakota dairy enterprise. Current efforts have focused on in-depth financial analysis with select advisory teams to balance the dairy enterprise with the farming operation. According to economic research from various universities, for every one dollar spent in dairying, the associated rural 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. Intangible benefits of participating in the diagnostic approach include the development of strategic alliances, on-the-job training in evaluating growth, improving

communication, and setting personal as well as business goals for growth.

Impact: Dairy families monitor and measure the impact of decisions formulated by their self-selected advisory board with the help of an ND3P facilitator. Granted the decline in farm numbers magnifies our measure of coverage, but based on December 2006 data, over 19% of the dairy farms permitted to sell milk have been involved in ND3P since its inception.

Accomplishments from selected farms (57 farms have been involved in the program):

Farm #1: Removed all rBST from the herd resulting in an annual cost savings of $106,680. Coincidentally, management changes resulted in increased average milk production by an additional 9# per cow per day. Gross impact was ***$428,610***.

Farm #2: /fans were added at the advice of the diagnostic team to increase cow comfort and the goal of reducing milk losses resulting during hot weather, typically dropping about five pounds per cow on a daily average. For the first year with fans, the drop in milk nearly eliminated. Milk receipts indicate an improved persistency of milk marketed during the heat. Estimated gross impact was ***$50,400.***

Farm #3: Adopted a milk-marketing plan using forward contracts. The results indicate an improved annual gross impact of ***$80,000***.

Farm #4: Developed a new management plan for their replacement heifer rearing facility. Results show a significantly reduced death-loss, decreased health-related costs, and increased number of available herd replacements eliminating much of the cost associated with past purchases. Gross impact - ***$ Priceless***, when considering the purchase of developed replacement heifers is from $1800 to 2600 apiece.

Source of Federal Funds: Smith-Lever

Scope of Impact: State specific

Key Theme - Agricultural Competitiveness: Dairy Retention and Sustainability

Demands for expertise in livestock development are escalating with the explosion of interest in investment for alternative fuels production. The 2004 grass-roots driven formation of the North Dakota Dairy Coalition (NDDC) is now attaining a foothold in the rural North Dakota landscape by incorporating dairy development with these emerging revitalization opportunities. The NDSU Extension Service, the Animal, and Range Sciences Department, the North Dakota Department of Agriculture – Dairy Division and the North Dakota Association of Rural Electric Cooperatives collaborated to launch the NDDC for providing central leadership for dairy expansion.

Impact: Emergence renewable fuel development like ethanol and bio-diesel has propelled the state and region into a highly competitive and frankly, volatile economic situation. Yet when comparing North Dakota to others in our region, the relative cost to resources to support livestock growth suggests we can have a decisive advantage, especially with availability of feed grains and associated co-products, all of which are well suited for dairy and feedlot producers. If North Dakota wants to capture this opportunity for livestock growth, the window of opportunity should exist for the next five to 10 years. Our vision for NDDC was to be a key element to gain momentum for rural growth with livestock. Many of our agricultural communities are now beginning to understand the significance of economics associated with dairy. Moreover, many

now see that livestock is an essential ingredient to the success of the sustainability for renewable fuels. As the effectiveness of the coalition grows, so does Extension's educational role, creating new challenges for assisting the development of sound business plans. Some of the accomplishments derived from the above-described efforts this past year include:

- Thirteen land sites have been pre-permitted for dairy use and are near established rural communities who welcome new dairy farm families (map available at http://www.nddairy.com/sites.htm); a few private investment groups are currently preparing business plans.

- Existing North Dakota producers have completed expansion projects with the help of ND3P and Extension resources.

- Recruitment of in-state and out-of-state operators who have purchased vacant dairies: 1] The largest of which includes 1600 cows, 2] Another added 100 cow its farm and brought in a young family of five kids, and 3] Another dairy began the process of filling a 490 cow facility with a new family.

Efforts currently in progress with a high likelihood of success include:

- 1] Helping a family to complete a dealing on an county dairy with about 75 cows, 2] Bringing in both Eastern and Midwestern U.S. dairy families to view offerings in North Dakota, and 3] Two parties are interested in a larger ND investor dairy that was recently closed

It is indeed encouraging that several larger dairies do see the advantages and want to build new facilities near North Dakota ethanol plants. We are optimistic these and other results will encourage lawmakers to include NDDC in the FY2008 fiscal budget as a show-of-support to the state's producers and support agencies that piloted this effort.

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. In 2005, 157 producers were enrolled in the program and of these, one was a goat herd, 115 were beef herds and 41 were dairy herds. In 2006, 159 producers were enrolled in the program and of these 124 were beef, and 35 were dairy herds. It should be noted that one of the beef herds was a demonstration herd funded by USDA:APHIS to study modes of transmission and attack rates by age cohort and type of environment.

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. In 2005 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. In 2006 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 - Animal Health: Regional Anthrax Control Program
In 2005, over 500 animals were lost to anthrax in North Dakota. In conjunction with regulatory, public health and extension veterinarians in Manitoba, Minnesota, North Dakota, and South Dakota, North Dakota State University entered into a regional program to assess the current knowledge about anthrax and develop recommendations for a unified anthrax education and control program for the region.

Impact: A regional meeting of regulatory veterinarians, public health veterinarians, extension veterinarians and international experts in anthrax was convened in Fargo, ND in October of 2005. The attendees were from Louisiana, Manitoba, Minnesota, North Dakota, and South Dakota. Information was exchanged on current anthrax recommendations from each state/province. Commitments were made to try to establish unified recommendations on the education and control efforts among the participants. Subsequent to this meeting, NDSU extension personnel received funding from the ND State Board of Agricultural Research and Extension to study the anthrax outbreak of 2005 from which recommendations can be made to this regional consortium for a unified anthrax education and control program. In the summer and fall of 2006, only 5 cases of anthrax on 4 premises were reported after an intensive media campaign was conducted in the spring of 2006.

Source of Federal Funds: Smith-Lever

Scope of Impact: Multi-state research and extension

Key Theme - Agricultural Profitability: Feedlot Development in North Dakota
Numerous research and 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. NRCS Equip funds and EPA 319 watershed funds have been used to build numerous 1000+ head feedlots designed for manure and water run off control. The NDSU Extension Service continues to deliver the North Dakota feedlot school, advanced cattle-feeding workshops (Feedlot MDA) and many 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. Cattle producers are participating in feedout projects, Dakota Feeder Calf Show and Eastern North Dakota Cattle Feedout, where they commingle groups of 3- 6 cattle per consignor at a university feedlot for finishing. While cattle returns over expenses, not including interest, have averaged over $100 per head for spring marketed calves during the past four years, the range between the most profitable group and the least is over $200 per head. More than 525 producers attended extension feedlot schools in the last six years. Lenders are exploring additional financing of cattle, feed, and cattle feeding facilities in North Dakota and have creatively increased funds for expanding feedyards including a feedlot loan guarantee program from the state owned Bank of North Dakota. 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 continue to develop business plans for economic development opportunities. Cattlemen then explore 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, a limited, limited liability partnership (LLLP) for owning cattle for feeding to finish and a marketing company for merchandizing locally grow, fed, and processed beef. Producers involved in the program have emerged as directors and managers of the proposed plans.

Impact: Cattle producers in 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. Forty-four producers developed a limited liability company to sell fresh and processed meats into a regional market. A natural beef company was organized to provide producers and purveyors an alternative to traditional markets.

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: North Dakota Natural Beef LLC, ND Branded Beef LLC, ND Branded Beef and Pack LLC, Sheyenne Valley Marketing LLC, and Central Dakota Beef LLC

Providing 'hands on' leadership and guidance from university extension specialists and agents, several new businesses were developed to aid cattle producers and entrepreneurs in North Dakota to capture more gross returns in North Dakota. These meat processing and/or marketing companies focus on using locally grown livestock fed to specific guidelines. Enhanced value is sought through marketing, public awareness, and health implications.

Impact: Businesses and infrastructure were developed in local communities. A vertically integrated livestock producer production network was developed for Central Dakota Beef LLC and ND Branded Beef. Feasibility studies for ND Natural Beef, LLC show a strong consumer willingness to pay for locally produced food products. New jobs were created construction and operation of a processing facility for harvesting, processing and cooking meat from animals grown in the local community. Also sales and marketing jobs were created when two marketing companies were established to develop and service a larger market area. This specialty market development has led to an increase the number of feedyards and the number of cattle fed special diets to cattle for specific companies and their markets.

Source of Federal Funds: Smith-Lever

Scope of Impact: State specific. Processed meat products have markets in ND, MN, WI, SD, CA, IL, MI, NJ, NY, LA, CO, IA and internationally.

Key Theme - Animal Production Efficiency: Improving the Reproductive Performance of 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. Therefore, reproductive performance of farm animals is a major limiting factor in efficient production of meat animals. Studying the growth

and development of the blood vessels in ovarian tissues is an important aspect of understanding the basic mechanisms that regulate reproductive processes and will lead to the development of improved methods of controlling ovarian function in cattle and sheep. Evaluation of the role of placental size and blood vessel growth in fetal growth and development in cattle and sheep is necessary to understand how placental growth influences both prenatal and postnatal health and postnatal growth and development. A recent focus of nutritional effects on oocyte quality and pregnancy outcome and fetal and placental growth increases the scope of this research area. The long-term objectives of this project 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, 3) to evaluate the role of ovarian cellular interactions in the regulation of reproductive function in domestic animals, and 4) to evaluate the role of placental size and blood vessel growth in fetal growth and development in cattle and sheep.

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/assisted reproductive technology methods will provide the means to help producers apply modern biotechnologies such as cryostorage of embryos, preimplantation genetic diagnosis, and embryo transfer to meet their needs. Modernization and/or adoption of existing techniques and discovery of new ones could have immediate benefits to animal production. Improvements in 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 will ultimately give livestock producers' important tools to improve the reproductive management of their animals and increase overall efficiency of livestock 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

Rangelands of the upper Great Plains region are important to the well-being of the livestock industry and wildlife populations. There are nearly 1 million beef cows in North Dakota comprising nearly a $750 million contribution to the agricultural income of the state. Many of these beef cows forage on rangelands for much of their annual dietary needs. Drought is a common occurrence in the upper Great Plains region historically occurring in 20-40% of years in the past century. 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 did not observe an interactive effect of grazing intensity and precipitation amount on herbaceous yield. This lack of response, in part, is attributed to the abundant spring moisture received annually on study plots. Due to this spring moisture the dominant cool-season herbaceous species of the northern mixed-grass prairie avoided the major impact of the simulated summer droughts. Researchers did not measure changes in floristic-quality or plant community composition due to consecutive annual summer droughts. There was also no difference in recovery of herbaceous yield or other plant community attribute with respect to the interaction of grazing intensity and precipitation treatment. The results provide evidence to suggest that the northern mixed-grass prairie is resilient to significant change due to grazing intensity and summer droughts.

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. In 2005 and 2006 bioterrorism awareness and training sessions were conducted throughout the state.

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 the impact of various feeds on beef composition.

Impact: Flax is an oilseed crop produced in the northern Great Plains. It contains high levels of n-3 fatty acids, making it a unique source of nutrients for livestock. Feeding 8% flax to feedlot heifers increased gain and efficiency, and processing flax increased available energy and resulted in increased efficiency of gain. Feeding 8% flax also increased levels of n-3 fatty acids in fresh beef.

Concentrated separator byproduct is a byproduct which results from the removal a portion of the residual sugar from feed grade molasses. This byproduct is produced in large quantities in areas where sugar beets are processed. It is higher in protein and minerals than molasses, but lower in total sugar content. Total volatile fatty acid concentrations in the rumen were greater for concentrated separator byproduct compared with controls; however, ammonia concentrations were reduced with concentrated separator byproduct addition. Supplementing medium-quality forage with 10% concentrated separator byproduct increased nitrogen intake, small intestinal protein supply, and total ruminal volatile fatty acids.

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.

Concentrated separator byproduct is a byproduct which results from the removal a portion of the residual sugar from feed grade molasses. This byproduct is produced in large quantities in areas where sugar beets are processed. It is higher in protein and minerals than molasses, but lower in total sugar content. Increasing inclusion of concentrated separator byproduct resulted in an increase in dry matter, organic matter, apparent N digestion, and water intake. Nitrogen balance (expressed in either total mass or as a percentage of nitrogen intake) increased with the addition of concentrated separator byproduct.

Protein supplements can vary in the level of undegraded or escape protein which they contain. Research has also examined the effects of increasing level of escape protein on ruminal fermentation, digestion, and blood metabolites in beef cattle. Supplemental protein increased apparent and true ruminal organic matter and nitrogen digestion, and medium and high levels of escape protein increased ruminal pH compared with the low level. Increasing level of escape protein increased urea N and baseline plasma insulin concentrations in steers fed low-quality hay.

Impact: Research in this area will increase understanding of forage supplementation strategies for cow-calf producers in the northern plains area. Some supplementation programs may have important effects other than direct effects on digestion or fermentation. In addition, investigations into the suitability of various byproducts as forage supplements should improve profitability of cow-calf operations in the Northern Plains and add dollars to the local economy where these byproducts are produced.

Source of Federal Funds: Hatch

Scope of Impact: Statewide

Program 1

Allocated Resources ($ x $1,000)		**FYO6**
1862 Extension ($)	Smith-Lever	616
	State	924
	FTE	22.0
1862 Research ($)	Hatch/McIntire	1,326
	State	1,950
	FTE	39.0

Program 2

Allocated Resources ($ x $1,000)		**FYO6**
1862 Extension ($)	Smith-Lever	336
	State	504
	FTE	12
1862 Research ($)	Hatch	170
	State	250
	FTE	5

Goal 2: A Safe and Secure Food and Fiber System

Overview: *There is an increased awareness of food safety issues in North Dakota and the country. Large-scale food production and marketing systems and food prepared in institutional or restaurant settings have 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. North Dakota producers play a key role in supplying food for the nation and world. Efforts to safeguard the food supply at the consumer level by improving food safety during food processing and protecting crops are important functions of NDSU research and Extension.

The NDSU Extension Service has developed materials based on the national Fight BAC produce safety, BAC Down and Thermy campaigns. Extension has partnered with other agencies to help ensure the safety of North Dakota-produced foods for the past 12 years. "Nutrition Facts" labeling of North Dakota food products has been provided since 1994. NDSU has tested more than 185 food products 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 about 620 North Dakota food products on the market. Ten on-line modules promoting food safety in temporary food stands and farmers' markets have been developed and available to the general public.

Initiated in 2002, the "Wash Your Hands" project has involved more than 8,700 children in grades K-12 throughout North Dakota. About 91 percent said they would wash their hands more often and 90 percent said they would wash their hands more carefully as a result of participating in the lesson.

Potato is a vegetatively propagated crop; therefore, diseases are a major economic constraint. Developing economically and environmentally viable disease management strategies for the major yield- and quality-limiting diseases of potato is critical. NDSU research has detected significant genetic variability in the black dot fungus, an important blemish disease of potato worldwide. This research is the first genetic analysis of this plant pathogen and will finally permit the study of the global population. Their research on Fusarium dry rot indicates a shift in the species responsible for causing this disease. While Fusarium graminearum is best known for causing head blight/scab of cereals, the NDSU group is giving the first published report of this pathogen causing a disease of potato.

The sugar beet root maggot is the most serious insect pest in the beet producing areas of the Red River Valley in North Dakota and Minnesota. It also is a major pest on more than two-thirds of the sugar beet-producing acres of the U. S. Sugar beet producers in the north-central and western U. S. have relied on the same chemical insecticide mode of action for controlling this pest. The threat of insecticide resistance development is a major concern, so alternative control strategies are needed. Grower adoption of alternative root maggot management tools would allow for less use of conventional nerve poison insecticides for control of this insect, thus potentially causing less harm to the environment and to non-target organisms. A significant discovery is the testing of insect-pathogenic fungi as bio-based tools for managing the sugarbeet root maggot. During the past two years of research, a strain F52 of this fungus has been evaluated in concert with oat and rye cover crops. The first year produced very encouraging results; however, post-application drought contributed to low levels of fungus

survival/sporulation and, correspondingly poor control of the sugarbeet root maggot. The F52 strain appears to be most suited for moist soil conditions, which are common to the Red River Valley growing area.

In the last decade, the wheat midge and Hessian fly have continued to be present throughout North Dakota, with some populations reaching economic levels. 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 or delay parasite adaptation to plant resistance. 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 for that year. For both wheat midge and Hessian fly there is highly effective and genetically simple (i.e. major gene) resistance available for incorporation into North Dakota spring and durum wheat genotypes.

An unprecedented epidemic of Fusarium head blight (FHB or scab) occurred in eastern North Dakota in 1993. Severe outbreaks have occurred each year since then in many areas of the state resulting in more than a $3 billion loss to North Dakota's economy. Producers who utilized fungicides as a management strategy on 0.8 million acres of wheat realized an average return of $18-20 per acre, resulting in $14.4-16 million revenue to these producers in 2006. Producers were provided training on use of the FHB disease forecasting model and the wheat disease forecasting web site to determine need for use of fungicide and also were trained on the proper use of the fungicide and how this strategy should be integrated with other management strategies for optimum control of FHB. Producers were provided the latest information on wheat variety response to FHB. Several new varieties have good tolerance to the disease.

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.

Beef Quality Assurance (BQA) training sessions have been held throughout North Dakota for the past seven years to improve the quality, safety and consistency of beef, resulting in a more consumer-acceptable product. As a result of these training sessions, 2,500 operations have been certified, and more than 3,000 cattle producers were educated in beef quality assurance practices. These operations produce more than 549,000 head annually, 55 percent of the state's calves. Comparison of pre- and post-tests taken by participants at each session found an average improvement of 24 percent in test scores. Producers have reported receiving up a $7 per hundredweight premium on their feeder cattle because they 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.

