2018 North Dakota State University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

Agriculture continues to be the dominant force in North Dakota's economy even though North Dakota has become the second largest oil producing state in the nation. The North Dakota Agricultural Experiment Station (NDAES) and North Dakota State University Extension (NDSUE) serve as major sources of innovation, new tools and knowledge, and educational support to agriculture's continued success. The following examples illustrate recent contributions in the areas of cropping systems, natural resources, livestock systems, economic and community vitality, 4-H youth development, and human development and education.

Cropping Systems

New Fungicide
A new seed treatment is a result of a partnership between NDSU and DuPont to find an effective fungicide for downy mildew, a disease that affects approximately 50 percent of sunflower fields every year. Downy mildew affects sunflower plant roots and often causes seedlings to wither and die. If the plants survive, they produce little, if any, seed. To make matters worse, the pathogen that causes downy mildew developed resistance to a very effective fungicide two decades ago. DuPont approached NDSU with a new chemical, and in turn NDSU launched a research project to test it. DuPont researchers knew the chemical would be effective on a certain class of pathogens, but they didn't know if it would work specifically on the pathogen causing sunflower downy mildew. Field experiments were conducted to determine the chemical's effectiveness and the best rate for applying it to seeds. After years of field trials, the new chemical is available to sunflower growers across the U.S. as Plenaris (Syngenta) and Lumisena (Corteva), and soon will be available in countries around the globe. What makes this fungicide particularly significant is that it has a new mode of action, or the way it inhibits pathogens. "The sunflower industry owes a great deal of gratitude to NDSU for being 'difference makers' in helping solve this very important production issue," says John Sandbakken, executive director of the National Sunflower Association. "This work was an excellent example of what a fantastic public/private partnership can achieve when working together, making a difference for sunflower growers across the globe."

NDSU Identifies Iron Deficiency Chlorosis-resistant Soybean Varieties
Each year, North Dakota soybean producers lose a portion of their yield to iron deficiency chlorosis (IDC). NDSU scientists are on the front line in the battle against IDC. A soybean breeder evaluates commercial varieties for resistance to IDC in field trials. A soil scientist works to reduce the deficiency's impact by evaluating iron fertilizers. Scientists are also is in the process of developing a rapid greenhouse test to determine which varieties offer the most resistance. Finding a chlorosis-resistant variety is the No. 1 priority. There is no fertilizer, foliar spray or other cultural practice that can turn a weak variety into a strong one. Soybeans grown on alkaline soils with a high water table are more susceptible to IDC. Iron is abundant in all North Dakota soils, but soybeans have a difficult time taking up enough, especially early in the growing season. Unlike most other nutrient deficiencies, IDC strikes the youngest tissues first, turning the tissue between the leaf's veins yellow. Twenty years ago, soybean varieties had a commercial lifespan of five years or more. Today, new varieties are released about every three years. With new products

released regularly on the market, NDSU's research assists seed companies and dealerships in finding the most resistant varieties for land prone to IDC. The disorder affects the North Central region, which includes eastern North Dakota, western Minnesota and north-central Iowa. Protocols are being developed for the rapid greenhouse test at the Agricultural Experiment Station Research Greenhouse Complex on the NDSU campus. Soybeans are grown in a mixture of sand and alkaline soil, and subirrigated with solutions that intensify the severity of IDC so that resistant varieties can be separated from susceptible varieties. The goal is to develop a rapid test that will determine within four weeks whether a soybean variety will be IDC-resistant. If planting an IDC-resistant variety isn't enough to prevent chlorosis, soybean producers should add a second level of defense of an in-furrow application of an effective iron fertilizer or planting in wider rows with heavier seeding rates. The third level of defense is to use all three strategies together. The community of Colfax as ground zero for IDC in soybeans in North Dakota. In 2017, an ND AES researcher and an NDSUE county based agent formed the Colfax Chlorosis Club with a private agronomist from Colfax Farmers Elevator to help hard-hit soybean producers. In the winter, club members learn about NDSU's variety trials, field-specific best management practices and implementation strategies. Members commit to trying a new strategy in their toughest fields. A field tour held in the summer when IDC is most prominent allows members to see the experiments. The club meets again in the winter to consider what to try the next year. The North Dakota Soybean Council also supports NDSU's efforts on IDC.