Key Theme - Food Safety: Consumers

Increasing numbers of foodborne illnesses are being linked to produce. Safe refrigeration temperatures and cooling practices are an issue in households across the United States. In 2005, two campaigns were introduced to North Dakota: the "Fight BAC" and the "BAC Down" campaigns. The "Fight BAC" produce safety campaign promotes concepts such as checking fruits and vegetables for bruises or damage; proper rinsing/cleaning of produce; avoiding cross-contamination; cooking or throwing away fruits or vegetables that have touched raw meat, poultry or their juices. The "BAC Down" campaign promotes the use of refrigerator thermometers and safe storage temperatures and cooling procedures for perishable foods. To promote these campaigns, lesson plans, displays and games were developed, and training sessions were held with staff across North Dakota. Participants were provided refrigerator thermometers and produce brushes

Impact: About 840 people have participated in the evaluation process for produce safety. The follow-up surveys are given at least one month after the educational session. Overall, 95 percent planned to engage in the safe handling behavior following the educational session. On the pre-survey, 59 percent reported "always" checking produce for bruises; on the follow-up survey, 66 percent reported "always" checking produce for bruises. On the pre-survey, about 26 percent reported "always" rinsing produce under running water before eating; on the follow-up survey, 42 percent reported "always" rinsing produce. On the pre-survey, 72 percent reported "always" separating their fruits and vegetables from household chemicals and raw food, compared to 80 percent on the post-survey. On the pre-survey, 51 percent reported "always" cooking or throwing away fruits or vegetables that have touched raw meat, poultry, seafood or their juices, compared to 71 percent on the follow-up survey. On the pre-survey, about 39 percent of participants reported "always" chilling cut produce within two hours compared to 52 percent on the post-survey. On the pre-survey, about 57 percent of participants "always" throw away any fruit or vegetable that will not be cooked if has touched red meat, poultry or seafood compared to 74 percent on the post-survey.

Since 2005 about 968 participants have participated in classes based on the BAC Down campaign. In 2006, pre-surveys and follow-up surveys were administered during educational sessions with more than 750 participants. Following the class, about 93 percent were able to correctly identify 40 F or lower as the recommended refrigerator temperature. About 99 percent planned to follow the recommendations they learned in the educational session, and 95 percent planned to use a refrigerator thermometer. The behavioral questions were based on a 4-point scale from "never" to "always." On the pre-survey, 59 percent reported "always" refrigerating perishable foods within two hours; on the post-survey, 80 percent reported "always" refrigerating perishable foods within two hours of purchase/use. On the post-survey, about 77 percent reported using the refrigerator thermometer they received.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide 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. In 2006, 10 on-line modules were added to the site, all with online evaluation tools and printable certificates. A youth module was included.

"Nutrition Facts" labeling of about 620 North Dakota food products has been provided since 1994. Participants in a HACCP certification course showed increased knowledge in these areas: microbiology of processed foods, safe food handling/processing procedures and the steps involved in setting up a HACCP plan. On-line modules for food entrepreneurs have been developed and are in the pilot-test phase.

Impact: More than 175 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 620 North Dakota food products currently on the market; past labels were updated to include trans fat content. Twenty HACCP managers and food safety students participated in a two-day HACCP certification course.

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.

In the past eight years, more than 2,300 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 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.

Impact/ HACCP: In 2006, 33 restaurant managers received ServSafe certification as evaluated by a national exam. Twelve people received "HACCP Manager" Certification since 2005 after completing an on-line series of modules and certification exam.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide Extension

Key Theme – Food Safety: Teen Food Handlers

"Teens Serving Food Safely" is a statewide NDSU Extension Service food safety education effort designed to improve young food handlers' food safety knowledge and skills and decrease risk of foodborne illness outbreaks associated with food service establishments. According to a 2000 U.S. Department of Labor report, 32% of employed 15- to 17- year olds work in eating and drinking establishments. Teaching young food handlers the "rules" could have significant public health implications. The pilot-tested "Teens" curriculum consists of five lessons based on the Fight BAC™ and Thermy™ national food safety campaign concepts. Youth benefit from the curriculum's experiential learning model, obtaining information and tools to share with their families. A grant from the U.S. Department of Agriculture made the project possible

Each summer high school students participate in the 2005 North Dakota Governor's School, an eight-week campus-based program with science, math, business and arts "tracks." The students meet four times weekly for "Life and Leadership" training. In 2006, during the "Life and Leadership" training 44 students participated in hands-on food safety education. They were provided classroom education, hands-on training and e-mails based on the Fight BAC food safety campaign, which promotes the four steps to food safety: clean, separate/don't cross-contaminate, cook and chill.

Impact -Teens Serving Food Safely: About 186 teachers and extension agents have received training and a copy of the curriculum. From 2003 to 2006, 3,249 students (51% female) participated in the school-based food safety training and evaluation process. All received "food safety kits" including food and refrigerator thermometers, refrigerator magnets and brochures to take home. Knowledge scores, as measured by pre/post testing, increased from 54% correct on the pre-test to 87% on the post-test. About 71% of participants had been involved in food preparation for the public. As measured by a follow-up survey (60% response rate), 82% reported washing their hands more often during food preparation, 48% reported thawing foods more safely (in the refrigerator or microwave oven), 67% reported being more careful about cleaning and sanitizing utensils, 52% had shared their knowledge about food safety with others, 38% had already applied what they learned when preparing food for the public, 19% are using a food thermometer more often, and 24% are checking refrigerator and freezer temperatures more often.

Impact - food safety/North Dakota Governor's School: As a result of participating in an eight-week healthy lifestyles program that included food safety education, 76 percent of the 44 participating teens reported washing their hands more often, 61 percent reported using water AND soap more often when washing their hands, and 78 percent reported washing their hands

longer (at least 20 seconds). About 59 percent reported avoiding cross contamination more often, 44 percent started using a food thermometer and 39 percent had checked that their home refrigerator temperature was 40 F or lower. About 42 percent planned to teach their parents about food safety, 39 percent planned to teach their siblings about safe food handling and 22 percent planned to teach their friends about safe food handling.

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 8,789 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). A follow-up survey is being implemented with teachers to determine their observations of behavior change among children in their classrooms.

Impact: Based on "seeing" where "germs" might hide on hands using a fluorescing dye and ultraviolet light, the "Wash Your Hands" project has reached 8,789 children in grades K-12 in schools throughout North Dakota. Fingertips, back of hand and wrists were commonly missed areas. According to post-surveys, about 91 percent said they would wash their hands more often, and 90 percent said they would wash their hands more carefully.

Source of Federal Funds: USDA

Scope of Impact: Statewide Extension

Key Theme - Food Security: Managing Field and Storage Diseases of Potatoes
Potato is a vegetatively propagated crop; therefore, diseases are a major economic constraint. This project will develop economically and environmentally viable disease management strategies for the major yield- and quality-limiting diseases of potato.

Genetic and vegetative variability has been detected in the potato black dot pathogen, Colletotrichum coccodes. Some vegetative compatibility groups (VCG) are more aggressive on roots then on foliage and vice versa. Specific AFLP bands have been found to be associated with VCGs and these DNA sequences are being converted to SCAR markers. This will permit the genetic analysis of the worldwide population of C. coccodes that was not previously achievable due to vegetative incompatibilities that exist among North American and European isolates. Mefenoxam-resistant isolates of Phytophthora erythroseptica were identified in potatoes from

ND, CO, WI and MN and in the later state >60% of the isolates are resistant to this fungicide. Research has demonstrated that mefenoxam-resistant P. erthyroseptica is more aggressive and more parasitically fit than the wild type isolates of this pathogen. A second generation backcross clone, derived from a somatic hybrid of Solanum etuberosum and S. berthaultii, has been demonstrated to be highly resistant to P. erthyroseptica and Pythium ultimum. This is the first potato germplasm developed in a S. tuberosum genetic background found to be resistant to both water rot pathogens. Seedlings from 52 families containing 4500 seedlings from directed late blight breeding were screened for late bight resistance by a detached leaf assay. None of the families had more than 60% of the population with resistance; one family had 58% of the population with resistance, and three families had 40-50% with resistance. Studies continued to identify the cause of a new disease of processing and table potatoes. The disease, named zebra chip, was transmitted by grafting, by the potato psyllid Bactericera cockerelli and to a limited extent by infected seed potatoes. A new phytoplasma, Candidatus Phytoplasma americanum, was identified and associated with symptoms resembling zebra chip in Nebraska. A second zebra chip agent has been determined to have a 1500 bp DNA sequence consistent with other known bacterial-like organisms. Fusarium graminearum was found to be the cause of potato dry rot in storage and sugarbeet decay in the field. Isolates of F. graminearum from wheat, potato and sugarbeet were cross pathogenic to all three hosts regardless of original source by controlled inoculations. Mycotoxins were detected in potatoes with dry rot caused by F. graminearum. Fungicide sensitivity testing with Cercospora beticola showed that resistance to triphenyl tin hydroxide has almost disappeared; there is a slow increase in resistance to tetraconazole and only a minor shift in sensitivity to pyraclostrobin and trifloxystrobin. Continued use of multiple fungicides will be necessary to prevent resistance development.

Impact: Our research has detected significant genetic variability in the black dot fungus, an important blemish disease of potato worldwide. This research is the first genetic analysis of this plant pathogen and will finally permit the study of the global population. Our research on Fusarium dry rot indicates a shift in the species responsible for causing this disease. While Fusarium graminearum is best known for causing head blight/scab of cereals, our group is giving the first published report of this pathogen causing a disease of potato. We are making substantial progress in breeding disease resistance into potato cultivars to late blight, pink rot and leak which is important since mefenoxam resistance is now widespread in the region and in the U.S.

Source of Federal Funds: Hatch

Scope of Impact: Multi-state research

Key Theme - Food Security: Biological Control - Sugarbeet Root Maggot
A significant portion of this work is aimed at discovery and testing of insect-pathogenic fungi as bio-based tools for managing the sugarbeet root maggot (SBRM). A previous reporting indicated our discovery of a strain of *Fusarium solani* that attacks the pupal stage of the root maggot. The isolate, ARSEF 7382, has since been characterized quantitatively for its virulence to SBRM pupae. The second portion of this work is focused on developing integrated pest management methodology that combines the use of another insect-pathogenic fungus, *M. anisopliae*, with cover cropping as a cultural control strategy, for control of the root maggot. During the past two

years of research, a strain F52 of this fungus has been evaluated in concert with oat and rye cover crops. The first year produced very encouraging results; however, post-application drought contributed to low levels of fungus survival/sporulation and, correspondingly poor control of the sugarbeet root maggot. The F52 strain appears to be most suited for moist soil conditions, which are common to the Red River Valley growing area. Irrigated fields may also provide a good environment for use of this bio-based system.

Impact: The sugarbeet root maggot is the most serious insect pest of sugarbeet in the Red River Valley of North Dakota and Minnesota. It is also a major pest in over 2/3 of the sugarbeet-producing acres of the United States. Sugarbeet producers in the north central and western United States have relied on the same chemical insecticide mode of action for controlling this pest. The threat of insecticide resistance development in these populations is a major concern, and alternative control strategies are needed. In addition, grower adoption of alternative root maggot management tools also would allow for less use of conventional nerve poison insecticides for control of this insect, thus potentially causing less harm to the environment and to non-target organisms.

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: Genetic Resistance to Pests - Sugarbeet Root Maggot
The potential for insecticide resistance in sugarbeet root maggot populations, as well as the possible removal of conventional chemical insecticides from federal registration, combine to form a strong impetus for the development of alternative strategies to manage this major insect pest of sugarbeet. 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. Much of this work is carried out in collaboration with colleagues at the USDA-ARS, NCSL (Fargo, ND). If successful, genetic material from these evaluations will be made available for incorporation into elite commercial lines. Thirty-six entries were evaluated in 2006, and varying levels of feeding injury were sustained among accessions. Future work in this area will include re-evaluation of accessions that have shown the most promise for potential resistance to root maggot feeding injury over the past several years of testing.

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. Insect-resistant varieties would also add simplicity to production systems because the previous requirements of pesticide calibration and correct application timing would no longer be necessary. Also, extensive grower adoption of resistant varieties for sugarbeet root maggot control 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
Since 1998, Lygus bug (*Lygus lineolaris*) infestations have been sporadically causing significant late-season injury in North Dakota and Minnesota sugarbeet fields. Tens of thousands of Red River Valley sugarbeet acres have been treated with foliar-applied insecticides to control the insect; however, its economic impact on the crop is not well understood. This research is being carried out to quantify the effects of feeding injury on sugarbeet yield and quality, and to develop safe, cost-effective tools for controlling Lygus in sugarbeet. Additional work is underway to determine the efficacy, plant health, and yield impacts of tankmixing insecticides for Lygus bug control with fungicides used for foliar plant disease control, and applying in the same operation. This practice is an attractive consideration for growers because it can save an expensive pass across the field with application equipment. It is also practical because Lygus bugs typically infest sugarbeet during the same period of the season that fields need treatment for Cercospora leaf spot management.

Impact: Field cage and growth chamber research indicates that the economic injury level for *L. lineolaris* infestations in sugarbeet occurs with infestations of between 1.7 and 3.9 Lygus bugs per plant. Based on these findings, the economic threshold for insecticide treatment to prevent economic injury has been set at one Lygus bug per plant (nymphs and adults combined). Field testing of foliar-applied insecticides has indicated that several materials are capable of controlling this insect. Tankmixing foliar insecticides with fungicides used for Cercospora leaf spot disease have resulted in major sucrose yield losses in two years of testing. Mixing methomyl insecticide with the fungicide triphenyltinhydroxide has been the most consistently damaging combination with regard to sucrose yield losses, even in the absence of insect or disease pressure. This information will equip growers with important aids to decide when it is appropriate to apply control measures and prevent economic injury. It also could reduce the incidence of unnecessary insecticide applications when Lygus infestations are at subeconomic levels and identify safe insecticide/fungicide combinations for combining Lygus control materials with those needed for foliar disease management in sugarbeet.

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 Minnesota.

Key Theme - Food Security: Preventative Pest Management - Sunflower Crop
Many insects attack the sunflower crop in North Dakota. It is desirable to develop new methods for pest control that prevent damage and which are environmentally sustainable. We are

identifying mechanisms, inherent in sunflower species, which may be able to be used for specific control against various crop pests. We conducted a preference-performance experiment using adult and larval sunflower moth to test whether these characteristics were correlated. For the test, we chose 17 pre-breeding lines of sunflower (Table 1) that were hybrids of the cytoplasmically male sterile *H. annuus* line, CMSHA89*2, and other species (including wild *H. annuus*). The aim of this experiment was to test whether a preference-performance relationship existed with these lines and if so whether any effect of line or parent species was apparent. Across all the data there were strong positive correlations between our measures of larval performance and female preference; that is, females preferred plants on which their offspring performed best. Moreover, both line and parent species showed significant effects. In particular, lines derived from *H. tuberosus* and *H. resinosus* had low preference-performance measures. This suggests that these species may contain useful transferable characteristics to cultivated sunflower for development of resistance to sunflower moth. Overall, this work shows promise for identifying sunflower resistance mechanisms.

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. We continue each year to hear about localized outbreaks in North Dakota.

For wheat midge, we have completed working with wheat breeders to incorporate resistance to wheat midge into breeding lines. Because wheat midge populations have not been at a high enough level to concern North Dakota wheat farmers, resistance to wheat midge remains in breeding lines rather than being progressed to cultivars. Because wheat midge is still a concern to North Dakota farmers, each year we continue to monitor wheat midge populations throughout the portion of the state north and east of the Missouri River. County Agents collect soil samples from wheat fields in the autumn and send soil samples to NDSU where we extract and quantify overwintering wheat midge larvae. In all but a few locations, wheat midge numbers remain low. However, the parasitoid which normally keeps wheat midge numbers in check was found at lower levels than in past years. Any disruption in control by natural enemies could lead to greater

wheat midge problems in years to come. Finally, we have completed a study of the behavior of the adult female wheat midge, the stage that is responsible for host selection and moves the population from one location to another. The female is highly selective. Thus, breeding for resistance to egglaying would be highly effective and complement the currently-know resistance to the feeding larva (e.g. *Sm1* gene).

For the Hessian fly, we used a colony of a North Dakota population of Hessian fly to determine whether there is resistance in the most popular North Dakota hard red spring and durum wheat lines/cultivars. Only one of ten spring wheat cultivars, Russ, showed any resistance to Hessian fly. Resistance was more common among durum genotypes. Out of ten popular cultivars, four were resistant (Ben, Monroe, Renville, and Vic). Out of three important durum breeding lines, two were resistant (D971511 and D97780). We also completed testing of our North Dakota Hessian fly population for virulence to each of the 30 available Hessian fly resistance genes. Only a small number of genes would be effective against North Dakota Hessian fly, which is quite virulent. Finally, in collaboration with Swedish scientists, we identified the sex pheromone of the Hessian fly in summer 2006. This sex pheromone is now being developed as a monitoring tool, a method that will be available to North Dakota farmers should Hessian fly populations become a problem.

Impact: In the last decade, the wheat midge and Hessian fly have continued to be present throughout North Dakota, with some populations reaching economic levels. 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 or delay parasite adaptation to plant resistance. 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 for that year. For both wheat midge and Hessian fly there is highly effective and genetically simple (i.e. major gene) resistance available for incorporation into North Dakota spring and durum wheat genotypes.

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, with an estimated $1 billion lost to the agricultural economy that year in the region. Severe outbreaks also occurred since 1993, resulting in more than a $3 billion loss to North Dakota's economy from 1993-2004. In 2005, record rainfall amounts in June across the state resulted in severe FHB in some areas once again, with an estimated $162 million loss to ND’s economy as a result of the disease in wheat, durum and barley. Losses would have been greater if management options had not been in place for this disease. Management options that limited the overall impact of FHB in 2005 were: the availability of more resistant cultivars; the

availability of an FHB risk forecasting model and web site that informed producers about the risk of FHB; and the availability of effective fungicides and information about the best application techniques. Growers were provided information about wheat variety response and growers have responded by growing more tolerant varieties, on at least 25% of the acres statewide, and about 40% in areas of high risk for the disease. Fungicide trials conducted by the NDSU Extension Service and Research Extension Centers have shown the most efficacious products and application procedures for FHB control. 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 return from use of the fungicides was between $30-36/acre in 2005, because of yield and quality improvements (increased test weight, reduced damage, and reduced DON toxin). Extension specialists provided this information on fungicide results to growers via numerous county and regional meetings, demonstrations and news releases. In 2006, the extension plant pathologist once again applied for a Section 18 emergency exemption for a specific fungicide with the best efficacy against the disease, and EPA granted it. The fungicide was applied to approximately 0.8 million acres of wheat and 100,000 acres of barley in 2006. Because 2006 was a relative drier year than 2005, economic return from fungicide use was slightly less. Use and economic return per acre translates to a positive economic impact of $14.4-16 million for wheat producers in 2006.

Impact: Producers who utilized fungicides as a management strategy on 0.8 million acres of wheat realized an average return of $18-20 per acre, resulting in $14.4-16 million revenue to these producers in 2006. The Extension Specialist wrote the Specific Exemption for use of the fungicide, which was sent to the ND Dept. of Agriculture and subsequently approved by EPA. Producers were provided training on use of the FHB disease forecasting model and the wheat disease forecasting web site to determine need for use of fungicide and also were trained on the proper use of the fungicide and how this strategy should be integrated with other management strategies for optimum control of FHB. Producers were provided the latest information on wheat variety response to FHB. Several new varieties have good tolerance to the disease.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Food Security: Sclerotinia Disease Development in Sunflower
Sclerotinia diseases remain the most significant of all diseases on both oilseed and confection sunflower production in the U.S. Sclerotinia incidence was lower in 2006 due to a widespread drought throughout much of the U.S. sunflower production area. Sclerotinia stalk rot and head rot affected 16% and 10% of the fields in ND and SD, respectively, and affected 0.9% and 0.3% of the crop in 2006. These figures are in stark contrast to previous years, such as 2002, when stalk rot and head rot were found in 29 and 50% of surveyed fields and affected a combined 7.4% of the crop. Several germplasm releases of both oilseed and confection sunflower were made, culminating several years of effort between NDSU and USDA-ARS to incorporate both head rot and stalk rot resistance. Five oilseed restorer lines (RHA 439, 440, 453, 454, 455) and three maintainer oilseed lines (HA 441, 451, 452), along with 8 confection genetic stocks were

released in 2006. The confection germplasm releases are the first material incorporating head rot resistance into long-seeded confection types, which is the ideotype desired by private seed companies. Seventy-five commercial hybrids were evaluated at multiple, inoculated field sites for resistance to stalk rot, and the same material was tested by personnel of the Carrington, ND Research and Extension Center for reaction to head rot. Stalk rot levels on the 75 hybrids ranged from 2% to 42% infected plants (averaged over 4 locations) while head rot ratings on the same hybrids ranged from 20 to 97% infected plants (averaged over two locations). Three hybrids were identified which combined high levels to both head rot and stalk rot. A check hybrid produced with USDA lines (HA 412 x RHA 409), which was the most resistant entry in the 2005 stalk rot trials, was exceeded in 2006 trials by 13 commercial hybrids, indicating private breeders are succeeding in incorporating stalk rot resistance, presumably from some of the public sector germplasm releases. A preliminary study was begun in 2006 to investigate the levels of calcium in various plant parts among sunflower hybrids with known Sclerotinia resistance. If a correlation between calcium content and Sclerotinia resistance can be established, this inexpensive test could be used as a selection criterion to achieve higher levels of Sclerotinia resistance.

Impact: Producers who selected sunflower hybrids based on information generated by this project (and disseminated online via A-652, "Sunflower Hybrid Performance Guide,") had less yield losses due to Sclerotinia diseases. Producers growing confection sunflowers were also less subject to having seeds rejected due to contamination with sclerotia.

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 Sciences, and Animal and Range Sciences is under way to manage leafy spurge, a key weed pest of rangelands. Leafy spurge causes over $23 million in losses each year in North Dakota. A 5 yr study to evaluate the change over time of leafy spurge phytosociological characteristics following release of flea beetles was initiated on leafy spurge-infested range and pastureland in the Little Missouri River drainage. Leafy spurge stem density was suppressed by flea beetles at 91% of the study sites. On two-thirds of the study sites stem density was reduced from greater than 100 stems to less than 25 stems per sq m. Leafy spurge foliar cover was less than 5% on approximately two-thirds of the flea beetle release sites and less than 25% on over 90% of the release sites. Approximately 40% of the release sites experienced flea beetle control over areas ranging from 1,000 to 5,000 sq m and 14% of the release sites had greater than 10,000 sq m of leafy spurge control. White mold, caused by *Sclerotinia sclerotiorum*, is an important disease of several row crops grown in North Dakota including but not limited to soybean, canola, dry bean, and sunflower. Eight strains of *Sporidesmium sclerotivorum*, a natural pathogen of the white mold fungus, were isolated from North Dakota

soils. Single spore cultures of each of these have been developed to be tested for their effectiveness as biocontrol agents. Trials are planned in the greenhouse for early 2007. Two field trials tested the ability of a commercial Contans, a commercial formulation of *Coniothyrium minitans*, to control white mold on canola. However, no disease data could be collected because Sclerotinia stem rot did not develop because of drought conditions in the state. The goal of a project on banded sunflower moth (*Cochylis hospes*) was the integration of management strategies to reduce both input costs and overall feeding injury caused by this insect in commercial oilseed sunflower fields. Experiments studied the effectiveness of treating only the margins of sunflower fields with biocontrol agents in reducing economic losses from banded sunflower moth, and determined the impacts of landscape structure and the parasitoid complex on populations of banded sunflower moth. Sixty-one percent of the banded sunflower moths reared was parasitized by two major species of parasitoids: *Glypta prognatha* and *Chelonus phaloniae*. Parasitism rates were negatively impacted by insecticide spraying in field edges. Parasitoids were effective in searching and foraging from field edges to 40 m in field and not dependant on the presence of sunflower in the landscape.

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. Fusarium head blight (FHB) has caused over $150 million in combined small grains losses for producers in North Dakota in 2005 alone. 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. FHB-resistant hard red spring wheat varieties (such as Glenn, Steele-ND and Howard) recently released by NDSU were developed with this approach. Pathologists are also 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. One objective of dry bean pathology is to identify new sources of resistance to Fusarium root rot into the dry bean breeding program. Pathologists identified a good genetic resistance in the dry bean line Vax 3. The resistance in Vax 3 has been introduced into the breeding materials. Incorporating root rot 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. 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.

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 Safety: Development of Intelligent Quality Sensors

This research project is a multidisciplinary research project consisting of faculty from different departments i.e. Agricultural and Biosystems Engineering, Animal and Range Sciences, Veterinary and Microbiology, Electrical and Computer Engineering etc. The aim is to develop miniaturized portable sensors to determine safety and quality of specific food and agricultural products. This project consists of three ongoing research projects that focus 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* and *E. Coli*), mold growth in barley. We have adopted sensor-fusion approach to investigate the capability of infrared gas sensing mechanism for quality and safety characterization of the selected food products. For the proposed intelligent sensors, a modular approach for developing and/or evaluating different sensor/sensing modules has been adopted. We have conducted experiments to evaluate the IR (infra-red)-based olfactory sensing using FT-IR (Fourier Transform Infra-red) spectrometry. Experiments using another electronic nose module (TF) based on commercially available metal oxide detectors were also conducted. Experiments were conducted using GC-MS and SPME (solid phase micro extraction) technique identification of volatile compounds of fresh meat (beef) during contamination with *Salmonella* in laboratory conditions. . Experiments were conducted to evaluate the performance of FT-IR-based olfactory sensing system for discriminating a given packaged beef for its spoilage. A meat sample was considered spoiled if the bacterial count was >= 6 $\log_{10}$(cfu/g). Algorithms and

techniques were developed to process the acquired FT-IR spectrum of headspace of meat samples. Statistical models were developed to classify a given meat sample into spoiled or not. A maximum total average accuracy of 89 % was obtained for classifying meat samples into two groups (spoiled or not spoiled) for samples stored at 50 degrees F. Experiments were also conducted for classifying packaged meat samples for *Salmonella* contamination. A sample was considered to be *Salmonella* contaminated if the *Salmonella* count was equal to or more than 0.7 $\log_{10}$(cfu/g). The overall maximum accuracy for classifying a given sample into either contaminated or not, was 88.7% and the statistical model used all the peak information in five different selected ranges between 500- 400 wave numbers. Vacuum packaged beef stored at 20 degree C were used. The same modeling technique and storage temperature provided a maximum overall accuracy of 86.5% when fresh beef samples were used. These findings shows potential of using FTIR-based olfactory sensing technique for classification of packaged meat samples for spoilage and Salmonella contamination using headspace gases. Additional validation is recommended. TF module also showed an average accuracy of more than 88% for classifying Salmonella contaminated packaged (aged) beef and the model used Radial Basis function neural network with leave-1-out method. Parallel studies were conducted for developing theoretical framework for a potential NDIR (non-dispersive infrared) sensor for meat contamination and spoilage. Simulation gas flow was done using commercial MEMS (micro-electromechanical-systems) software.

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: Improvement of Thermal and Alternative Processes for Foods
The engineering and biochemical properties of many foods and food crops are not sufficiently understood. This is especially true of foods from oilseed crops, such as flaxseed-based foods, because use of these crops in foods is relatively recent or they are being used in new ways in foods. The potential formation of off-flavors and discoloration is a particular concern. This project develops methods for the engineering and biochemical analysis of various foods. These methods will in turn be used to improve the processing of these foods.

Ensuring safety in our food system is a high priority for our nation. Intelligent quality sensors (IQS) refer to the devices that are robust, adaptable, and accurate and could be used to provide critical quality information about food and agricultural products. To make their integration in food systems more useful, we also need to make the sensors cost-effective, non-destructive, and portable. Recent advancements in non-destructive and intelligent sensing techniques along with the rapid growth of computer based hardware/software technologies show promise. However, independent research needs to be done to identify, adapt, and develop sensing techniques and sensors for rapid and non-destructive quality evaluation of food and agriculture products to ensure safety as well to enhance their value. The long-term goal of this research is to develop

miniaturized portable sensors that can provide quality information to users about specific food and agricultural products. Because the meat and grain industries are important segments of U.S. agriculture and food industry, the research will focus on these food products. The short-term goal of this research is to develop small size, handheld integrated sensors that can be used to provide quality information to users about specific food and agricultural products. We hypothesize that the metabolites can be used as an indicator to alert the consumer regarding safety and quality of the food products. We have adopted multidimensional approaches for developing/integrating integrated olfactory sensing system for sensing the headspace of packaged beef to evaluate spoilage and Salmonella contamination in the meat. We have also evaluated a commercially available system for which we have developed our in-house developed software and algorithm. We have taken a modular approach and each of the modular sensing system could operate separately and all the sensing modules could work together to provide sensor fusion framework for sensing. The detectors we have used are based on metal oxide. We have also used infra-red based olfactory sensing using FTIR spectroscopy. The overall average maximum accuracy for detecting a packaged beef for spoilage was 89%. 90%. For Salmonella contamination detection, the overall average maximum accuracy was 88.7%. We have observed variations among biological samples (meat). Current work involves in developing and testing novel sensing materials or sensing technique that could detect specific compounds in low concentrations. Research is in progress for soymilk beany flavor and trypsin inhibitor inactivation by processing methods including traditional and UHT heating. Kinetic analysis for inactivation will be carried out. Additional emphasis are given on Phytochemical retention in legume foods after cooking, steaming, direct steaming and e xtrusion, and how food processing affect chemical compositions, antioxidant activities, bioavailability and antitumor activities as determined by cell culture methods. Focus is being given on how physical separation methods affect fats content in soy foods.

Impact: Development of robust and reliable sensors for food safety application is critical need. Research-based development and evaluation of suitable sensor and sensing techniques could also be used for measure critical parameters to control or monitor different food processing operations.

Source of Federal Funds: Hatch

Scope of Impact: Statewide 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.

Continuing work in consumer valuation will focus on measuring consumer preferences for organic and natural beef and translating consumer beef attribute demand to producer production

decisions. Measuring consumer preferences for organic and natural beef will build on previous survey and focus group studies and use scanner data from retail locations offering both natural/organic and traditional meat products. Sales data, including price and quantity of product, will be evaluated to determine natural/organic demand and premium over traditional meat. Data from on-going local focus groups will be evaluated in relation to the current sales information. The feasibility of starting new natural/organic beef operations will be evaluated with respect to premiums currently found in the local market. Specific project outputs will include the measurement of actual organic premiums received in the market by producers; evaluation of stated versus revealed preferences for natural meats; evaluation of consumer preferences for locally grown, organic, and grass-fed beef products; assessment of consumer willingness-to-pay for different meat cuts and attributes; and provide beef production suggestions for aligning beef quality and attributes to consumer preferences for meat attributes.

Impact: The expectation is that beef producers will be better informed about consumer decision making and will be better able to incorporate this information in to their production decisions. Beef producers will be able to take advantage of price premiums in specialty beef markets to enhance their long term profitability.

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 seven 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, 2,500 operations have been certified, and more than 3,000 cattle producers were educated in beef quality assurance practices. These operations produce more than 549,000 head annually, 55 percent of the state's calves. Comparison of pre- and post-tests taken by participants at each session found an average improvement of 24 percent in test scores. Producers and marketing organizations report a heightened interest in North Dakota BQA certified cattle by alliance programs and feedlots requiring source and age verification and animal health records. 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 they 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.

Over 100 dairy producers were educated in Dairy Beef Quality Assurance practices. Surveys indicate dairy producer have changed their injection practices and are improving their record keeping practices to decrease the incidence of antibiotic residues in their market dairy cows.

Further, youth educational programs have been developed and conducted, and as a result over 400 youth have demonstrated the ability to correctly use and administer animal products and accurately keep good herd and animal health records.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Allocated Resources ($ x $1,000)		**FYO6**
1862 Extension ($)	Smith-Lever	812
	State	1,218
	FTE	29
1862 Research ($)	Hatch	459
	State	675
	FTE	13.5

Goal 3: A Healthy, Well-Nourished Population

Overview: *As reported by the National Centers for Disease Control, nearly a third of all adults in the United States are classified as obese (NHANES, 1999-2002). In 2004, 63 percent of adults in North Dakota were either overweight or obese (CDC, BRFSS, 2004). Between 1990 and 2004 the percentage of adults in North Dakota who were overweight increased from 34 to 38 percent (11 percent increase) and the percent obese increased from 12 to 25 percent (100 percent increase). Nationally 31 percent of children ages 6-19 were either overweight (16 percent) or at-risk of overweight (15 percent) (NHANES, 1999-2002). In 2005, 24 percent of North Dakota high school students were either overweight (11.2 percent) or at-risk of overweight (12.8 percent) (CDC, YRBS, 2005).*

Diet and physical activity behaviors are related to the development of obesity and the risk for several chronic diseases such as heart disease, cancer, type 2 diabetes, and osteoporosis. 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.

In North Dakota more than two-thirds of adults do not meet the recommended amount of vigorous physical activity and half do not meet the recommended amount of moderate physical activity (CDC, BRFSS, 2005). No leisure time physical activity was reported by 21 percent of adults in 2004, down from 32 percent in 1994. Heart disease is the leading cause of death in North Dakota. Thirty five percent of North Dakotans report elevated cholesterol and 23 percent report elevated blood pressure, both risk factors for heart disease (CDC, BRFSS, 2005). Cancer is the second leading cause of death in North Dakota. For 2004, cancer was newly diagnosed for about 3,250 individuals in North Dakota with about 1,340 cancer deaths. Most deaths are due to cancers found in the lung, colon-rectum, breast and prostate. 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. In North Dakota, 6.7 percent of adults reported having diabetes in 2005, up from 3.6 percent in 1994 (86 percent increase). The rate of diabetes rises to more than 16 percent for those 64 and older. Among Native Americans in North Dakota, more than 15 percent have diabetes.

Participation in all types of physical activity declines as age and grade in school increases. Among North Dakota high school students, 33 percent did not participate in either moderate level physical activity (on 5 or more days each week) or more vigorous levels (on 3 or more days each week) and 63 percent did not attend daily physical education classes in school (CDC, YRBS, 2005). Vigorous physical activity was defined as activity making you sweat or breathe hard ≥20 minutes on three of the seven days preceding the survey. Moderate physical activity was defined as activity that did not make them sweat or breathe hard ≥ 30 minutes on ≥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). Nearly 47 percent of North Dakota high school students report they are trying to lose weight, and 86 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 while more than 50 percent drank more than 13 fl oz of sweetened beverages each day. Habits begun in childhood often persist in adulthood.

The NDSU Extension Service has helped form "5 Plus 5" community coalitions across the state to bring together local experts to increase the consumption of fruits and vegetables to five to nine servings daily and increase physical activity levels to at least 30 minutes of moderate activity on five or more days of the week. In 2006, 17 community coalitions were recognized for their efforts to improve health with the potential to reach over 70 percent of the state's population with nutrition and physical activity education. In 2006, the program launched a Web site to increase awareness about the program, provide information to communities on how to improve nutrition and physical activity environments, links to resources, and a means of communication about the programs.

More than 1,000 people have participated in the worksite wellness challenge for the PERS 5 A Day Challenge Program. Three hundred and seventy six people in worksites have completed the online pre-survey for the program. About 92 percent of participants are trying to eat 5-9

servings of fruits and vegetables daily, compared to 51 percent who were trying to eat 5-9 servings of fruits and vegetables daily prior to completing the PERS 5 A Day Challenge Program. About 90 percent of those completing the program were "likely" or "very likely" to participate in another worksite wellness program.

A folic acid campaign features displays, handouts, posters and public service announcements based on the national Centers for Disease Control and Prevention "Ready or Not" campaign and is directed toward women statewide. Over 2,146 people have participated in interactive educational displays and evaluation at health fairs, bridal shows and other events, and thousands of people have been exposed to the messages in a variety of settings. According to a 2006 survey with 146 participants, 56 percent could identify folic acid as a B vitamin, 68 percent recognized the current recommendation (400 micrograms), 95 percent knew that leafy greens are a good source of folate, and 92 percent knew that folic acid can help prevent birth defects.

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 and one tribal college, 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. A total of 1,448 families participated in the EFNEP program, reaching 5,406 persons in those households. Seven percent of the families reached with the North Dakota EFNEP program had children under the age of one, with 97% of the families having children between the ages of one and five years of age. More than 81% of the program families reached by EFNEP were enrolled in group sessions. Results from the EFNEP program families show: 71% improved one or more food resource management practices; 79% improved one or more nutrition practices; and 53% improved one or more food safety practices.

"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. According to pre- and post-surveys, 1,130 participating children in Cass County showed increases in knowledge of nutrition and physical activity concepts and changes in self-reported behavior upon completion of the program. At a Reservation site with 115 participating children, knowledge scores and self-reported behavior showed improvements. On the post-test, 94 percent of 115 participating children correctly identified the recommendation for five or more serving of fruit/vegetables a day, compared with 43 percent on the pre-test. In surveys of 154 children participating in "On the Move" programming in seven counties, 80 percent of the participants reported setting at least one family goal with their parents, 53 percent reported eating more fruits and vegetables, 66 percent reported drinking more milk and consuming more dairy foods, 75 percent reported drinking less soda pop, 67 percent reported drinking more water, and 62 percent increased the amount of time they were physically active.