Producers Battle Weeds With Extension's Help

Identifying weeds is the first step in controlling them, especially Palmer amaranth, a very aggressive weed found in North Dakota for the first time in 2018. Early identification and control of Palmer amaranth is important before it gets a chance to grow or spread. However, Palmer amaranth can be difficult to identify because it resembles other pigweeds, so Extension developed a website and posters to help distinguish it from other plants, and provided recommendations for chemical control. Recommendations to producers included study images of the plant to give yourself some familiarity with its appearance, and scout your fields, pastures and gardens for plants that might be Palmer amaranth. Ideally, these weeds should be pulled and removed from the field whenever possible. Palmer amaranth isn't the only concerning weed. Extension specialists involved with weed issues have named stinkgrass the weed of the year for 2019. Like Palmer amaranth, it's difficult to control. Other worrisome weeds include kochia, waterhemp, marestail and common ragweed because of their resistance to glyphosate, one of the most widely used herbicides in the U.S. To make matters worse, other herbicides may not work well, either. Pesticides that are used in other states aren't necessarily good North Dakota choices because of the various other crops planted in the cropping sequence. The switch to no-till or conservation-tillage practices has placed more emphasis on chemical control that has resulted in more or different weeds in certain situations. For instance, common ragweed is a bigger weed control challenge because soybean production has replaced wheat acres, where ragweed is easier to control. Waterhemp, a member of the pigweed family, is believed to cross-pollinate with native pigweeds, allowing it to adapt to the state's environment. To combat the growing weed problem, agents and specialists work with producers to determine which control methods, whether chemical (herbicides), mechanical (tillage) or cultural (planting cover crops), or combination of them are the best options. Extension's Weed Management Education Committee developed a training program for agents. It includes weed management options and a website to help agents identify weeds in a producer's field or plants producers bring them. Agents also receive weed seeds to grow for "show and tell" at pesticide training programs they conduct.

Natural Resources

Bees Deliver Control

Biocontrol agents that bees deliver to sunflowers have been effective against head rot in the plants. Head rot is a disease that causes major damage, particularly when cool and wet weather occurs when sunflowers are blooming or maturing. As its name implies, the fungal pathogen infects the sunflower head, initially making the tissue soft and spongy and eventually shredding heads and decimating yield. Past research on the use of fungicides to control head rot in sunflowers has been insufficient and inconsistent.

As a result, NDSU began studying whether bumble bees or honeybees carrying biocontrol agents to sunflowers, a process known as bee vectoring technology (BVT), would be more effective. Bees pick up the control agents as they leave the hive and deposit the control agents on sunflowers as they forage. Biocontrol agents that the scientists are studying include CR-7, a strain of Clonostachys rosea, which is a mycoparasitic fungus. Using bees to vector a biocontrol agent is a very novel way to combat this very serious disease. More research is needed, but early results are promising.

Leafy Spurge Under Control

In in 1979, the yellow-flowered perennial weed was invading several western states with no sign of stopping. Many ranchers teetered on the edge of bankruptcy because of the damage leafy spurge caused. Scientists within NDSU's Plant Sciences Department spent the next 39 years combatting the weed, and they have good news. "We've stopped the expansion and are starting to reduce the infestation," they say. Leafy spurge first was spotted in North Dakota in Fargo in 1909. It made the state's noxious weed list in 1935, when it was found in all but 10 counties. Statewide leafy spurge control programs that NDSU and the North Dakota Department of Agriculture (NDDA) led were unable to halt its spread. The weed doubled in area every 10 years, infesting nearly 1.8 million acres by the 1980s. Its white sap is toxic to cattle and horses. Only sheep and goats can graze it. The early emerging weed outcompetes other plants and spreads by seed and root. One stem can produce 140 seeds, and each seed remains viable in the soil for up to eight years. Roots extend to 30 feet, enabling the weed to withstand drought. The Agricultural Experiment Stations in Montana, Nebraska, North and South Dakota, and Wyoming, with North Dakota taking the lead, launched a cooperative project following the inaugural Leafy Spurge Symposium in 1979. The initial research focused on the herbicides 2,4-D, Banvel and Tordon in the 1980s. By the late 1980s, efforts shifted to biocontrol with the introduction of the flea beetle Aphthona, a natural predator successful in Europe. Establishing the beetles near Valley City and Minot, was a slow process, with no movement until a helicopter accidentally oversprayed the Minot insectary with herbicide. The beetles moved out of the field. The interaction between the herbicide and flea beetles was synergistic. As a result, all the Aphthona flea beetles redistributed in North America originally came from these two sites. In many areas, neither herbicide nor flea beetles alone could control leafy spurge. The two tools were more successful when used together. The beetles' larvae feed on the root system, making the weed more susceptible to herbicides. Grazing by sheep and goats is a third tool to control leafy spurge. Grazing early in the spring slows the weed's spread. By 2004, infested acres dropped to 800,000, the lowest since 1979. Today, a dozen herbicide options are available. The various Aphthona beetle species work well in one-third of the state and moderately well in another third, but not in sandy, shady or flooded areas. Flea beetles have nearly eliminated leafy spurge near Medora, since their introduction in 1999, when the weed made up 70 percent of the soil seed bank. When flea beetles remove leafy spurge, the native plants begin to return.

Research Improves Rangeland for Livestock, Wildlife, Pollinators

Kentucky bluegrass, an aggressive non-native perennial grass, is displacing North Dakota's mixed-grass prairie species and altering its ecosystem, and NDSU scientists are studying its impact and how to control it. This collaborative effort involves on-campus scientists and the NDAES Central Grasslands Research Extension Center (CGREC) near Streeter. For example, a soil scientist in the School of Natural Resource Sciences (SNRS), is evaluating Kentucky bluegrass's impact on water and soil at the center. A range scientist in the SNRS, is analyzing how Kentucky bluegrass at the center responds to grazing management strategies such as patch-burn burning and intensive grazing early in the growing season. By determining how Kentucky bluegrass changes soil function and health, management strategies can be determined that best enhance plant community function while sustaining the livestock herd. On-campus scientists also work with the CGREC on other range and soil issues affecting livestock and wildlife. One range scientist in the SNRS is researching the impact of rotational patch-burn grazing on forage and vegetation while another range scientist in the SNRS, is assessing the influence of two types of patch-burn grazing and season-long grazing without fire on the butterfly community. The scientist also is studying the impact of patch-burn grazing on bird nesting and breeding. Patch-burn grazing is a grasslands

management strategy that involves burning a portion of prairie. Livestock concentrate their grazing on the new growth in that patch, allowing previously burned and unburned patches to recover. In related research, scientists from the Hettinger Research Extension Center (HREC) and NDSU's Range Sciences Program are analyzing the impact of patch-burn grazing on pastures previously enrolled in the Conservation Reserve Program (CRP) when sheep or cattle are the main grazers. While the use of cattle in a patch-burn grazing format has been previously evaluated elsewhere, no information exists concerning sheep performance and grazing preference in a patch-burn grazing management strategy, which makes the research in western North Dakota novel. In addition to livestock performance, hunting and beekeeping are also important aspects of the local economies, so efforts are focused on evaluating how ring-necked pheasant, sharp-tailed grouse, ducks and pollinators are using local pastures. The scientists also overseed native forbs into areas burned the previous year to see if they can increase species diversity in post-CRP grasslands. The data being collected will be crucial in determining if there is potential for a patch-burn grazing system to be deployed on post-CRP. The act of putting fire on the ground has also been a positive because livestock producers have seen that a prescribed fire can be done in a safe manner. Preliminary results from the Kentucky bluegrass study indicate that Kentucky bluegrass dominance and land management practices may play a role in soil water infiltration. Soil water infiltration, in turn, affects plant growth and, thus, nutritional value for grazing livestock. Future research will help provide important characterization of soil properties, water dynamics and the rebounding nature of these grassland ecosystems following a fire disturbance. In the prescribed burn study, preliminary research indicates these burns may be an effective management tool on Kentucky bluegrass invasion, but that may not be enough. Research has shown that burning alone can reduce Kentucky bluegrass for a year, but a return to pre-burn levels the following year suggests that additional disturbance is necessary. Livestock prefer grazing in the recently burned patches, even though those areas have less forage available, which is good news. Although patches are intensively grazed for a season, the subsequent seasons of rest ensure the long-term sustainability of the forage base. Patch-burn grazing also seems to increase the number of butterflies and butterfly species. Patch-burn grazing also can benefit birds by providing a diversity of habitat. The use of fire on rangeland is not universally accepted. Scientists recently initiated another study to evaluate the effects of patch grazing without the fire. The new study will mimic patch burning through different grazing intensities. If grazing intensity can be modified across a pasture to create heavy use, full use and light to no use without fire, maybe varied grazing practices can negatively impact Kentucky bluegrass while enhancing native broadleaf and grass production.

Livestock Systems

Efficiency Key to Cattle Profitability

Just what is the right cow size? That's a question NDSU scientists are working to answer through studies that are evaluating how a cow's frame size affects beef production factors such as feed needs and reproduction, as well as early indicators of longevity. They also are collecting genomic data that could help producers select animals with desirable traits for breeding. Efficiency and profitability in the production of meat animals is key to producers within North Dakota, across the U.S. and worldwide. Without sustainable and efficient production practices, there is concern that agricultural production may not meet demands in the next 50 years due to the ever-increasing human population. For the past four years, scientists have conducted summer feed trials at NDSU's Beef Cattle Research Complex (BCRC) in Fargo on one-year-old heifers of differing frame sizes from the Dickinson Research Extension Center (DREC). Preliminary data can provide information on issues such as how much feed cows of varying sizes need, what pastures to place them on and what size calves the cows will produce, which can help producers decide on the right type and number of cattle to fit their operating system and goals. Larger cattle appear to be more efficient at using feed for growth, while smaller cattle wean more calf for their weight. While the cows are at the BCRC, they are bred to various sized bulls, and the pregnant cows get sent back to the DREC for the winter. The scientists continue to track the cows while they are at the center for traits such as good udder conformation, calving ease and temperament. The scientists plan to have the cows go through the study again in 2020 to compare the mature cows' performance with their performance as heifers. This study is a