The North Dakota State University Extension Service and Bison Athletics collaborated to launch a statewide educational campaign, which emphasizes combining healthy eating and physical activity among youth. Based on an initiative of the USDA Food and Nutrition Service, the overall goal of the "Eat Smart, Play Hard, Together." project is to increase awareness of the

importance of a healthy lifestyle, particularly food choices, regular physical activity and family meals, in maintaining good health among North Dakota youth and their families. The "Eat Smart. Play Hard. Together" message reached about 45,000 youth in grades K to 5 and 45,000 parents/caregivers through printed materials and handouts, using funding from a variety of sources.

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). The curriculum developed by WV University Extension called "Dining with Diabetes," was introduced to North Dakota with the goal to provide diabetes nutrition education for medically underserved areas. A pilot project thru local Extension agents with dietitians or certified diabetes educators to evaluate the effectiveness of a community-based nutrition curriculum to help people with diabetes better manage their disease through healthy food and lifestyle choices was held at 5 sites in eastern North Dakota during 2006. Participants from each county attended 4 weekly classes with a follow-up class at 3 months. A total of 119 participants attended the initial lesson and 83 were at the 3 month follow-up. Participants at every site wanted the lesson series to continue with follow-up monthly meetings. Trends indicated improvements in several areas related to diabetes self-management: attitudes; lifestyle behaviors; and nutrition behaviors. The area which indicated the most improvement was in attitude; the area with least improvement was nutrition knowledge.

Key Theme - Human Health: Adult – Dietary Guidelines/MyPyramid

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. According to results of a North Dakota Department of Health survey, 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 2005, new Dietary Guidelines were released along with a tool, MyPyramid, to promote implementation of those guidelines. Many consumer-friendly tools have been created to help promote this nutrition and physical activity guidance among diverse audiences.

The North Dakota *5 Plus 5 Program*, modeled after the Iowa program of the same name, began in 1998 and has grown each year. The "fives" in *5 Plus 5* come from the guidelines for the national 5 A Day Program, which encourage five to nine servings of fruits and vegetables each day, and from guidelines that recommend that every American adult accumulate 30 minutes or more of moderate physical activity five or more days of the week. Community coalitions are working to reduce their residents' chronic disease risks by promoting awareness, helping to build skills, and adapting the community environment and policies to encourage lifestyle change. Specific activities of *5 Plus 5* community coalitions include working with local school districts to implement school wellness policies and practices, implementing community-wide nutrition and physical activity motivation/promotion and challenge programs, designing and providing

educational materials for native communities, and helping make communities more pedestrian friendly. Participants in 5 Plus 5 programs range in age from children to adults. Programming has varied from school-based educational activities to formation of walking groups to classes in businesses and community settings. As an example, members of the *Fargo Five* coalition are actively involved with city planners to help enhance the walkability of Fargo and surrounding communities.

The "NDPERS 5 A Day Challenge" is a collaborative effort of the North Dakota Department of Health, North Dakota Public Employees Retirement System (Health Insurance) and the NDSU Extension Service. The program promotes fruit and vegetable consumption and getting at least 30 minutes of moderate physical activity on most days of the week. Participants receive a packet of information, two sessions from a trained member of a cadre of nutrition educators and follow-up e-mails. In addition, they can participate in additional activities planned by the worksite coordinator. For further information, see http://www.state.nd.us/ndpers/insurance-plans/pers-5-a-day.html. Website with tools can be found at http://www.ag.ndsu.edu/pers/.

The on-line eight-week 5 A Day Cyber Challenge was piloted with adults in 2005. In 2006, 190 people participated. The Challenge consists of an interactive Web site where participants receive on-line education via seven weekly "modules" plus interactive Web site explorations. Participants can log their fruit and vegetable intake and pedometer readings and get immediate feedback.

Impact:

Dietary Guidelines/MyPyramid Education: Pre/post/follow-up surveys were conducted with 1,346 participants in Dietary Guidelines/MyPyramid education programs. Participants gained knowledge and 94 percent of participants indicated intentions to make choices more consistent with MyPyramid recommendations immediately following the lessons, including being more active, eating more whole grains, fruits and vegetables. About 90 percent identified the figure by MyPyramid as representing physical activity. The behavioral surveys were based on a scale including "never", "sometimes", "usually" or "always." On follow-up surveys, about 56 percent reported "usually or "always" eating at least three vegetables daily, compared to 43 percent on the pre-survey. About 85% percent reported "usually" or "always" eating two fruits daily, compared to 53 percent on the pre-survey. About 80 percent reported "usually" or "always" eating at least one whole grain food daily, compared to 60 percent on the pres and 77 percent reported "usually" or "always" being physically active 30 minutes on most days of the week.

In a survey of 149 participants (87 percent more than 60 years old) in a MyPyramid-based "Cooking for One or Two" lesson plan, 31 percent indicated an intention to plan menus more often, 25 percent planned to use the MyPyramid recommendation to help plan their menus, 21 percent planned to visit the Web sites on the lesson for recipes and tips, 40 percent planned to eat a wider variety of foods, and 35 percent planned to divide favorite recipes into smaller numbers of servings. About 85 percent planned to share the information with family and friends.

5 Plus 5 Programs: In 2006, 17 community coalitions were recognized for their efforts to improve health with the potential to reach over 70 percent of the state's population with nutrition and physical activity education. In 2006, the program launched a Web site to increase awareness

about the program, provide information to communities on how to improve nutrition and physical activity environments, links to resources, and a means of communication about the programs. The website is found at http://www.health.state.nd.us/5plus5/

NDPERS 5 A Day Challenge: More than 1,000 people have participated in the worksite wellness challenge. Three hundred and seventy six people in worksites have completed the online pre-survey for the PERS 5 A Day Challenge. On the pre-survey, 76 percent of participants reported bringing fresh fruit for snacks compared to 80 percent on the post-survey. On the pre-survey, about 13 percent reported consuming three to five servings of vegetables daily compared to 35 percent on the post-survey. According to post-surveys with half of the participants responding, 63 percent reported eating more fruits and 59 percent reported eating more vegetables. The variety of fruits and vegetables being chosen has increased, with 38 percent eating more orange/yellow/gold fruits and vegetables, 37 percent eating more green fruits and vegetables and 33 percent eating more red fruits and vegetables. About 92 percent of participants are trying to eat 5-9 servings of fruits and vegetables daily, compared to 51 percent who were trying to eat 5-9 servings of fruits and vegetables daily prior to completing the *PERS 5 A Day Challenge Program.* About 90 percent of those completing the program were "likely" or "very likely" to participate in another worksite wellness program.

5 A Day Cyber Challenge: More than 280 people have participated in the Cyber Challenge evaluation since 2005. According to 2006 post-survey results, 94 percent of participants reported improved food choices, 56 percent reported a more varied diet, 56 percent reported a sense of personal accomplishment, 44 percent reported more energy/stamina, 34 percent reported better fitting clothes and 31 percent reported weight loss. On the pre-survey with 190 participants, 41 percent reported spending one or fewer hours watching TV, compared to 53 percent on the post-survey. On the pre-survey, about 26 percent of participants reported eating five or more servings of fruits and vegetables compared to 50 percent on the post-survey.

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. "Banking on Strong Bones" is a five-week, school-based educational intervention, with instruction by NDSU Extension Service Agents/Assistants, that was implemented in 26 classrooms with 818 students (average age, 10 years; 84% Caucasian, 50% male) in 14 North Dakota counties in 2006. The purpose was to increase knowledge/awareness of the role calcium-rich foods and weight-bearing activities play in building and maintaining strong bones among children and to improve food and beverage choices. "Banking on Strong Bones" included classroom lessons with participation incentives, educational materials in the libraries and taste testing activities. Families received newsletters designed to improve knowledge of nutrition and physical activity.

Impact: Students improved their knowledge scores and reported positive attitude and behavior changes toward consumption of dairy products. On the pre-survey, 50 percent reported drinking three or more glasses of milk the previous day, compared to 66 percent on the post-survey. On the pre-survey, 15 percent reported drinking soda pop every day, compared to 10 percent on the post-survey. On the pre-survey, 39 percent of children indicated they would choose soda pop over milk if given the choice; on the post-survey 25 percent would choose soda pop over milk if given the choice. About 56 percent of parents reported positive changes in their child's eating habits as a result of this program. In a survey with classroom teachers, 61 percent reported noticing children making healthier choices at lunch and 73 percent reported seeing children choosing milk, yogurt and/or cheese more often.

Source of federal funds: Smith-Lever

Scope of Impact: Multi-county level extension

Key Theme - Human Health: Young Adult Females - 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) recommend 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 intake with reduced risk for heart disease, certain types of cancer and possibly, Alzheimer's disease.

This project 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 newspaper columns, radio public service announcements, brochures and displays to reach the target audience. Campus promotions were held in cafeterias, libraries, health centers, dorms and sororities.

Impact: Over 2,146 people have participated in interactive educational displays and evaluation at health fairs, bridal shows and other events, and thousands of people have been exposed to the messages in a variety of settings. According to a 2006 survey with 146 participants, 56 percent could identify folic acid as a B vitamin, 68 percent recognized the current recommendation (400 micrograms), 95 percent knew that leafy greens are a good source of folate, and 92 percent knew that folic acid can help prevent birth defects. In addition, 72 percent recognized a potential link between adequate folic acid and reducing the risk of Alzheimer's, and 75 percent recognized a potential link between folic acid and reducing risk of heart disease. About 79 percent planned to meet the folic acid recommendation.

The March of Dimes conducted a nationwide Gallup Organization random telephone survey with

20,903 adult participants, including 400 in North Dakota. 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 24 percent 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.

Source of federal funds: Smith-Lever

Scope of Impact: Statewide Extension

Key Theme - Human Health: Adult - Physical Activity
Risk for several chronic diseases, including 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, North Dakotans do not meet national physical activity goals. The goal of the Walk North Dakota program is to increase physical activity among adults with a goal of 10,000 steps (5 miles) per day based on pedometer readings and using a technology-based educational delivery and evaluation system. Walk North Dakota is a statewide eight-week walking program that uses an interactive Web site for data collection and assessment of miles walked. The program provides biweekly educational e-mails and incentives at the conclusion of the program. In 2006, the program was piloted with children enrolled in 4-H Clubs.

Impact:
Walk ND (Adults): In the past three years, 2,628 people have participated in the Walk North Dakota program. From May 2004 to March 2007, participants have walked 992.3 million steps (about 496,000 miles) based on results of a Web-based data collection system. According to a 2006 post-survey with 166 adults, 99 percent rated physical activity as "important" or "very important." About 82 percent of participants reported using pedometers as tools to monitor daily steps. About 58 percent reported their number of steps increased as a result of the program, 44 percent reported meeting the goal of 10,000 steps or more per day, and 83 percent planned to continue walking for physical fitness. About 92 percent rated the e-mails as helpful, and 89 percent reported accessing and using information from the Web site at least one time. Information for policy makers, such as suggestions to make communities more "walkable" (e.g., improved lighting and sidewalks, walking trails) and success stores, were captured via the online survey.

According to some success stories: "I lost 10 pounds by increasing my walking and cutting out snacks." "I have lost 20 pounds by watching my diet and walking. I have gone from a size 18 in pants to a size 12." "I have a lot of back problems so walking and being more active really has decreased my number of visits to the chiropractor." "It gave me and my kids an incentive to get

out and walk – and spend more time together while getting fit. I noticed that my pants fit better, so I guess I lost some weight, too!"

Stretching Toward Better Health (Adults): About 140 adults have participated in the evaluation of the lesson. About 94 percent of participants were able to correctly identify the recommended type of stretching (static), 73 percent planned to stretch more in the future, and 89 percent planned to share this information with family and friends.

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 improves practices in food production, preparation and food safety. EFNEP sites are located at four Indian Reservations and at two of our more populated cities in Cass and Grand Forks Counties.

Impact: A total of 1,448 families participated in the EFNEP program, reaching 5,406 persons in those households. Seven percent of the families reached with the North Dakota EFNEP program had children under the age of one, with 97% of the families having children between the ages of one and five years of age. More than 81% of the program families reached by EFNEP were enrolled in group sessions. Eighteen percent received instruction as an individual and 1% were reached using a combination of the two forms of instruction. As a result of the EFNEP program, 5% of families enrolled in one or more food assistance programs.

Results from the EFNEP program families show: 71% improved one or more food resource management practices; 79% improved one or more nutrition practices; 53% improved one or more food safety practices; participants with acceptable food resource management practices increased from 28% at entry to 41% at exit; participants with acceptable nutrition practices increased from 16% at entry to 25% at exit; participants with acceptable food safety practices increased from 61% at entry to 72% at exit; and participants with acceptable practices in all three areas increased from 5% at entry to 16% at exit.

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 Expanded Food and Nutrition Education Program (EFNEP) focuses on increasing the ability of families experiencing limited income circumstances to make wise use of their food dollars and

provide a safe food supply for their families. This is accomplished by providing classes to low-income audiences on nutrition and meal planning; food purchasing, preparation, and safety; and food resource management.

In 2006 staff received training in food safety related to increasing knowledge and acceptable practices in produce safety and in knowledge and practice related to correct food storage temperatures.

Impact: Follow-up evaluations show 53 percent of homemakers showed improvement in one or more of the food safety practices. Also, 61 percent of participants at entry into the EFNEP program demonstrated acceptable food safety practices. At the end of the program, 72 percent of the participants 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. Classes are often held at a variety of cooperating agencies such as tribal organizations, WIC or Head Start. Goals were for participants to increase their knowledge of thrifty shopping practices thru: using planned-leftovers; taking advantage of seasonal values; using unit prices; shopping with a list; and shopping a sale. Participants were also taught how basic mixes can save time and money in shopping and food preparation.

Impact: A survey of participants indicated that 88% intend to plan menus, 92% intend to use grocery ads to plan purchases, 96% plan to shop with a grocery list, and 83% plan to use unit pricing. Also, 78% plan to use master mixes.

Source of federal funds: Smith-Lever

Scope of impact: Statewide

Key Theme - Human Health: Childhood Obesity–Healthful Eating and Physical Activity
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.

To promote health and reduce childhood obesity, policy change within schools related to nutrition and physical activity, as well as other health behaviors, has been promoted by The

Centers for Disease Prevention and Control by establishing Coordinated School Health Grants (CSHG). In North Dakota the Department of Public Instruction receives and distributes funds from the CSHG by grant application to school districts within the state. NDSU Extension has assisted Fargo Public Schools, the largest school district in the state and a recipient of a CSHG, with the evaluation of nutrition and physical activity behaviors, fitness measures, and BMI in relation to academic measures. Assessments done with FPS can serve as models for other school districts to help direct policy and curriculum changes related to nutrition and physical activity and to provide Extension with direction for school-based interventions.

To address the childhood obesity problem, the United States Department of Agriculture mandated changes in school policies related to nutrition and physical activity policy ("School Wellness Policies") to be implemented beginning with the Fall Semester 2006. The need of school districts for evaluation and monitoring tools is now being addressed by NDSU Extension and the Department of Health, Nutrition and Exercise Sciences.

The North Dakota State University Extension Service and Bison Athletics collaborated to launch a statewide educational campaign, which emphasizes combining healthy eating and physical activity among youth. Based on an initiative of the USDA Food and Nutrition Service, the overall goal of the "Eat Smart, Play Hard, Together." project is to increase awareness of the importance of a healthy lifestyle, particularly food choices, regular physical activity and family meals, in maintaining good health among North Dakota youth and their families. The materials developed included pocket folders, parent newsletters, teacher/4-H leader activity guides, posters, bookmarks and billboards. To engage 4-H youth in healthy lifestyle activities, a statewide recognition program for 4-H Clubs program with defined healthy lifestyle goals was piloted and two statewide poster contests were conducted.

An eight-week pedometer-based physical activity program was conducted with youth enrolled in the North Dakota Governor's School. The campus-based eight-week program targets high school students with an interest in science, math, engineering, business or musical/theater arts. Every day the students take part in a healthy lifestyles program that includes nutrition, physical activity, food safety and several other healthy lifestyle concepts.

"On the Move to Better Health" is a four-week program for children in grades five and six. The overall goal of "On the Move to Better Health" is to promote healthy lifestyle decisions regarding nutrition and physical activity among elementary-age youth in order to foster healthy lifestyle decisions regarding food choices and amount of physical activity during adolescence and adulthood. In an ongoing activity, children record their goals and activities in a journal. They measure progress toward their goals in a unique way: they "walk around" their county (or state) on a paper map showing a path of circles. To earn the reward of coloring in a circle, the student records the completed activity in his/her journal, an adult initials the activity, and the student colors in a circle on his/her map. The circles are color-coded to represent different health categories: fruit and vegetable consumption (green), physical activity (blue), beverage choices (red), and other healthy behaviors, such as brushing teeth (yellow). For every five circles earned, the student receives a different-colored bead to add to a string provided at the beginning of the program. The string of colorful beads can become a necklace, bracelet, or key chain.

Impact:

Nutrition, Physical Activity, and Academics (Fargo Public Schools): Associations were described between nutrition/physical activity behaviors, fitness tests, and body mass index with academic measures for approximately 800 sixth grade students (collected spring 2005 with analysis during 2005-06) from Fargo Public Schools. Nutrition and physical activity behaviors were assessed utilizing the questions from the Youth Risk Behavior Survey. Height, weight and fitness measures (mile-run, push-ups, curl-ups) were recorded by physical education teachers. All data was matched with standardized academic measures (MAP Reading and MAP Math Scores). Height and weight were categorized by body mass index by age and gender. Students were also categorized by those who meet nutrition and physical activity recommendations (example such as those getting 3 or more glasses of milk each day) or fitness norms (needs improvement, healthy, or excels). Results: When analyzed individually, higher MAP Math scores related to each of the following: reduced intake of sweetened beverages; reduced intake of 100% juice; more frequent breakfast consumption; more vigorous physical activity; reduced time viewing television; greater number of sports teams; being male; lower BMI; and higher performance on all fitness measures. When analyzed together, higher MAP Math scores were associated with higher levels of physical activity (greater number of days of vigorous activity; greater number of sports teams; higher performance on mile run); and male gender. When analyzed individually, higher MAP Reading scores related to the following: reduced intake of sweetened beverages; more frequent vigorous activity; more frequent moderate activity; reduced time viewing television; being female; and higher performance on curl-ups. When analyzed together, higher MAP Reading scores were associated with reduced intake of sweetened beverages; reduced time viewing television; being female; and higher performance on curl-ups. Conclusion: Many positive nutrition/physical activity behaviors were individually associated with enhanced academic measures. When analyzed together, the most consistent relationship was found between math achievement and physical activity/fitness parameters.