continuation of research on cow size and efficiency issues the DREC has been conducting since the mid-1990s. In 2008, the center created two cow herds to help with this research. One herd consists of smaller-framed cows for range research projects and the other has moderate-framed cows for beef research. The smaller-framed cows have a mature body weight of about 300 pounds less than the larger-framed cows when the calf is weaned. Scientists have looked at issues such as calving ease, growth and calf weight as a percentage of the cows' weight. The calves from the larger cows have an advantage when a cattle system is evaluated based on calves as the unit of production. From the same cow-calf perspective, looking at economic efficiency, the calves from the smaller cows, based on acres as the unit of production, have an advantage.

New Tests Will Make Livestock Feed Safer

New tests NDSU Veterinary Diagnostic Laboratory (VDL) scientists are developing will help determine whether grains and forages are safe to feed to livestock. Wet conditions in this region and elsewhere in the U.S., as well as no-till and organic farming practices, have resulted in an increase in ergot, a fungal disease that can develop in crops. Ergot contains alkaloids (organic compounds of fungal origin) that are toxic to livestock. Ergot is common in cereal grains such as wheat and rye. It has also been detected in forages as well, such as timothy and bromegrass. Depending on the type of ergotism, symptoms in livestock include the death of cells in the tip of the ears, tail and tongue, and the area just above the hoof; lameness; poor body temperature regulation; decreased feed intake; and low weight gain and milk production. A chemist at the lab has spent the last year working on a method to test for the main ergot alkaloids, as well as their alternate forms, or isomers, in cereal grains and grasses using the liquid chromatography-mass spectrometry technique. Testing of isomers is critical to accurately determine the risk of toxicity because alternate isomers can increase during grain storage, scientists say. The lab received a U.S. Food and Drug Administration grant to help develop and validate the assay. NDSU's VDL will be the first to offer testing for both forms of ergot alkaloids. VDL scientists also are developing more sensitive tests to detect mycotoxins in stored grain. Mycotoxins are toxic compounds produced by certain types of molds, and they can affect the liver and kidneys in livestock and humans. Mycotoxins are especially a problem now because producers are having to store their grain in less-than-ideal places, such as piles and bags on the ground, as a result of trade disputes that limit their ability to sell their grain for the export market. The piles can get wet and bags can be damaged, letting in moisture, which leads to mold development in the grain. The new mycotoxin tests also can help producers decide what to include in their livestock's feed rations. Today's producers are feeding many more components and byproducts than just hay.

Bovine Emergency Response Plan Program Prepares First Responders

Each year, hundreds of thousands of livestock are transported on U.S. roadways and, inevitably, crashes involving livestock trailers occur. Emergency responders are trained to deal with injured humans at the scene of an accident, but not always livestock. NDSU Extension has helped change that. Extension specialists developed the Bovine Emergency Response Plan (BERP) program in 2015. Their aim was to help emergency responders and law enforcement more appropriately address accidents involving livestock transport vehicles. Imagine that a semi loaded with cattle has crashed and rolled over, it's dark outside and cattle are injured inside the semitrailer and loose on the scene. The plan helps emergency personnel know how to assess the situation, make critical decisions, and keep themselves and the public safe. Since 2015, the training has been presented to more than 30 emergency response teams in 14 states. "This training was appropriate and eye-opening for myself, our sheriff and fire department staff that took it," says the Dickey County Emergency Management director. "There were things we had not thought about, like documentation, media involvement and urban versus rural accident scenes. I would absolutely take the training again." In addition to a decision tree for dispatchers receiving and dispatching calls, the plan has guidelines for:

- Arrival protocols
- Scene assessment

- Scene security and containment
- Extrication of cattle
- Humane euthanasia
- Relocation of cattle
- Mortality disposal
- Righting of the vehicle
- Debriefing

The Bovine Emergency Response Plan was created in collaboration with Extension staff at NDSU, West Virginia University, Iowa State University and the University of Tennessee, and funded through the National Beef Quality Assurance program using Beef Checkoff funds, and the U.S. Department of Agriculture's National Institute of Food and Agriculture's Smith-Lever Special Needs Grant.

Economic and Community Vitality

U.S. Wheat and Barley Scab Initiative Making a Difference

The U.S. Wheat and Barley Scab Initiative has made a positive impact in North Dakota and throughout the U.S. The national multi-disciplinary, multi-institutional research system develops control measures to minimize the threat to wheat and barley from fusarium head blight (also known as scab) and deoxynivalenol (DON), a mycotoxin associated with scab. Since 1997, scientists from NDSU and other universities throughout the U.S., the U.S. Department of Agriculture's Agricultural Research Service and private companies have worked closely with producers, input providers, millers and food processors to reach that goal. Their efforts resulted in an estimated savings in hard red spring and winter wheats, soft red wheat, durum and barley of $9.6 billion from 1997 through 2014 nationwide, according to a study from NDSU's Agribusiness and Applied Economics Department. North Dakota saw a $1.1 billion economic gain from scab reduction during that period. Scab and DON cause major problems, including yield losses and market discounts for excessive DON in grain, forcing producers to use more costly management practices. As a result, some producers have shifted to growing less risky crops. Scab and DON also impact other parts of the supply chain by raising costs for testing and cleaning grain, and breeding resistant wheat and barley varieties. Each year, NDSU scientists on campus and at the NDAES Research Extension Centers across the state are involved in research funded through the initiative. The scientists have developed some of the nation's top scab-resistant crop varieties. They've also been instrumental in determining ways to use fungicide to combat scab successfully, evaluating the effects of cropping practices on scab, finding new disease resistance sources, and pioneering gene discovery and transformation. The authors of the scab initiative's impact study say that of the risk mitigation tools developed as a result of the initiative, two are particularly significant. One is fungicide use, which has increased from virtually nil in the 1990s to being applied to 70 to 80 percent of the cereals area planted in recent years. The other is the development and adoption of resistant varieties. Fungicide and resistant varieties are complementary and have an interdependent impact on reducing DON. The study also found that the scab initiative is very cost effective. The initiative spent $76 million from 1997 through 2014, which resulted in a net savings of nearly $5.4 billion from reduced production. That is $71 in benefits for every $1 invested.

NDSU Extension LRP Education Benefits Producers Nationwide

Increasing U.S. inventories, record high meat production, trade agreement negotiations and tariff disputes contributed to livestock price volatility in 2018. To help offset the uncertainty, Extension agricultural economics and livestock specialists educated producers about Livestock Risk Protection (LRP) insurance from the U.S. Department of Agriculture's Risk Management Agency (RMA). The LRP was developed to protect livestock producers from catastrophic price declines for livestock they will market in the future. It was created especially for producers who raise small numbers or those who prefer to pre-price only a few animals at a time. The insurance is available for feeder and fed steers and heifers, market swine and lambs. Extension specialists spoke to livestock producers, marketing clubs, agribusiness groups, NDSU

and Dickinson State University classes, Extension agents and North Dakota Farm Business Management instructors about LRP. There are very few livestock marketing economists providing LRP education in the U.S., so NDSUE developed LRP resources are being used nationally. Total U.S. LRP indemnity payments for the 2018 insurance year amounted to $7,399,097. From July 1, 2017, to June 30, 2018, North Dakota livestock producers insured 5,965 lambs, 3,448 feeder cattle and 574 fed cattle and received a total of $242,305.

Academy Prepares Water and Soil Conservation Leaders

Attending NDSUE's initial North Dakota Soil and Water Conservation Leadership Academy was enlightening for the West McLean Soil Conservation District board. One topic presenters covered was soil conservation and watershed leaders' roles and responsibilities in conservation, stewardship and watershed management. "That opened the eyes to many that they had more power than they thought," a district manager said. Extension partnered with the North Dakota Health Department's Watershed Management Program and State Soil Conservation Committee to create the academy to help water resource board members and soil conservation district supervisors be better prepared to lead watershed, conservation and community-based projects to protect water quality for future generations. Other academy topics include watershed hydrology basics, managing nutrients in watersheds, impacts of human activities on watersheds, components of an effective meeting, navigating conflicts successfully, group facilitation and the role of citizens in watershed planning. Academy graduates come away with information and training, and when they return to their respective counties they can take an active approach to resource management. Expectations are that at the grass roots level, soil conservation districts will create plans to conserve the state's soil resources and control and prevent soil erosion.