At the time of this data collection (Spring 2005), Fargo Public Schools had sixth grade students either in elementary school (about 300 in individual classrooms) or middle school (about 500 students). In the middle school setting, the sixth grade students had access to ala carte food items in the cafeteria and vending and met the recommendation of an average of 150 minutes per week of physical education. In the elementary school setting, the sixth grade students had access to only the USDA school lunch and no vending but averaged only 125 minutes of physical education per week. Results: The sixth grade students in both school settings had a similar proportion (~32 percent of students who were classified as either overweight or at risk of overweight). However the proportion of students in the middle school setting who were overweight (above the 95th percentile BMI) was lower (11 percent) compared to those in the elementary school setting (19 percent). Similarly a higher proportion of sixth grade students in the middle school setting passed the mile run, push-ups and all-fitness tests compared to those in elementary school setting. However, the sixth grade students in elementary school, compared to those in middle school, had a higher proportion self-reporting vigorous activity and 60 minutes or more of physical activity per day. This may indicate that the sixth grade students in the elementary setting participated in more play and extracurricular physical activity than those in the elementary setting. Self-reported nutrition behaviors from sixth grade students in the middle school setting with access to ala carte and vending indicated a higher proportion drinking sweetened beverages (≥1 can per day at 48 percent compared to 39 percent) and a lower

proportion drinking the recommended amount of milk (≥ 3 glasses per day at 41 percent compared to 54 percent) when compared to those in elementary schools with only school lunch and no access to vending. Conclusion: The school environment including access to various types of food as well as time in physical education can influence the ability of students to meet recommendations for good health related to nutrition and physical activity.

School Wellness Policies: NDSU Extension provided educational materials and resources to assist school districts with the development of their school wellness policies. School wellness policies provided by school districts from across the state are now available on the NDSU webpage: http://www.ag.ndsu.edu/k12wellpolicy/ .

Eat Smart. Play Hard: The "Eat Smart. Play Hard. Together" message reached about 45,000 youth in grades K to 5 and 45,000 parents/caregivers through printed materials and handouts, using funding from a variety of sources. All teachers in grades K to 5 in North Dakota and any interested 4-H Club leader received an "Activity Guide" with MyPyramid-based materials to use in classroom/club education. In the "Healthy North Dakota 4-H Club" project, 426 youth from 21 clubs across North Dakota were recognized with a certificate and rubber bracelet for participating in at least six 4-H club meetings where a healthy lifestyle activity was conducted. About 200 children participated in the Eat Smart. Play Hard poster contest, and the posters were displayed at the state fair. A county-wide educational campaign that included targeted public service announcements (paid media), an "Eat lunch with the Bison" radio promotion, billboards and media releases were used to reach the community.

WalkND (Youth): According to a survey with 14 children who participated in the evaluation of the pilot eight-week program, 93 percent rated physical activity as "important" or "very important." About 71 percent walked with a parent or friend, 61 percent planned to continue wearing their pedometer, 58 percent reported an overall increase in steps, 73 percent reported walking at least 10,000 steps per day, and 71 percent reported spending one hour or less playing video games. According to the reports by children, "We took 2-mile walks almost every day for two months! I like walking with my mom!" "Walk North Dakota showed me that I love to walk, and I've gotten in better shape!"

Governor's School (Teens): In 2006, 36 percent of the 44 participants involved in the eight-week program reported an increase in overall daily steps based on pedometer readings, with 84 percent reporting at least 10,000 steps per day. About 50 percent planned to continue to wear a pedometer after Governor's School and 96 percent planned to get more physical activity.

On the Move to Better Health (Youth): According to pre- and post-surveys, 1,130 participating children in Cass County showed increases in knowledge of nutrition and physical activity concepts and changes in self-reported behavior upon completion of the program. The students who identified "at least five" as the recommended number of daily fruit and vegetable servings increased from 52 percent to 84 percent. Overall, students who consume the recommended number of daily fruits and vegetables (five) increased from 17 percent as reported on the pretest to 27 percent on the post-test. The number of children consuming three or more servings of milk per day increased from 78 percent to 83 percent, and the number of children consuming two or more servings of soda pop per day decreased from 28 percent to 20 percent. Children engaging

in physical activity at least five days a week increased from 66 percent to 79 percent, and children watching more than 2 hours of television per day decreased from 39 percent to 24 percent.

At a Reservation site with 115 participating children, knowledge scores and self-reported behavior showed improvements. On the post-test, 94 percent of 115 participating children correctly identified the recommendation for five or more serving of fruit/vegetables a day, compared with 43 percent on the pre-test. On the post-test, 97 percent of participants reported they consume three or more servings/day of dairy, compared with 80 percent on the pre-test. On the post-test, 79 percent reported they are physically active five or more days/week, compared with 71 percent on the pre-test. As a result of this intervention, 58 percent of participants reported they increased the amount of fruits and vegetables they eat, 60 percent drank less soda pop, 80 percent set at least one family goal with their parents, and 76 percent increased the amount of time they are physically active.

In surveys of 154 children participating in "On the Move" programming in seven counties, 80 percent of the participants reported setting at least one family goal with their parents, 53 percent reported eating more fruits and vegetables, 66 percent reported drinking more milk and consuming more dairy foods, 75 percent reported drinking less soda pop, 67 percent reported drinking more water, and 62 percent increased the amount of time they were physically active.

Source of federal funds: Smith-Lever

Scope of Impact: Multi-county level extension

Key Theme – Human Health: Adult - 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 6.7 percent of the total adult population of North Dakota rising to greater than 16 percent in the 65- to 74-year-old population (CDC, BRFSS, 2005). Diabetes is on the rise in North Dakota from 3.6 percent of the population in 1994 to 6.7 percent in 2005. 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.

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). The curriculum

developed by WV University Extension called "Dining with Diabetes," was introduced to North Dakota with the goal to provide diabetes nutrition education for medically underserved areas. This curriculum partners local Extension agents with dietitians or certified diabetes educators to present the food-based curriculum to help diabetics make better food choices for improved disease management.

Impact: Dining with Diabetes: North Dakota Style! Pilot
The purpose of the pilot project was to evaluate the effectiveness of a community-based nutrition curriculum to help people with diabetes better manage their disease through healthy food and lifestyle choices at 5 sites in eastern North Dakota during 2006. Participants from each county attended 4 weekly classes with a follow-up class at 3 months. Extension agents teamed-up with local dietitians and/or certified diabetes educators to present the information. Lessons included information on meal planning; portion control; reading nutrition labels, carbohydrate content of foods to promote normal blood sugar levels; food fats to promote heart health; and target values for clinical laboratory tests used to medically manage diabetes. At each lesson the focal points included both nutrition education and food demonstrations with taste testing based on the "plate method" for meal planning. The recipes utilized in the food demonstrations were developed to present healthy versions of familiar foods and cooking techniques used in North Dakota. At the initial lesson and at the 3-month follow-up the following measures were recorded: hemoglobin A1c; blood pressure; and survey questionnaires (demographics; self-reports of tests used in the medical management of diabetes; areas affecting diabetes self-management). A total of 119 participants attended the initial lesson and 83 were at the 3 month follow-up (70% retention). The approximate breakdown of the population was as follows: 93% Caucasian; 80% female; 83% ≥ age 50; 49% reported incomes ≤$30,000. Positive subjective feedback was recorded from all involved in the pilot project: participants, medical partners and Extension Agents. Participants at every site wanted the lesson series to continue with follow-up monthly meetings. Extension Agents and their medical partners gained knowledge and respect for the role/abilities that each brought to this endeavor and reported an interest in teaching additional lesson series together. Positive trends were found for reductions in HgbA1c and blood pressures overtime, however, no significance was found due to the large standard deviation. Trends indicated improvements in several areas related to diabetes self-management: attitudes; lifestyle behaviors; and nutrition behaviors. The area which indicated the most improvement was in attitude; the area with least improvement was nutrition knowledge. This program will be continued with curriculum and evaluation revisions.

Source of federal funds: Smith-Lever

Scope of impact: Statewide Extension

Key Theme – Human Health: Agriculture to Health
The Dakota Diet concept suggests that foods produced in the Dakotas and Northern Plains, when incorporated into the framework of the Dietary Guidelines, will promote health and reduce chronic disease. This concept was first introduced by Dr. Gerald Comb, Director of the USDA ARS Human Nutrition Research Center I Grand Forks. 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, beans contain a high amount of plant protein, dietary fiber (especially soluble fiber), folate (a B-vitamin); potassium and other minerals as well as being low in fat, saturated fat and calories. The nutrient and chemical profile of beans allows them to play an important role when used as a component of a healthy diet pattern to reduce the risk of being overweight, developing type 2 diabetes, heart disease or colon cancer. The region is also a top producer of a number of healthy plant oils such as canola, flaxseed, soybean, and sunflower. Whole grains such as whole wheat, oats, barley, and buckwheat have been implicated in reducing the risk of diabetes, heart disease and some types of cancer. The variety of crops grown in North Dakota presents opportunities for producers and processors to look for innovative ways to market the health qualities of regional foods locally, nationally, and internationally.

Impact: Healthy North Dakota Oils: Agriculture to Health
North Dakota is the leading producer of many foods which are featured in the Dietary Guidelines. The Agriculture to Health lesson series (flaxseed, beans, healthy oils, and whole grains) features these crops in the context of current dietary recommendations with emphasis on the health benefits related to reducing risk of chronic disease. The goal of the "Healthy North Dakota Oils" educational materials was to increase awareness of the health benefits of healthy oils. All food sources of healthy oils are discussed with special emphasis on those oils produced from North Dakota crops: canola, flaxseed, soybeans and sunflower seeds. Topics included: (1) ND grain and oilseed production; (2) types of fat and food sources; (3) health benefits of healthy oils to reduce risk of chronic disease; and (4) recommended amounts of fat. Lessons were given in 14 counties during 2005-06 with 212 participants completing evaluations (82 percent female and 67 percent age sixty or older). Forty-five percent reported having attended lessons on both flaxseed and beans. About 20 percent reported daily use of ground flaxseed (2-4 Tbsp) and 48 percent reported eating beans 1 or more times each week. Current consumption of food sources of omega-3 fats was reported as follows: about one-third were eating ground flaxseed/oil and eating canola oil on 3 or more occasions each week; about half were eating fish at least once a week; about 40 percent were eating walnuts at least once a week. More than half indicated a "future intention" to consume food sources of omega-3 fats at least once a week: 51 percent for ground flaxseed or oil; 63 percent for canola oil; 57 percent for walnuts; 63 percent for fish. The proportion of participants who responded to the question, "how much oil do you eat each day", is as follows: 28 percent reported eating 3-5 teaspoons of oil each day; 51 percent reported 1-2 teaspoons of oil each day. The 2005 Dietary Guidelines recommend 5-6 teaspoons of healthy oils each day for a 2,000 calorie intake. As a result of the lesson, about 58 percent correctly identified the recommended amount of healthy oils to consume each day. The program is applicable to other adult audiences to promote the moderate intake of healthy oils to help reduce risk of heart disease, diabetes, and cancer.

Source of federal funds: Smith-Lever

Scope of impact: Statewide Extension

Allocated Resources ($ x $1,000)	**FYO6**

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 cropland, grazing land and feedlots presents a significant threat to North Dakota's surface waters. According to the North Dakota Department of Health, 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. 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.*

In 2006, programs focusing on site-specific management totaled about 1,500 attendees at various presentations around North Dakota. In addition, site-specific soil testing has been woven into nearly all presentations given, amounting to about 3,500 additional attendees. It is estimated that an additional 15,000 growers were reached indirectly about some aspect of site-specific farming/N management in 2006. The new nitrogen recommendations that have resulted from N calibration work to date are expected to reduce N fertilizer use in 2007 on dry beans by 12,000 tons of N on 600,000 acres of dry beans, and 9,000 tons of N on 900,000 acres of canola.

Effective irrigation water management requires accurate daily crop water use estimates. As of January 2007, there are 2238 irrigation permits in the state. Assuming one permit per irrigation system and that most irrigators have more than one system, there are probably about 1300 irrigators in the state. The crop water use maps and numerical tables are used extensively for irrigation scheduling. For example, during June, July, August and September of the 2006 growing season, there were around 5000 successful requests for crop water use information. Many crop 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. The NRCS has adopted the

computerized irrigation-scheduling program to support the irrigation water management portion of their Environmental Quality Incentive Program (EQIP). The program provides documentation showing irrigation management decisions made by the cooperator that the NRCS need to evaluate the impact of their water conservation programs.

Leafy spurge expanded rapidly in the state following introduction in the early 1900s and doubled in area every 10 yr to a maximum of 570,000 ha in the mid-1990s. The spread of leafy spurge began to slow in the late 1990s and the area infested in 10 counties actually declined. The leafy spurge infestation in North Dakota has held steady to declining in the state over the last few years. This is a major accomplishment compared to the spread in the 1990's. An integrated management program using herbicides, grazing, and Aphthona spp. flea beetles may provide the best long-term control of leafy spurge in the region. This research resulted in the first known establishment of Aphthona species flea beetles in the habitat of the western prairie fringed orchid, an endangered species. Improved information for ranchers and range managers concerning economics of alternative means of controlling leafy spurge have been distributed in paper formats which they preferred compared to electronic media. Leafy spurge occurred on an estimated 385,000 ha in 2005 compared to a projected acreage of 1.1 million ha if no control measures had been implemented.

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. In the past year this program has provided education to producers, NRCS employees, 319 Watershed Coordinators, County Extension Agents, commodity association members, regulators and policy makers through 51 workshops, 30 on-farm producer consultations, and development and distribution of three new Extension publications. Nearly 1500 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 focused on manure nutrient utilization in cropping systems as well as how livestock facility management can lower the risk of runoff that can impact surface water.

Key Theme - Water Quality: Nutrient Management

Extension specialists and experiment station researchers have developed methods to compare various types of zone delineation methods, which increase the effectiveness of soil testing and nitrogen fertilization efficiency. Tools that were evaluated included aerial photography, satellite imagery, soil EC sensor measurements, topography and yield monitor data. Sugarbeet growers in the Red River Valley use satellite imagery and aerial photography to map 200,000 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 to nutrient management is progressing west of the Red River Valley with an estimated 200,000 acres now being managed using these methods.

In addition, nitrogen fertilizer calibration experiments have been conducted in several crops recently, including canola, dry bean and malting barley. Work is ongoing to update nitrogen recommendations in spring wheat/durum. Recommendations being developed will include consideration of soil N mineralization, which was a factor not previously integrated into recommendation formulas.

Impact: In 2006, programs focusing on site-specific management totaled about 1,500 attendees at various presentations around North Dakota. In addition, site-specific soil testing has been woven into nearly all presentations given, amounting to about 3,500 additional 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, and are out of print and need to be revised. These circulars were well received by growers and received a national award from the American Society of Agronomy in 2000. It is estimated that an additional 15,000 growers were reached indirectly about some aspect of site- specific farming/N management in 2006. The final report for the USDA-CSREES IFAFS zone delineation project led by NDSU is available to the public at http://www.soilsci.ndsu.nodak.edu/franzen/franzen.html

The new nitrogen recommendations that have resulted from N calibration work to date are expected to reduce N fertilizer use in 2007 on dry beans by 12,000 tons of N on 600,000 acres of dry beans, and 9,000 tons of N on 900,000 acres of canola.

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 - Water Quality: Irrigation Technical Information and Assistance
An integral part of effective irrigation water management is access to accurate daily crop water use estimates. Since 1995, the NDSU Extension Service has provided this service during the growing season to irrigators for the 10 major irrigated crops in North Dakota. The crop water use estimates were calculated during the growing season using the weather data from the automated weather stations that comprise the North Dakota Agricultural Weather Network (NDAWN) and presented on the NDSU Extension website.

In 2005, the crop water use algorithm was integrated into the NDAWN website: http://ndawn.ndsu.nodak.edu/index.html. The water use for each crop is calculated using weather data from the 67 automated stations that comprise 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 emergence date. The look and feel of the crop water use section matches the other parts of the NDAWN website so a visitor will have the same experience whether accessing crop water use data or finding out the latest small grain Fusarium head blight infestation potential.

Additional features have been added to help the irrigator or crop consultant make better, more

informed irrigation decisions. For instance, when accessing the crop water use numerical tables, daily rainfall, total rainfall, daily crop water use, total crop water use and deficit conditions are all presented. In addition, a simple click of an icon at the top of each column will bring up a graph of the data. To trace the progress of water deficit (which applies to both irrigated and dryland conditions), a user can obtain a color-coded map showing the difference between the crop water use and rainfall. As the growing season progresses, these maps clearly show the areas of the state with deficit water conditions.

An important added feature is the ability to look at the crop water use for the 10 crops using weather data from previous years. This allows irrigators and crop consultants to compare irrigation management decisions from year to year.

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: As of January 2007, there are 2238 irrigation permits in the state. Assuming one permit per irrigation system and that most irrigators have more than one system, there are probably about 1300 irrigators in the state. The crop water use maps and numerical tables are used extensively for irrigation scheduling. For example, during June, July, August and September of the 2006 growing season, there were around 5000 successful requests for crop water use information. July had the most requests and the two busiest days were Monday and Thursday. During the day, 9 am to noon was the busiest time period. Many crop 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.

The NRCS has adopted the computerized irrigation-scheduling program to support the irrigation water management portion of their Environmental Quality Incentive Program (EQIP). The program provides documentation showing irrigation management decisions made by the cooperator that the NRCS need to evaluate the impact of their water conservation programs. Since the inception of this program in 2003, over 100 copies of the program have been distributed to EQIP participants. Copies were also provided to many county NRCS offices and the state irrigation engineer.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Natural Resources Management: Development of Water Management Practices and Tools for Improved Crop Production and Natural Resource Management
Following an initial year of installing monitoring equipment and collecting soil samples to characterize pre-irrigation conditions, researchers at NDSU have completed the first crop growing season of full to excess irrigation for a watershed-scale study of irrigation, evapotranspiration, and soil and water compatibility. In another project, we have developed modeling capabilities in the area of nonpoint source hydrologic modeling of agricultural watersheds.

Impact: The irrigation and 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. The hydrologic modeling effort has given the ND Department of Health personnel the capability to conduct similar modeling studies for other watersheds as part of its charge to conduct total maximum daily load studies on impaired watersheds in the state.