4-H and Youth Development

Mentoring Program Benefits Sioux County Youth

Youth in Sioux County are gaining valuable life skills through a national 4-H youth mentoring program. The Standing Rock Reservation covers the south-central North Dakota county and extends into South Dakota. Sioux County has the state's lowest average high school graduation rate, and 72.4 percent of youth birth to age 17 live in poverty. Since 2012, NDSUE's Center for 4-H Youth Development has received grants annually from the National 4-H Council to implement Youth and Families With Promise, a mentoring program designed to reduce youth delinquency and strengthen at-risk students' academic and social skills. The mentoring program gives the youth a consistent and stable relationship with their mentor, ranging from teachers to community members. Youth gain lifetime skills that could possibly move them into a career following high school. The mentoring project appears to be contributing to the increase in graduation rates and students pursuing post-secondary education. Youth possess more confidence and business-related skills, according to annual program surveys. Many youth are mentoring younger students. A ripple effect also has emerged, with parents, grandparents and community members feeling pride in the students' progress. Youth are leading efforts to make community changes, including operating a local gymnasium, starting an anti-bullying project, beginning a school recycling program and hosting a community 5K race. "Without the opportunity to learn valuable business skills, I would not have finished high school, let alone enrolled in college," one former student says.

4-H STEM Projects Excite Youth

How do you put toothpaste on a toothbrush in seven steps? You build a Rube Goldberg contraption, of course. Goldberg (1883-1970) was a Pulitzer Prize-winning cartoonist known for his wacky inventions in his cartoons. Now, a Rube Goldberg contraption is a complex device made of everyday items that does a simple task. It's also the basis for the Rube Goldberg Challenge, a new 4-H program that encourages critical thinking, creativity, innovation and problem-solving in youth from fourth through 12th grade. In 2018, the program's first year, 15 North Dakota 4-H teams used their STEM (science,

technology, engineering and math) knowledge to solve the toothpaste-on-a-toothbrush puzzle at the county level; six of those teams competed at the North Dakota State Fair. "Our team worked hard creating their Rube Goldberg machine," recalls an NDSU Extension agent in Emmons County. "There were nights when everyone wanted to go home and go to bed, but they kept persevering. It seemed the project would never come to completion, and they were still making last-minute touches until the competition. However, all the frustrations were erased when they received grand champion at the State Fair." North Dakota 4-H also engages youth in STEM through a $23,000 Microsoft grant. The grant allows older 4-H youth to plan and lead digital activities for elementary and middle school students. In 2018, the older 4-H'ers worked weekly with students from two Fargo middle schools and Fargo's CHARISM program on computer science activities. The 4-H'ers also were involved in Microsoft's Hour of Code computer coding event for elementary students at Kindred School.

Human Development and Education

Health Program Targets Males

Human bodies and vehicles have something in common - both need to be maintained - and preventive maintenance helps humans avoid major health issues. That's why NDSU Extension food and nutrition specialists created 'Healthwise for Guys', a program for adult males in rural areas primarily working in agriculture. The team developed a website, PowerPoint presentations, displays, toolkits with handouts and other material such as games and experiments/demonstrations for interactive learning, and Facebook and Twitter posts with information on heart disease, cancer, diabetes and obesity. Healthwise for Guys launched in January 2018. Extension agents in several counties offered classes and interactive displays. In addition, Extension agriculture and natural resource agents integrated education on preventing skin cancer from prolonged sun exposure into their pesticide use and safety training. Extension also partnered with registered nurses from local public health units who helped teach sessions on two sensitive topics: prostate and colon cancer. A Nelson County producer is protecting his skin and encouraging his family to do the same after learning about skin cancer prevention during pesticide certification training. Program developers hoped at least 300 participants would respond to follow-up surveys. They heard from 753. Keys to the program's success include distributing an online survey to learn what men want to know about health and the do-it/see-it-for-yourself experiments and demonstrations during classes, the developers say. The program's information isn't just for men, though. As a leading source of health information, spouses or significant others also need to arm themselves with accurate content for these important face-to-face conversations with all the men in their lives.

Diabetes Prevention Program Empowers Lifestyle Changes

North Dakotans with prediabetes are finding hope. An estimated 198,000 North Dakotans have prediabetes, or sugar levels that are above normal but not high enough to be diabetes. Diabetes costs North Dakota $902 million annually. NDSU Extension agents in 17 counties are helping prediabetic adults delay or prevent diabetes through the Diabetes Prevention Program. The Centers for Disease Control and Prevention designed the community program, which promotes weight loss of 5 to 7 percent through long-term healthful eating and 150 minutes of physical activity weekly. Participants meet weekly for 16 weeks, then monthly for eight months. The class is offered free or at a nominal fee. The program is not a diet plan, but rather a lifestyle change program individualized to each participant to empower them with knowledge to make long-term healthy choices. In the program, Extension agents, along with public health staff and local health-care providers, serve as a team of trained lifestyle coaches. Participants track fat grams and calories to gain awareness of food choices that could derail their success. They also learn to identify portion sizes, read food labels and move more. A male program participant from Valley City lost 20 pounds in the class led by an Extension agent in Barnes County. "I thought to lose weight, I could just eat less of the same kinds of foods," he said. He learned to make better food choices and took over meal preparation. He also exercises 150 minutes weekly. He goes on to praise the agent and two other lifestyle coaches. "Their hearts are in what they are doing," he says. "It's a matter of if we want their help, it's there. I want the help, and I do my best to do what they tell me."

Total Actual Amount of professional FTEs/SYs for this State

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	160.0	0.0	99.0	0.0
Actual	146.6	0.0	95.0	0.0

II. Merit Review Process

1. The Merit Review Process that was Employed for this year

- Internal University Panel
- External University Panel
- Combined External and Internal University Panel
- Expert Peer Review

2. Brief Explanation

Research programs were subjected to four different types of scientific peer review. These reviews occur prior to, during and at the conclusion of each research project. First, research faculty who participate in multistate research projects receive a critical review of their contributing project from fellow committee members, the administrative adviser and the North Central Multi-State Research Committee. Second, most faculty augment their multistate research funding with competitive grants. These grants are awarded on the basis of scientific merit and afford an opportunity for external peer review. Third, each research faculty member with the NDAES is required to have a station project that is reviewed for scientific merit by a Project Review Committee that is comprised of one faculty member from each discipline. Finally, all research is peer reviewed, either internally or externally, prior to publication.

Extension program leaders in agriculture and natural resources, family and consumer science, 4-H and youth development, and community resource development from the North Central Region meet twice a year to evaluate program needs and develop plans of work for the whole region. Ongoing efforts are made to update North Central regional logic models and develop and collect multi-state impact indicators. Extension specialists frequently submit grant proposals to regional and federal agencies and commodity groups to fund applied-research and Extension program activities. These proposals are externally reviewed prior to selection for funding. Extension bulletins are internally peer reviewed prior to publication.

III. Stakeholder Input

1. Actions taken to seek stakeholder input that encouraged their participation

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals

- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey specifically with non-traditional groups
- Other (Input from State Board of Agricultural Research and Education)

Brief explanation.

Building linkages with the public enables us to discover information about community/county/district/state assets and needs. Various methods for stakeholder input are utilized on an on-going basis. Advisory and commodity boards are used annually to identify issues and refine research and Extension programs. Examples include county extension advisory boards, Sustainable Agriculture Research and Education (SARE) advisory board, nutrient management advisory board, soil health advisory board, sugar beet research and Extension board, research extension center (REC) advisory boards, and the State Board of Agricultural Research and Education (SBARE). Input from stakeholders, the general public and from targeted audiences is used to develop our five-year plan of work and make adjustments to the plan based on crisis situations that may develop in the state, e.g. drought, flood, insect infestations, plant diseases, high-risk issues of youth, bioenergy economics, animal welfare issues. Using several methods and several venues to collect data ensure that high priority issues are identified, people that have self-interest in the issue are brought to the planning meetings, and the appropriate research project or educational program and design is developed to address the issue using a variety of delivery methods. Of special note, an external review of NDSUE was conducted in 2017 at the request of the SBARE and the ND legislature. Additional information about the review is contained in section III, 2(B), 3.

2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Needs Assessments
- Use Surveys

Brief explanation.

The State Board of Agricultural Research and Education (SBARE) is charged by the state legislature 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 NDSUE; annually evaluating the results of research and extension activities and expenditures; and report the findings to the North Dakota Legislative Council and the State Board of Higher Education. SBARE actively solicits input from all sectors of agricultural interests (i.e. different commodity and livestock groups), other community interests, and meets throughout the state to gather input.

County commissioners actively participate in county extension program reviews with extension district directors. The county extension budgeting process also results in strong engagement from

county government. Local needs are also identified through input from county advisory councils, crop and livestock improvement boards, soil conservation districts, 4-H councils, and area focus groups. End of program surveys are used at most county and state extension programs to identify emerging clientele needs.

In 1992, the North Dakota Department of Human Services and NDSUE were legislated by the North Dakota state legislature to form a statewide Family Life Education Committee. 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. 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.

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. NDSUE is represented on this coalition. Networking among these professionals is invaluable, in addition to the legislative work.

2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals

Brief explanation.

The process of collecting stakeholder input was described above in III, 2(A),1 along with the process in identifying stakeholder groups and individuals.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities

Brief explanation.

The State Board for Agricultural Research and Education (SBARE) is charged with developing ongoing strategies for the dissemination of research information through NDSUE;

annually evaluating the results of research and Extension activities, recommending faculty and support positions and areas for program expenditures; and reporting the findings to the North Dakota Legislative Council and the State Board of Higher Education. Their findings directly affect the research and Extension budgeting process. The SBARE priority research and Extension needs can be found at: http://www.ag.ndsu.edu/sbare/. Commodity councils and research-education boards guide research and Extension program priorities and activities through their call for proposals, proposal review sessions, and grant funding. The staff from the seven RECs use the input from winter meetings with their advisory boards to set program direction for research projects and Extension programs at their centers.