Source of federal funds: Hatch

Scope of impact: Statewide research

Key Theme - Integrated Pest Management: Insect 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. From 2004-2006, the survey was limited to five crops: wheat, barley, soybean, canola and sunflower. A total of 1,975 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. Pests include grasshoppers, cereal aphids, cereal leaf rust, *Fusarium* head blight, soybean aphid, flea beetles, white mold/sclerotinia, and 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. Pests of regulatory importance are also recorded to assist detection efforts of the State Department of Agriculture and USDA APHIS, such cereal leaf beetle.

Regional surveys for detection of overwintering larvae of the orange wheat blossom midge have been conducted for over ten years. These surveys identify locations of high populations of overwintering midge, and provides an estimate of the risk that wheat midge represent to the wheat/durum producers. Producers and managers use the information 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. The soil survey conducted last year detected increasing levels of overwintering wheat midge larvae for the upcoming 2007 season, especially in the northeast region of North Dakota.

Insect Pest Trapping: Canola Insect Pest Trapping Network was conducted in the major canola growing areas of North Dakota for the past eight years. Pheromone traps are used to monitor for two insect pests of canola: Bertha armyworm *(Mamestra configurata*), and Diamondback moth (*Plutella xylostella*).Trap data provides growers, Ag consultants, field researchers, and county extension agents/specialists with an "early" risk warning system of when these insect pests are active and their population levels. A total of 25 pheromone traps in 15 counties were monitored for two Lepidopteran insect pests of canola in the major canola growing areas of North Dakota: Overall, most of the trap sites, about 88%, had cumulative trap catches below 300 and was at "low" risk of larval infestation. This marks the third year in a row with low risk for bertha armyworm infestations. An average of 101 diamondback moths per trap was captured in 2006, which was lower than the average trap catches for 2005 (199 moths per trap). As a result, insecticide spraying for bertha armyworm or diamondback moth was not necessary in 2006 canola crop.

A new trapping effort was conducted to determine the distribution of corn rootworms in North Dakota. A total of 100 trap sites for corn rootworms were monitored in 37 of the corn producing counties of North Dakota. Corn rootworms were trapped in 30% of the corn fields surveyed in North Dakota. Western, northern, and southern corn rootworms were observed 10, 9, and 17% of the corn fields, respectively. The southeastern region of North Dakota produces the majority of corn acreage and also had the highest concentration of corn rootworms. The western and southern corn rootworms appeared to be more widely distributed than the northern corn rootworm. Generally, the numbers of corn rootworm captured per trap were low across North Dakota.

Extension Entomology actively participates in the **National Plant Diagnostic Network** (NPDN) of the USDA, CSREES. The network is a collective of Land Grant University plant disease and pest diagnostic facilities from across the United States. The mission of the network is to enhance national agricultural security by quickly detecting introduced pests and pathogens. This will be achieved by creating a functional nationwide network of public agricultural institutions with a cohesive, distributed system to quickly detect deliberately introduced, high consequence, biological pests and pathogens into our agricultural and natural ecosystems. It provides a means for quick identifications and establishing protocols for immediate reporting to appropriate responders and decision makers. The network will allow Land Grant University diagnosticians and faculty, State Regulatory personnel, and first detectors to efficiently communicate information, images, and methods of detection throughout the system in a timely manner. The establishment of the network will provide the means necessary for ensuring all participating Land Grant University diagnostic facilities are alerted of possible outbreaks and/or introductions and are technologically equipped to rapidly detect and identify pests and pathogens. This will be accomplished by establishing an effective communication network between regional expertise, developing harmonized reporting protocols with the national diagnostic network participants, and cataloging pest and disease occurrence to be included in national database. (Source: Mission statement of NPDN - http://www.npdn.org/)

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.

Source of Federal Funds: Smith-Lever

Scope of Impact: State Specific

Key Theme - Conservation of Biodiversity: Evaluation of Transgenic Corn
Corn rootworms cost U.S. producers about $1 billion annually in yield losses and control costs. These pests pose major management challenges to the industry because of two forms of resistance to crop rotation. Strains of the northern corn rootworm are able to pass through two winters before hatching, thus circumventing the practice of a single-year crop rotation from corn. The second rotation resistance mechanism involves a behavioral shift in which western corn rootworm adult females lay eggs in soybean, which leads to infestation of corn during the following year after eggs overwinter in the soybean stubble field. Transgenic corn varieties, genetically engineered to express a beetle-specific crystalline protein (Cry3Bb1) that is toxic to corn rootworms, have recently been developed for use in U.S. production systems. This technology should offer excellent rootworm control in affected areas; however, it is conceivable that some non-target organisms could ingest pollen, silks, or other residual plant materials from these varieties. We are involved in collaborative work with South Dakota State University to determine whether this material is likely to pose a significant threat to the abundance or species diversity of non-target Coccinellidae (Lady beetles), Anthocoridae (i.e., pirate bugs and flower bugs), or Chrysopidae (green lacewings) common to many midwestern cornfield habitats.

Impact: Rootworm-resistant Cry 3Bb corn is anticipated to have a rapid adoption rate among U.S. corn producers affected by the pest; however, the potential effects of this new Cry protein on non-target insect taxa, especially those genetically similar to corn rootworms, are not well understood. Thus far, we have found that monocultures of corn expressing the Cry3Bb1 protein are not likely to pose negative impacts on the lady beetle complex of species monitored in this study. Currently, the data associated with Cry3Bb1 impacts on the Anthocoridae and Chrysopidae are being analyzed and reports are being prepared. This information will be helpful in understanding the overall environmental impact of this promising pest management strategy on important beneficial organisms. If determined environmentally compatible and benign to non-target organisms, transgenic rootworm-resistant varieties will allow for major reductions in the prophylactic use of soil insecticides for rootworm control.

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.

Since the early 1990s, 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 also 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 control has generally been improved with combinations of chemical, biological, or cultural methods, as compared to a single method. The effect of *Aphthona* spp. biological control agents, imazapic, and interseeded native grass species alone or in combination for leafy spurge control was evaluated at two locations in southeastern North Dakota over a 5 year period. Leafy spurge stem density, canopy cover, and production were reduced for 1 to 2 yr in all treatments that included the herbicide imazapic, but there was no difference in control between the single and combination treatments. The *Aphthona* spp. and interseeded native grasses did not reduce the leafy spurge infestation as effectively as imazapic. Leafy spurge seed in the lowland and upland seedbanks in southwestern North Dakota decreased while high-seral forbs increased 5 yr following *Aphthona* spp. release. Leafy spurge seed remained the most common seed in lowland and upland seedbanks in 2004, but had been reduced an average of 89% since 1999. High-seral forb seed increased by over 300%, which indicated the quality of species is returning to a pre-infestation state. Native grass reestablishment has been slow in areas where leafy spurge was controlled by *Aphthona* spp. flea beetles. Native grass production was reduced nearly 50% when grown in soil from *Aphthona* spp. release compared to non-release sites. The cause and extent of reduced native grass production in sites where *Aphthona* spp. were released have yet to be determined. Field studies were conducted to evaluate the impact of ground cover, winter soil temperature on the over wintering success of *Aphthona* flea beetles. During all study years, *Aphthona* flea beetle spring emergence was lower than the population entering the over wintering period. A snow only cover was effective at protecting the *Aphthona* larvae from winter mortality only when the mean soil temperature did not fall below -5 C. A snow plus debris ground cover provided similar protection as snow alone. Twelve years after the initial release of *Aphthona* spp. at one study site, the flea beetle populations and leafy spurge stands were lower in thicket, forest, and meadow habits compared to high and mid prairie habitats. At a second study site, the leafy spurge stem count was significantly lower in the mid prairie habits compared to the high prairie, forest, and meadow habitats.

Impact: Leafy spurge expanded rapidly in the state following introduction in the early 1900s and doubled in area every 10 yr to a maximum of 570,000 ha in the mid-1990s. The spread of leafy spurge began to slow in the late 1990s and the area infested in 10 counties actually declined. The leafy spurge infestation in North Dakota has held steady to declining in the state over the last few years. This is a major accomplishment compared to the spread in the 1990's. An integrated management program using herbicides, grazing, and *Aphthona* spp. flea beetles

may provide the best long-term control of leafy spurge in the region. This research resulted in the first known establishment of *Aphthona* species flea beetles in the habitat of the western prairie fringed orchid, an endangered species. Improved information for ranchers and range managers concerning economics of alternative means of controlling leafy spurge have been distributed in paper formats which they preferred compared to electronic media. Leafy spurge occurred on an estimated 385,000 ha in 2005 compared to a projected acreage of 1.1 million ha if no control measures had been implemented.

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: 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.

In a biological assessment of the leafy spurge natural enemies Aphthona spp., herbicides, a competitive native grass mixture and combinations of these treatments, the flea beetle spp. established and an increase in population densities was recorded at each of three study sites during a two year period. Differences in flea beetle populations were noted among the experimental treatments except for at one study site, where insect populations averaged 0.4-2.2 adults/m2. Mean seasonal flea beetle counts across two sites averaged 15.4 and 7.0 adults/m2 for the insect and grass only treatments, respectively, and 1.6 and 12.1 adults/m2 for treatments with the herbicides Plateau and 2,4-D, respectively. At two of the sites, leafy spurge was reduced to less than 15% of the original stand density in the Plateau treatments. Combining flea beetles with Plateau provided little or no additional reduction in leafy spurge compared to herbicide alone. The leafy spurge density increased or only slightly decreased in treatments of grass or insects alone, or in treatments with 2,4-D at one site only. At another site however, these treatments had a substantial reducing effect on leafy spurge. Aphthona flea beetles alone reduced leafy spurge to 24% of its original density. Interseeding native grass reduced leafy spurge to 8% of its original density. The herbicide 2,4-5, with or with out grass, provided an 84%-90% reduction in leafy spurge. When flea beetles were combined with herbicide plus grass, there was a 99% reduction in spurge. The effects of groundcover (snow, debris and snow plus debris), winter soil temperature and winter period were evaluated on overwintering Aphthona flea beetles during a four year period in southeast North Dakota. Spring flea beetle emergence was 52 to 90% lower than the mean population entering the winter. The effect of groundcover on flea beetle

emergence was significant during two of these experimental years. When the soil temperature was as low as -4.4 C, 90% of the Aphthona flea beetle emergence was from snow-covered plots. The ranges of soil temperatures and winter periods for overwintering Aphthona flea beetles were determined as -5.0-4.5 C and 56-132 d, respectively. The population dynamics of Aphthona spp. and extent of leafy spurge (Euphorbia esula L.) infestations 16 years after initial releases of the flea beetles were evaluated at a wildlife management area and a range pasture in southeast North Dakota during a three year period. High-prairie, mid-prairie, treed, wetland and thicket habitats were sampled at the sites. During the three-year study period at the wildlife management area, the Aphthona spp. population was almost non-existent in the thicket, treed and wetland habitats, and <1 beetle/soil core in high- and mid-prairie habitats. For leafy spurge, <1 stem/0.5 sq m was observed at the wildlife management area. The flea beetle species populations and leafy spurge infestations were of similar levels in the range pasture. Aphthona lacertosa constituted >90% of the flea beetle populations across the study habitats at both study sites.

Impact: The investigation into the biological assessment of the leafy spurge natural enemies Aphthona spp., herbicides, a competitive native grass mixture and integrated pest management (IPM) will result in sustainable management of leafy spurge, at least in some habitats. Information from this study will benefit land managers in reducing their production costs, increasing production values of there spurge infested land, enhance the environmental quality of their lands, and enhance the growth of native plant species on their lands. The study that evaluated the effects of winter environmental conditions on the overwintering success of Aphthona flea beetles provides a better understanding of the importance of groundcover, soil temperature and duration of low temperature exposure to overwintering Aphthona flea beetles. This knowledge will improve the understanding of overwintering conditions that may limit Aphthona establishment or their population development in the temperate region of North America. The study on the population dynamics of Aphthona spp. and extent of leafy spurge (Euphorbia esula L.) across habitats provides baseline data for future studies relating to population dynamics of Aphthona flea beetles and their interaction with leafy spurge.

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 and pasture management across the state. Key components of the effort included:
Extension
Development of extension and NRCS publication “Grasses for the Northern Plains: Growth Patterns, Forage Characteristics, and Wildlife Values - Volume I – Cool-Season”. This manual encompasses 12 species of grasses include varieties available, basic facts, growth patterns and characteristics, nutritional quality for forage, fiber content for biomass and biofuel potential, livestock grazing/haying value, and wildlife uses. The manual was developed to help land resource managers select the best fit grass and cultivar for perennial grass establishment in the northern plains region. Areas revegetated include pastureland, hay land, wildlife lands, and lands associated with conservation programs such as CRP. In North Dakota, lands were

converted or reenrolled to perennial grass/legume mixtures for conservation practices on over 3,343,900 acres in 2006, including established grass, wildlife habitat, introduced grass, native grass, wetland restoration, and saline-tolerant vegetation.

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 Dickinson, Killdeer and Carson for livestock producers. Ranchers learned to improve their rangeland management skills, develop yearlong forage use strategies, and improve overall management of their beef herd. One-day range management and/or natural resource workshops were conducted at 28 locations in North Dakota. These one-day programs are designed to introduce ranchers, farmers, conservationists, and youth range management principles that can enhance grazing management, conservation programs, drought management, 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 Dakota: This program was conducted at Fort Yates, N.D. and concentrated on local ranchers and farmers, professionals in the region, and students at the colleges. Conduct 1 three-day in-service training session for North and South Dakota extension agents/educators and North and South Dakota Natural Resource Conservation Service conservationists in Antelope, SD. Thirty-three educational professionals (Extension agents and NRCS Staff) in North and South Dakota were taught using classroom and field activities under a sustainable agricultural program for western rangeland.

Impact: The first volume of "Grasses for the Northern Plains: Growth Patterns, Forage Characteristics, and Wildlife Values - Volume I – Cool-Season" will be published in May 2007 with 10,000 copies produced for the Northern Plains land managers including farmers and ranchers, and natural resource professionals. The impacts this educational material can have included development and management of over 3,343,900 acres of land assessed by the Farm Service Agency. Fifty-four ranchers participated in the cow/calf and 12-month forage planning workshops. These two workshops impacted over 113,400 acres of native rangeland, pastureland, and hayland and 7,216 animal units of livestock. More than 76 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 1,469 participants in North Dakota, bordering counties of South Dakota and Montana, Iowa, 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. Thirty youth ages 13-18 participated in the four-day range camp and 124 participated in the State Range Judging Contest.

Twenty-four people participated in a natural resource educational program associated with tribal

lands on Fort Yates in North 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. There is also 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-three county agents/educators and Natural Resource Conservation Service staff participated in a two-day sustainable agricultural program. This program was the third phase 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 2007 and funded by the NCC SARE program.

Research

1) 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 and 97 percent, respectively, on single-species and multi-species grazing treatments after ten 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 94 percent, respectively, after ten 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.

2) 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, 4 and 5 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.

Source of Federal Funds: Hatch and Smith-Lever

Scope of Impact: Multi-state research and extension

Key Theme - Water Quality: Livestock Manure Nutrient Management Technical Information and Assistance

Educational programs are being developed to address manure nutrient utilization, livestock feeding, housing, and management impacts on water quality. Fifty-one educational workshops targeted to ND producers and their advisors were held in 25 communities across the state. Nearly 1500 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 focused on manure nutrient utilization in cropping systems as well as how livestock facility management can lower the risk of runoff that can impact surface water. This same type of information was presented at out of state educational events by request. There was one event in Cincinnati, OH. The target audience at this event was extension employees for a total number of nearly 500 people reached.

Impact: In the past year this program has provided education to producers, NRCS employees, 319 Watershed Coordinators, County Extension Agents, commodity association members, regulators and policy makers through 51 workshops, 30 on-farm producer consultations, and development and distribution of three new Extension publications. Increased awareness of this key theme is reflected by numerous newspapers, television, and radio interviews conducted in the past year to clarify the issues for the general public. The requests to present livestock manure nutrient management information to audiences outside of ND show that this program continues to gain regional and national attention.

Source of Federal Funds: Smith-Lever and EPA

Scope of Impact: State specific

Allocated Resources ($ x $1,000)		**FYO6**
1862 Extension ($)	Smith-Lever	378
	State	567
	FTE	13.5
1862 Research ($)	Hatch	204
	State	300
	FTE	6

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. 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.

Extension has organized agencies and organizations to develop and deliver a statewide curriculum and program for community strategic planning to help rural communities. 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. One hundred and fifteen communities 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 115 communities by taking an average of 15 hours per steering committee member times 12 or the average size of a committee times $18.04 (value of one hour of volunteer time according to Independent Sector) times 115 communities you would get $373,428 total value of volunteer time spent on strategic planning in ND communities. The strategic plans that have been completed are currently being analyzed by the ND State Data Census Center to determine begin to look at what has been done, what were the factors for successful planning and what has been completed. This began in 2005 and will continue into 2006 and 07.

Available, affordable, and adequate housing is necessary for rural community economic development. Housing is needed if new residents and employees are to migrate into North Dakota's rural communities and if young families are to remain in those communities. The NDSU Extension Service worked with local rural community committees on local strategic planning in the fall of 2004. The communities each identified a lack of low to moderate priced housing as a critical need but could not use Essential Function Bonds to help finance the cost of new housing due to community size. State law did not allow communities under 5,000 people to create housing authorities. The local committees drafted an amendment to the current bill which authorizes Housing Authorities to include small communities. The amendment passed in 2005

and became law. Essentially the bill allows communities of any size to create Housing Authorities by demonstrating a need for low-to-moderate income housing. By mid-2006 25 North Dakota communities had Essential Function Bond housing projects completed or underway, for a total of 170 housing units and a project cost of nearly $20.4 million dollars.

Examination and modeling of the economic impact of the state's elderly reveals significant contributions by seniors. Currently, 14% of the state's population are at least 65 years of age; a proportion that will increase to over 20% over the next decade. The relative proportion of earners by type (e.g., wage/salary, self-employment, interest, Social Security, etc.) was modeled using age-specific population projections to determine the impact of income generation as a result of the shifting age profile over the next 15 years. Findings indicate that a significant reduction in wage/salary earnings will occur because of the retirement of babyboomers. The modeling simulation indicates that losses to the state in wage/salary income among the 34-54 age group alone will total nearly $1 billion when contrasting 2000 with 2020. Part of these loses will be offset by gains among those 55 and over. Nonetheless, an overall loss of nearly $420 million between the two years is projected which will have serious consequences on statewide revenues because of losses in payroll taxes. In contrast, significant gains will be made in income derived from Social Security, interest, and retirement. These gains are projected to outpace losses, yet the implication on the redistribution of taxable revenues is still significant.

North Dakota has tremendous potential for capitalizing on the emerging biobased products and fuels industry. NDSU specialists have helped develop a strategic plan for establishing a biomaterials industry from crop residues, specifically wheat straw. A cellulose based biorefinery producing 50 million gallons of ethanol per year would use 900,000 tons of wheat straw annually, employ 77 workers, and result in more than $50 million in annual payments to North Dakota entities. Multiplier effects were estimated to result in a total annual contribution to the North Dakota economy of $183 million, supporting more than 2,000 additional jobs. At an ethanol price of $1.80 per gallon (2005 average), the biorefinery would earn a positive net return (7 percent).

Developing skills to prepare youth for the workforce is one of the underlying goals of many 4-H activities. The "Healthy North Dakota 4-H Club" project reached 426 youth from 21 clubs and nearly 200 youth displayed knowledge and awareness of healthy lifestyle activity by participating in the "Eat Smart, Play Hard" poster contest. More than 5000 youth are involved in conference judging interviews in county programs, helping to build communication skills with adults and youth. 350 youth practiced skills in communication arts contests beyond the county. 592 youth practiced decision making and presentation skills through participation in judging contests at the state level. Local club meetings add to the development of communication skills and leadership roles in both individual and group situations.

The Teen Maze program (a prevention program designed to teach youth the community resources available to them if/when they need them) was offered to all eighth grade students in a public school system. 647 students went through the maze and 99 percent (641) reported they were more aware of the community resources available to them. 48 percent (315) of participants stated the program experience will influence them a lot, and another 41 percent (266) stated the experience will influence them a little when making decisions to engage in risky behaviors. The

program was also used with eighth grade students in another school where 74 percent of 170 students indicated they learned new information about potential situations.

The High School Financial Planning Program has shown significant improvement nationally in student's behavior to set aside money for future needs and wants and distinguish the difference. Management of financial resources is an important aspect of career readiness and a skill needed by youth as they transition to adult life. 1560 students from 30 schools participated in North Dakota this past year.

Assets, such as the ability to follow through and complete tasks is evident by the completion of a project as demonstrated by 11,021 4-H exhibits at the 2006 North Dakota State Fair. Older youth demonstrate their organization and communication skills as part of the media team for 4-H events at the fair.

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, Private Businesses 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 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. ND Job Service compiled results of this survey. 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. Workforce needs were shared with the North Dakota University System through the Higher Education Roundtable.

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. One hundred and fifteen communities 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 115 communities by taking an average of 15 hours per steering committee member times 12 or the average size of a committee times $18.04 (value of one hour of volunteer time according to Independent Sector) times 115 communities you would get $373,428 total value of volunteer time spent on strategic planning in ND communities. The strategic plans that have been completed are currently being analyzed by the ND State Data Census Center to determine begin to look at what has been done, what were the factors for successful planning and what has been completed. This began in 2005 and will continue into 2006 and 07.

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 have 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.

Surveys were sent to 306 of our extension agritainment workshop participants. Fifty-three responded. Of the respondents, 24 had a business. Thirteen of 24 businesses said that the workshop had a direct positive impact on their business. Comments included: decision to start a business, decision to expand a business, awareness of their business in the state, ideas for promotion, information on how to start a business, better ways to market my business, resource directory is a valuable tool for resources, networking opportunities, etc. One of our most successful businesses whose owners attended one of our first workshops is West Bay Resort, LLC by Devils Lake, ND. In follow-up to their survey I made a direct contact in 2005. They informed me that not only have their cabins been very successful but also they have decided to build an RV park for the more than 40 people who contact them every week during the summer asking for this kind of accommodation. In updating this information I found that they did indeed build 30 new RV sites plus a private boat launch for guests.

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 assisted in the first election of officers for the association in 2006 and has since stepped back from taking leadership but is still there to assist. The fourth annual Marketplace for Entrepreneurs pre-conference nature and rural tourism event drew approximately 125 people.

Source of Federal Funds: Smith-Lever

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

Key Theme - Impact of Change on Rural Communities: Small Town Housing
Available, affordable, and adequate housing is necessary for rural community economic development. Housing is needed if new residents and employees are to migrate into North Dakota's rural communities and if young families are to remain in those communities.

Impact: The NDSU Extension Service Horizons Coach in Dickey County worked with local rural community committees on local strategic planning in the fall of 2004. The communities each identified a lack of low to moderate priced housing as a critical need but could not use Essential Function Bonds to help finance the cost of new housing due to community size. State law did not allow communities under 5,000 people to create housing authorities. The local

committees drafted an amendment to the current bill which authorizes Housing Authorities to include small communities. The amendment passed in 2005 and became law. Essentially the bill allows communities of any size to create Housing Authorities by demonstrating a need for low-to-moderate income housing. By mid-2006 25 North Dakota communities had Essential Function Bond housing projects completed or underway, for a total of 170 housing units and a project cost of nearly $20.4 million dollars.

Source of Federal Funds: Smith-Lever and NDSU Extension Administration

Scope of Impact: State

Key Theme - Impact of Change on Rural Communities: Population Change in Rural Communities

Rural regions of the U.S. are being transformed as a result of changing demographic patterns including migration, natural increase, and shifting age distribution. The changing demographic patterns present unique challenges to policymakers, businesses, community leaders, and residents including labor force issues, economic development concerns, and problems with the delivery of services. This project explores the socio-demographic changes in the region in order to examine resulting shifts in social and economic conditions for rural communities.

The major focus of research in 2006 was an examination of the economic impact of the growing state's elderly. Currently, 14% of the state's population are at least 65 years of age; a proportion that will increase to over 20% over the next decade. Detailed age-specific data from the 2000 Census was used to model income generation within the state. The relative proportion of earners by type (e.g., wage/salary, self-employment, interest, Social Security, etc.) was modeled using age-specific population projections to determine the impact of income generation as a result of the shifting age profile over the next 15 years. Findings indicate that a significant reduction in wage/salary earnings will occur because of the retirement of babyboomers. The modeling simulation indicates that losses to the state in wage/salary income among the 34-54 age group alone will total nearly $1 billion when contrasting 2000 with 2020. Part of these loses will be offset by gains among those 55 and over. Nonetheless, an overall loss of nearly $420 million between the two years is projected which will have serious consequences on statewide revenues because of losses in payroll taxes. In contrast, significant gains will be made in income derived from Social Security, interest, and retirement. These gains are projected to outpace losses, yet the implication on the redistribution of taxable revenues is still significant.

Impact: This project is expanding policy makers' understanding of the economic consequences of population change in rural areas of the Great Plains. It is expected that the results will provide insight into current and future challenges that region will face as a result of population dynamics.

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-2006 Special Grant

Rural communities in the Great Plains need to diversify their economic development options. This project explores the value of two different economic development strategies for rural communities in the Great Plains, specifically nature-based tourism and community strategic planning.

Nature-Based Tourism

Nature tourism is increasingly being considered as an economic development opportunity for rural areas of the Great Plains. As rural communities seek to develop nature tourism, questions regarding the characteristics of tourism-related businesses, as well as the attributes and interests of the nature tourist arise. This study sought to address these questions through (1) a statewide survey of outdoor recreation/tourism- related businesses and a survey of participants at two birding festivals, one held in central North Dakota and the other in the extreme northwestern part of the state. Among the nearly 200 businesses responding to the survey, almost two-thirds offered hunting-related services and more than 70 percent provided lodging and/or meals. Most businesses were seasonal and provided only supplemental income to the operator. However, most of these businesses had been established only in the past few years, and their operators were very optimistic about the prospects for future growth. The Birding Festival participants were found to be predominately from outside the local area, and most of these visitors were from out-of-state. As has been reported in other studies of birders and nature tourists, the festival participants were middle-aged (more than 70 percent between age 40 and 70) and highly educated (73 percent had college degrees) with relatively high income levels. The visitors spent an average of three nights in the local area, with average local expenditures of $160 per person, approximately $54 per day. The visitors enjoyed the festival and the area; almost all would recommend the birding festival to a friend, and almost two-thirds indicated they were likely to attend the Festival again within the next two years. Given the satisfaction of the participants, who seemed to represent a cross-section of the potential birding clientele, the potential for growth of this form of nature tourism appears substantial.

Community Strategic Planning

A second component of our research was directed at examining the feasibility of combining all community strategic plans from the state into an integrated database that could be used for statewide planning and resource sharing. Work on the initial database was completed by incorporating strategic plans covering 128 different geographies. Goals and objectives were organized into 12 basic themes ranging from housing, infrastructure, and health to city promotion and child care. We used GIS mapping technology to display which communities had similar goals and objectives. These maps effectively demonstrated the concentration of activities and will be used to enhance interdependence among communities. In addition, this research provides evidence of the areas of the state that need assistance. A survey is being developed to gain additional information from communities regarding successes in achieving their goals and the types of barriers that were encountered. These details also will be incorporated into a searchable database which is expected to be available on-line in 2007.

Impact: This research is increasing the information available to policy makers regarding the economic contribution of nature-based tourism through presentations to academic audiences and

local and state decision makers. In addition, it is expanding decision makers understanding of community strategic planning and establishing an interactive and searchable database that will be available to community leaders throughout the state.

Source of Federal Funds: CSREES Grant

Scope of Impact: Statewide

Key Theme - Promoting Business Programs: Developing a Nanocomposite-Based Biomaterials Industry in North Dakota

North Dakota has tremendous potential for capitalizing on the emerging biobased products and fuels industry. Utilizing technologies to produce bioproducts from crop residues, specifically wheat straw, North Dakota State University, Agribusiness & Applied Economics, in conjunction with MBI International, is currently engaged in a project that would commercialize the use of very small cellulose fibers (nanofibers) to make a bio-based cellulose reinforced composite that could be used in place of fiberglass reinforced composites. The cellulose nanowhiskers (very small fibers) would be processed from wheat straw and mixed with a biobased polymer to form a low cost, biodegradeable replacement for glass fibers in polymer composites. Over the next 10 years, the growth of bio-based chemicals and materials is expected to generate $160 billion in new revenues annually. As one of the top three ranking states for available low-cost biomass, North Dakota is uniquely positioned to become a key player in this emerging industry.

The aim of the project is to commercialize MBI's technology for producing bio-based cellulose nanofibers (nanowhiskers) from wheat straw with ethanol and high-value chemicals as co-products. The first major milestone in the effort is to address key engineering and economic questions to determine the technical and economic feasibility of a pilot scale production process while at the same time analyzing the integration of components made from biomaterials into the automotive supply chain. The critical next step in a North Dakota-based biomaterials industry is the construction and operation of a pilot plant (in North Dakota) to demonstrate the commercial potential of this technology. With this information and expertise, full-scale commercialization can commence.

Findings to date have been very encouraging and include:
* Wheat straw is a preferred feedstock for a biorefinery as it has a higher content of both cellulose and lignin than alternative feedstocks, such as switchgrass.
* Wheat straw can be supplied to a North Dakota biorefinery at costs lower than for alternative feedstocks (e.g., corn stover, switchgrass).
* A cellulose based biorefinery producing 50 million gallons of ethanol per year would use 900,000 tons of wheat straw annually, employ 77 workers, and result in more than $50 million in annual payments to North Dakota entities. Multiplier effects were estimated to result in a total annual contribution to the North Dakota economy of $183 million, supporting more than 2,000 additional jobs.
* Biobased composites could substitute for fiberglass in many applications and could be especially attractive to the automotive industry. Biobased products provide equal strength at one half the weight of fiberglass.

* At an ethanol price of $1.80 per gallon (2005 average), the biorefinery would earn a positive net return (7 percent).
* Advances in process technology for biorefineries, primarily accomplished through biotechnology research, are feasible and likely in the near to medium term. As these advances are made, other raw materials (for example, switchgrass, industrial hemp) will likely become economical.

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: Community Vitality through Arts and Heritage

Cultural arts are an essential part of building community vitality. Fine arts, the humanities and development of heritage resources enrich the quality of life and strengthen a community's social fabric. Today's high-tech world gives workers and businesses the mobility and freedom to choose where they'll locate. Thus, quality of life and sense of place are more important than ever for rural communities. North Dakota can provide a rich cultural environment if they learn to build on what they have.

Impact: A pilot program to help communities to build on these assets and to enhance their appreciation and value of local arts and heritage resources began in 2006 in Walhalla, Carrington and Ellendale North Dakota. The program was a project of the NDSU Extension Center for Community Vitality in cooperation with Extension Agents from Dickey, Pembina and Griggs counties. Extension designed and implemented the program. Other collaborators were the North Dakota Council on the Arts, local economic developers, area schools, New Bohemia, Dr. Tom Isern, a NDSU history professor and Jon Offutt, Fargo artist. Program objectives were to: showcase area artists; help community leaders develop a strategic plan to promote cultural arts; and introduce area adults and youth to cultural wealth in their community. Each site hosted a day long workshop to accomplish these three objectives. Primary audiences for the workshops were community leaders, area artists, others interested in arts and heritage and area schools. The workshops included a strategic planning session workshops were attended by approximately 500 adults and youth.

Early results from the implementation of the strategic plans that were developed at the workshops include the organization of an Arts Council or non-profit board in all three locations. In Ellendale they have started a web-based directory of area artists, are featuring an area artist

each month in a historic downtown building for promotion and local education, began research of the historical significance of downtown buildings and successfully connected with the Agraria Restaurant in Washington D.C. to showcase the work of several local artists. The Agraria agreed to purchase several photos from six area artists. In Walhalla, the newly-organized non-profit Arts Council has begun the restoration of the Walla Theater and has developed a relationship with the local school to begin an arts education program, something that hasn't been done in the schools for several years. Carrington is working on a series of exhibitions at the Putnam House to feature local artists and is also compiling a directory of artists.

Many activities have just started but early results show that this program is very effective in building community capacity to appreciate and utilize local assets to enhance their quality of life and assist artists to showcase and market their work. Evaluation will be conducted in 2007 to measure economic and other impacts of the program.

Source of Federal Funds: Smith-Lever and State Extension Administration

Scope of Impact: Three county area pilot

Key Theme - Promoting Business Programs: Food Entrepreneurship
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. The NDSU Extension Service and the Institute for Business and Industry Development in partnership with the North Dakota Department of Agriculture developed a resource binder, "Starting Your Food Business in North Dakota". 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. On- line modules have been developed and are in the pilot-test phase.

Impact: More than 175 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 400 North Dakota food products currently on the market.

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 2002 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 statewide using a train-the-trainer format in 2002-2003. In 2003-2004, "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 2005-2006. Programs developed for 2004-2005 were: "Planning for Long-Term Care", "Post Secondary Education Planning", and "Forecasting Retirement Income and Expense." In 2006-2007, a lesson and web site on "Final Wishes Planning for North Dakotans" was developed. In 2007-2008, a lesson is being developed on "Healthy. Wealthy and Whys: the Health and Wealth Connection".

Impact: After survey results.
Take the Road to Financial Security in Later Life: 76% indicated they had increased their financial literacy related to later life issues and 70% completed a Financial Timeline.

North Dakota Saves: 73% were more aware of how to increase their personal wealth, 68% indicated they better understood how financial dreams could become reality, and 75% indicated that they knew how to set SMART goals as a result of participation in the program.

Basics of Saving and Investing: 87% indicated they learned about the difference between saving and investing, 64% understood the investment pyramid as a result of participation in the program, and 68% indicated they understood the time value of money.

Mutual Fundamentals: 80% indicated they better understood the different types of mutual funds, 65% indicated they knew more about the various fees and charges, and 80% indicated they were more aware of the pros and cons of mutual funds.

Basics of Bonds: 82% indicated they better understood the principles of Bond investing as a result of participating in the program, 87% indicated they were more aware of the various types of bonds, and 85% indicated they better understood the risks and rewards of bond investing.

Critical Conversations about Long Term Care: 85% indicated they were more aware of their potential for needing long term care, 98% indicated they better understood the issues involved in long term care planning, and 92% indicated they were more aware of the costs and implications of financial care planning.

Final Wishes Planning: 100% indicated that their knowledge of funeral/cremation planning in North Dakota had increased, 76% indicated they planned to fill out their "Final Wishes" form, and 73% indicated they planned to fill out their Advance Directives form.

Saving for Education: 86% indicated they had increased their knowledge of saving for post secondary education and 35% planned to begin an Education Savings Plan.

Wall Street: 65% indicated they better understood the history of the American Stock Market and 58% indicated they now knew more about Wall Street.

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. The Becoming Money Wise will target limited resource audiences. Over the past five years 138 educators have used the High School Financial Planning Program materials in their North Dakota classrooms to reach 8720 students.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Key Theme - Parenting: Countdown to Kindergarten Parent Education Program
Countdown to Kindergarten is a prevention-focused parent and family education program designed to facilitate child development and school readiness. The program was developed and is administered by the regional Parent Resource Center in Fargo, ND, under the direction of the NDSU Extension Service. Participating families are selected at five different area sites. Targeted sites are intended to facilitate recruitment of participant families more likely to need assistance with preparing children for school achievement (new immigrant families, economically challenged families, etc.).

Participants are involved in educational sessions consisting of 1-1/2 hour sessions, with 45 minutes of parent-child activity followed by 45 minutes of separated parent education and child activities. A total sample of 59 participants from all five program sites completed the program evaluation survey in fall 2006. The response rate to the survey was 85.5%.

Impacts: A post-training evaluation was administered to assess the impact of the training and materials in the Countdown to Kindergarten parent education program. Participants were asked to respond to a series of questions about their perceptions of the program as a whole and some of its effects on them. Among the participants surveyed:

- 73 percent of them indicated the program was useful or very useful for them.
- 44 percent of the participants indicated that the program increased their knowledge of child development much or very much, with an additional 49 percent it increased such knowledge somewhat for them.
- 53 percent of participants indicated the program increased their knowledge of healthy parenting much or very much, with another 41 percent somewhat of an increase in this area.

Participants were also measured on a variety of parenting efforts both prior to and after participation in the program. Participants in the program showed significant increases after the program on 14 of 16 items, including such areas as paying attention to factors affecting a child's growth, avoiding harshness with children, discussing books with their children, using positive guidance techniques with children, and guiding their child's use of media. These results suggest a positive outcome for the participants regarding their knowledge about parenting young children and their ability to use the training provided to assist parents in meaningful ways in their communities.

Source of Federal Funds: Smith-Lever

Source of Impact: State specific extension

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 would 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 – Strengthening Families: CYFAR New Community Project, Building Connections at Standing Rock

The purpose of the Building Connections Strengthening Families Program at Standing Rock, ND is to strengthen families and foster positive youth development in a culturally sensitive way. This project is funded and operated as a CYFAR New Community Project. Over 600 participants (adults, adolescents, and children) on the Standing Rock Indian Reservation have been involved in parent education and programs focusing on positive youth development.

Impacts: Ongoing evaluation of participants in the parent education programs indicated the following:

- 93 percent of parents/caregivers found the information useful—most or all of the time.
- 100 percent of parents/caregivers felt they got something positive out of participating in the program.
- 97 percent of parents/caregivers agreed they know more about how to help their child develop now than before the program.

Analysis of pre and post-program responses by parents who have participated in the program are promising. Findings showed that parents significantly decreased in their use of corporal punishment and inconsistent discipline practices. There was also significant improvement shown by parents on all other scales on the Alabama Parenting Questionnaire (parent involvement, positive parenting, and monitoring of children).

Parents also significantly decreased in poor supervision practices with children. Further, there was also a significant increase over time in parents reporting exploration of their ethnic identity and a sense of belonging with their ethnic group.

Parents on Standing Rock also reported in their own words about topics they learned about. In response to survey questions, 87 percent of parents reported an increase in general parenting skills; 97 percent reported an improvement in parent-child relationships; 99 percent reported an increase in knowledge related to learning positive ways to help their child behave better. The percentage of parents reporting that they age vegetables in the last few days also increased significantly from 57% to 71%.

Finally, parents and caregivers also indicated in response to open-ended survey questions that as a result of attending this program they saw improvement in parent-child relationships, increased their knowledge about nutrition, and improved their parenting skills.

Source of Federal Funds: Smith-Lever

Source of Impact: State specific extension

Key Theme – Youth Development/4-H: Asset Building in Youth/Career Readiness/Preparing North Dakota Youth

Youth benefit from opportunities to develop and practice attitudes, skills, and work habits valued by employers and needed by entrepreneurs. Extension youth programs provide experiences which build assets contributing to successful workforce experiences. As science and information technology affects the kinds of career opportunities and decisions relating to future education and careers, the 4-H program can supplement and enhance science and technology education currently offered in schools for youth and adults. Many components of a 4-H program, such as the commitment and effort to complete a project, planning and organization skills, communication and showing respect for others when a young person works on a project or competes in an activity, are the types of attributes found in successful employment.

Impact: Outcomes from youth programming are demonstrated in a variety of ways, some as community service, others are development of specific skills which prepare youth for the workforce. The "Healthy North Dakota 4-H Club" project reached 426 youth from 21 clubs and nearly 200 youth displayed knowledge and awareness of healthy lifestyle activity by participating in the "Eat Smart, Play Hard" poster contest. More than 5000 youth are involved in conference judging interviews in county programs, helping to build communication skills with adults and youth. 350 youth practiced skills in communication arts contests beyond the county. 592 youth practiced decision making and presentation skills through participation in judging contests at the state level. Local club meetings add to the development of communication skills and leadership roles in both individual and group situations. These experiences build assets for youth participants which contribute to workforce readiness.

Programs, delivery methods, and types of outcomes vary by county. Some examples are:

Sioux County Extension works with the Night Lights After-school program on a weekly basis with programs to build lifetime skills. More than 400 youth are reached with this program effort. Youth in K-12 are involved in digital photography, woodworking, cultural activities, day camps, bison, equine, and field trips. A local 4-H Drummers and Dancers group formed and demonstrates their heritage and culture with people off the reservation including the North Dakota Extension Conference and Dickinson Research Extension Center Centennial Field Day. These experiences have contributed to increased self-esteem and improved communication skills.

Mountrail County had significant increase in participation in the county communication arts program attributed to increased involvement by volunteers to help youth interested in participating. Many of the youth had never done any type of speaking in front of a group and now demonstrate more confidence and poise when presenting themselves to others.

The Teen Maze program (a prevention program designed to teach youth the community resources available to them if/when they need them) was offered to all eighth grade students in the Bismarck Public School system. 647 students went through the maze and 99 percent (641) reported they were more aware of the community resources available to them. 48 percent (315)

of participants stated the program experience will influence them a lot, and another 41 percent (266) stated the experience will influence them a little when making decisions to engage in risky behaviors. The program was also used with eighth grade students in Devils Lake. 74 percent of 170 students indicated they learned new information about potential situations

The High School Financial Planning Program has shown significant improvement nationally in student's behavior to set aside money for future needs and wants and distinguish the difference. Management of financial resources is an important aspect of career readiness and a skill needed by youth as they transition to adult life. 1560 students from 30 schools participated in North Dakota this past year.

Community service is an important part of the 4-H experience. McLean County youth practiced technology skills learned through youth programs to serve the historical society by mapping 34 cemeteries with GPS technology. The Washburn Cowboys helped the homeless in the county and surrounding area by collecting food and money as well as donating time at the local resource center to make gift baskets, stock shelves and clean. The 4-H Ambassadors demonstrated a commitment to community service by incorporating service into Extension Youth Conference and other projects, donating more than 700 hours.

Forty youth were trained in character counts in the Towner-Granville-Upham schools, providing another recognized asset for participants.

Assets, such as the ability to follow through and complete tasks is evident by the completion of a project as demonstrated 11,021 4-H exhibits at the 2006 North Dakota State Fair. Older youth demonstrate their organization and communication skills as part of the media team for 4-H events at the fair.

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: Two hundred forty-three young people participated in 30 hours each of entrepreneurship "hands on" learning in 2006 in classrooms, after school programs and a 4-H camp in North Dakota. A new addition in 2006 was a Mini-Society summer camp for adults and

youth. It was both a learning experience for youth and a train the trainer program for teachers, 4-H leaders and extension agents. Eighteen youth and adults participated, eleven of the participants where Native American. Extension agent quote: "Mini-Society is a wonderful program that allows individuals to experience entrepreneurship at it's finest. Through the week I watched shy youth blossom into budding business managers. When reading through the youth evaluation forms at the completion of the week, it was wonderful to read how they grew and what they learned. There were many success stories, one of which from a youth participant who chose not to open a business or participate fully during the week. In his evaluation he explained that if he could change one thing from the week it would be that he would have opened his own business instead of working for someone else because he believed he had enough knowledge to take the risk. That, to me, is success for the program."
The value of volunteer hours given to this program is more than $1 million when $18.04 is used as the value for one hour. This number does not include preparation and other time spent outside the classroom on the program.

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, Building Connections at Home on the Range
The purpose of the Building Connections Youth Development Program at Home on the Range, ND is to provide the opportunity for positive youth development by focusing primarily on life skill enhancing activities, improved communication between youth and parents, and support and information to parents. This project is funded and operated as a CYFAR New Community Project. Over 150 participants (children and adolescents) have been involved in a youth program in Home on the Range, an in-home youth facility in western North Dakota.

Impact: Evaluation of responses from youth participating in the program indicated the following:

- 68 percent of youth participants found the information useful—most or all of the time.
- 32 percent of youth participants found the information useful—some of the time.
- 90 percent of youth reported getting something positive out of the program.

Analyses of program responses by youth participants who have participated in the program are promising. Youth providing both pre-enrollment and post-participation questionnaires reported a significant decrease in negative feelings and distress. Also, there was a somewhat significant decrease in affiliation with peers who behave in antisocial ways.

Findings showed that 75 percent of youth reported learning new skills (working independently, using new technologies, learning about specific crafts, etc.). One in five youth reported learning how to work with people and help others. Youth participants also indicated in response to open-ended survey questions that as a result of engaging in this program they learned to be more respectful and listen more, to not do drugs, to work things out with their parent, to stay calm and control anger, and to trust others. A majority of youth indicated they would continue

participating in the program if it was offered, and would also join a similar program back home.

Source of Federal Funds: Smith-Lever

Scope of Impact: Statewide extension

Allocated Resources ($ x $1,000)		FYO6
1862 Extension ($)	Smith-Lever	798
	State	1,197
	FTE	28.5
1862 Research ($)	Hatch	51
	State	75
	FTE	1.5

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 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, and 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 focus 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 Agriculture and University Extension (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).

County Government Oversight
County commissioners actively participate in county extension program reviews. During staff evaluations each year, programming input is gathered from commissioners who take part in the staff evaluations. 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.

Citizens' Support Group for Nutrition, Youth and Family Science
The Citizens' Support Group for Nutrition, Youth and Family Science was formed to provide citizen input for Extension programming at the state level. In the fall of 2006, as NDSU Extension prepared for the upcoming legislative session, the Citizen Support Group disbanded and Nutrition, Youth and family Science efforts were addressed by the State Board for Agriculture, Research and Education (SBARE). The SBARE group meets monthly and was formed by the ND legislature to assist in bringing citizen input to the entire research and education agenda at NDSU, including Extension. Membership is based on the following criteria: state geographic representation, diversity, content expertise, and leadership roles. A process is followed to develop a list of needs/issues and a ranking procedure is used to prioritize issues.

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 four area Parenting Resource Coordinator positions. The four 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. NDSU extension is involved in the other four regional efforts as a resource, but does not fund the positions.

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.

North Dakota Healthy Alliance
The ND Department of Health, under the direction of the Governor of North Dakota, formed an alliance of organizations in ND that provide significant support and leadership for health-related initiatives. NDSU Extension is represented on this coalition. Networking among these professionals is invaluable, in addition to the legislative work.

North Dakota Jumpstart Coalition
A number of government and non-governmental units have formed a coalition to address the financial needs of North Dakotans. Saving more and reducing credit card debt are two of the key issues being addressed. NDSU Extension is a part of the team, and indeed, has a significant contribution as our Family Financial Specialist, also co-chaired the eXtension effort on financial security for all.

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

County and multicounty program unit advisory councils, specific boards and groups like SBARE, and our own extension staff identified the issues addressed in most "multi and joint" activities. 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 years 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 with topics covering 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.

Strengthening Families: Building Connections

Two programs around building connections with families and youth were carried out under different settings. The first was a program is to strengthen families and foster positive youth development in a culturally sensitive way on the Standing Rock Indian Reservation. Over 600 participants (adults, adolescents, and children) on the Standing Rock Indian Reservation have been involved in parent education and programs focusing on positive youth development. Parents on Standing Rock reported in their own words about topics they learned about. In response to survey questions, 87 percent of parents reported an increase in general parenting skills; 97 percent reported an improvement in parent-child relationships; 99 percent reported an increase in knowledge related to learning positive ways to help their child behave better.

The second program was on the Home on the Range, an in-home youth facility in western North Dakota. The program's purpose was to provide an opportunity for positive youth development by focusing primarily on life skill enhancing activities, improved communication between youth and parents, and support and information to parents. Over 150 participants (children and

adolescents) have been involved in the program. Analyses of program responses by youth participants who have participated in the program are promising. Findings showed that 75 percent of youth reported learning new skills (working independently, using new technologies, learning about specific crafts, etc.). One in five youth reported learning how to work with people and help others. Youth participants also indicated in response to open-ended survey questions that as a result of engaging in this program they learned to be more respectful and listen more, to not do drugs, to work things out with their parent, to stay calm and control anger, and to trust others.

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 has been active in developing educational programs for NPSAS. More than six 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.

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. In 2005, a Farmers Market and Growers Association in ND held its first annual meeting with eighty people registered. Farmers markets are being established in the larger cities in North Dakota, providing an outlet for producers to sell.

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. Curriculum materials are now being revised. Training and educational materials will be offered to agents once the curriculum is completed and they in turn will do programming at the county level.

E. MULTISTATE EXTENSION ACTIVITIES

Sugarbeet Program
North Dakota ranks second in sugarbeet acreage, 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 triazole fungicide, to control Cercospora leaf spot. EPA provided a full label for Eminent in 2005 and another

triazole, Enable in 2006. The average number of fungicide applications applied per acre was reduced from 3.74 in 1998 to 2.08 in 2006, and 92% of surveyed respondents indicated good to excellent disease control. Rhizoctonia, Rhizomania 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.

Researchers tested different fungicides to control Cercospora including resistant and/or tolerant strains. This has led to the full registration of two effective strobilurin fungicides, Headline and Gem, and two triazoles – Eminent and Enable. The use of a triazole 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. Specialists have also determined that azoxystrobin should be applied when the temperature at the four inch soil depth is between 62 and 73ºF for best control of Rhizoctonia crown and root rot. 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.

Excellent pest and disease control coupled with favorable weather conditions resulted in a 38% increase in yield in 2006 compared to 2005.

The sugarbeet root maggot is the most serious insect pest of sugarbeet in the Red River Valley of North Dakota and Minnesota. It is also a major pest in over 2/3 of the sugarbeet-producing acres of the United States. Sugarbeet producers in the north central and western United States have relied on the same chemical insecticide mode of action for controlling this pest. The threat of insecticide resistance development in these populations is a major concern, and alternative control strategies are needed. 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. Extensive grower adoption of resistant varieties for sugarbeet root maggot control could potentially allow for major reductions in the overall pesticide load on the environment in areas infested by the insect.

In 2006, growers used our standard fertility recommendation and had a 38% yield increase compared to 2005. Growers had an excellent experience of the impact of mineralization on the improvement of their crop yield.

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.

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 160,000 acres in 2006. Dry peas have increased from about 2,000 acres to 610,000 acres during the same period. Canola acres in 2006 were 940,000. Potato is the highest volume vegetable crop grown in the North Central region. With over 150,000 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 are 5 processing/marketing facilities with more being proposed.

Cattle producers in 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. Forty-four producers developed limited liability company to sell fresh and processed meats into a regional market. A natural beef company was organized to provide producers and purveyors an alternative to traditional markets. 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.

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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 2006
Sugar Beet Program	49,000
Value Added Programs	43,500
Total:	92,500

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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. These results are from years 1, 2, 3, 4 and 5 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.

Distribution of these results was accomplished thru different means. The first volume of "Grasses for the Northern Plains: Growth Patterns, Forage Characteristics, and Wildlife Values - Volume I – Cool-Season" will be published in May 2007 with 10,000 copies produced for the Northern Plains land managers including farmers and ranchers, and natural resource professionals. The impacts this educational material can have included development and management of over 3,343,900 acres of land assessed by the Farm Service Agency. Fifty-four ranchers participated in the cow/calf and 12-month forage planning workshops. These two workshops impacted over 113,400 acres of native rangeland, pastureland, and hayland and 7,216 animal units of livestock. More than 76 percent of the participants were planning to add new range improvement practices or cattle nutritional programs.

Beef Research/Education
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 the impact of various feeds on beef composition.

Impact: Flax is an oilseed crop produced in the northern Great Plains. It contains high levels of n-3 fatty acids, making it a unique source of nutrients for livestock. Feeding 8% flax to feedlot heifers increased gain and efficiency, and processing flax increased available energy and resulted in increased efficiency of gain. Feeding 8% flax also increased levels of n-3 fatty acids in fresh beef.

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

Entomology Research/Education
The development of a truly integrated pest management system that combines the use of another insect-pathogenic fungus with cover cropping as a cultural control strategy is being evaluated as a protection of fields from yield losses associated with sugarbeet root maggot feeding injury. One objective is to survey for and screen native isolates of entomopathogenic fungi for pathogenicity to the sugarbeet root maggot. Preliminary findings suggest additive root protection results from combining the two control strategies. A new federally registered and commercially produced strain (F-52) of this fungus has been demonstrated as having high virulence to the root maggot. During the past two years of research, a strain F52 of this fungus has been evaluated in concert with oat and rye cover crops. The first year produced very encouraging results; however, post-application drought contributed to low levels of fungus survival/sporulation and, correspondingly poor control of the sugarbeet root maggot. The F52 strain appears to be most suited for moist soil conditions, which are common to the Red River Valley growing area. Irrigated fields may also provide a good environment for use of this bio-based system.

Impact: The sugarbeet root maggot is the most serious insect pest of sugarbeet in the Red River Valley of North Dakota and Minnesota. It is also a major pest in over 2/3 of the sugarbeet-producing acres of the United States. Sugarbeet producers in the north central and western United States have relied on the same chemical insecticide mode of action for controlling this pest. The threat of insecticide resistance development in these populations is a major concern, and alternative control strategies are needed. In addition, grower adoption of alternative root maggot management tools also would allow for less use of conventional nerve poison insecticides for control of this insect, thus potentially causing less harm to the environment and to non-target organisms.

Canola Insect Pest Trapping Network was conducted in the major canola growing areas of North Dakota for the past eight years. Pheromone traps are used to monitor for two insect pests of canola: Bertha armyworm and Diamondback moth. Trap data provides growers, Ag consultants, field researchers, and county extension agents/specialists with an “early” risk warning system of when these insect pests are active and their population levels. A total of 25 pheromone traps in 15 counties were monitored for two Lepidopteran insect pests of canola in the major canola

growing areas of North Dakota: Overall, most of the trap sites, about 88%, had cumulative trap catches below 300 and was at "low" risk of larval infestation. This marks the third year in a row with low risk for bertha armyworm infestations. An average of 101 diamondback moths per trap was captured in 2006, which was lower than the average trap catches for 2005 (199 moths per trap).

Impact: As a result, insecticide spraying for bertha armyworm or diamondback moth was not necessary in 2006 canola crop.

The Extension statewide IPM pest survey has evolved into a more comprehensive program for obtaining crop and pest information. From 2004-2006, the survey was limited to five crops: wheat, barley, soybean, canola and sunflower. A total of 1,975 fields were visited from late May until the end of August. The maps summarizing the sampling data were used to graphically illustrate where pest problems were developing in the region. Pests include grasshoppers, cereal aphids, cereal leaf rust, *Fusarium* head blight, soybean aphid, flea beetles, white mold/sclerotinia, and more that are specific to the crops. A new trapping effort was conducted to determine the distribution of corn rootworms in North Dakota. A total of 100 trap sites for corn rootworms were monitored in 37 of the corn producing counties of North Dakota. Corn rootworms were trapped in 30% of the corn fields surveyed in North Dakota. Western, northern, and southern corn rootworms were observed 10, 9, and 17% of the corn fields, respectively. The southeastern region of North Dakota produces the majority of corn acreage and also had the highest concentration of corn rootworms. The western and southern corn rootworms appeared to be more widely distributed than the northern corn rootworm. Generally, the numbers of corn rootworm captured per trap were low across North Dakota.

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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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 2006
Renewable Resources	2,200
Beef Education	18,000
Entomology Education	17,000
Total:	37,200

Check one:

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

Title of Planned Program/Activity	Actual Expenditures FY 2006
Renewable Resources	17,000
Beef Research	16,300
Entomology Research	7,100
Total:	40,400

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