SBARE conducted a comprehensive review of NDSUE, which included 30 recommendations to endorse existing practices or for improvements. NDSUE received the input and has begun to implement changes in response to the review. The review and progress in response can be found at https://www.ag.ndsu.edu/sbare/ndsu-extension-service-comprehensive-review.

During county staff evaluations each year, program input is gathered from commissioners who take part in the staff evaluations. This arrangement helps assure that extension programs are grass roots driven and are focused on local issues and needs. County commissioner input is also critical in determining the staffing level and emphasis within county Extension offices as 50 percent of the Extension agent's salary is paid by the county.

The statewide Family Life Education Committee, 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 determine the availability of designated funds which direct 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 which in turn affect budgeting.

Stakeholders are frequently important contributors on the search committees of Extension state specialists and county commissioners are partners in the search committees and interview process of county staff. A SBARE member or another stakeholder is often a representative on faculty position searches.

Brief Explanation of what you learned from your Stakeholders

Our stakeholders are very supportive of the NDAES, NDSUE and their activities and efforts. It is very important that Federal capacity be maintained to ensure NDSU's continued success. The NDAES and NDSUE enhance the lives of the citizens of ND.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{No Data Entered}	{No Data Entered}	{No Data Entered}	{No Data Entered}

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	3412241	0	2585615	0
Actual Matching	3412241	0	2585615	0
Actual All Other	6501912	0	8607115	0
Total Actual Expended	13326394	0	13778345	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	0	0

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Cropping Systems

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	15%		5%	
103	Management of Saline and Sodic Soils and Salinity	5%		15%	
202	Plant Genetic Resources	5%		5%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	5%		10%	
205	Plant Management Systems	20%		10%	
211	Insects, Mites, and Other Arthropods Affecting Plants	15%		10%	
212	Pathogens and Nematodes Affecting Plants	15%		15%	
213	Weeds Affecting Plants	5%		10%	
216	Integrated Pest Management Systems	5%		10%	
405	Drainage and Irrigation Systems and Facilities	10%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	45.5	0.0	51.5	0.0
Actual Paid	41.9	0.0	43.4	0.0
Actual Volunteer	5.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1098593	0	1334024	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1098593	0	1334024	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1766838	0	3617680	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Meet with stakeholder groups to gather input and refine program directions.
- Develop improved crop cultivars acceptable to growers and those who use and process the grain.
- Present crop research results at field days and grower meetings, popular press, radio and TV spots, web sites, and educational classes and workshops to foster producer adoption.
- Evaluate the effectiveness and impact of the Extension programming.

2. Brief description of the target audience

The targeted audience will include but not be limited to:

1. Crop producers in North Dakota and surrounding states
2. Crop consultants and agricultural advisors
3. Commodity groups
4. Crop improvement associations
5. Extension personnel
6. Agribusiness and agricultural finance personnel
7. Government agencies

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	327825	29950144	9367	302527

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	52	63	115

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of acres of hard red spring wheat and number of acres of durum wheat grown in North Dakota are seeded with ND AES derived cultivars.
2	Number of farmers adopting new practices to achieve highly productive crops in a changing environment.
3	Number of farmers adopting new practices to improve pest management in a changing environment.

Outcome #1

1. Outcome Measures

Number of acres of hard red spring wheat and number of acres of durum wheat grown in North Dakota are seeded with ND AES derived cultivars.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1677500

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Crop producers, crop consultants, nutritionists, crop consultants, commodity groups, Extension personnel, Crop Improvement Associations, and end users are directly impacted by the number of acres planted with NDAES derived cultivars. NDAES derived cultivars are environmentally adapted to flourish in the upper great plains thereby increasing wheat production and enhance the economic sustainability of the region.

What has been done
Development of new and improved germplasm in 14 crops, including some with multiple market classes. Improved germplasm has improved resistance to abiotic and biotic stresses. The improved germplasm also has improved end use quality that is desired by those who use and process the harvested seed.

Results
The NDAES released two new crop varieties in 2018: ND18008GT soybean and ND Hammond flax.

The NDSU soybean breeding program developed ND18008GT. It is a glyphosate-resistant soybean variety with a relative maturity of 00.8, which makes it a good fit for the northern growing areas of North Dakota. This variety is tolerant to soybean aphid and resistant to race 4 of phytophthora root rot. It is sensitive to metribuzin herbicide.

The NDSU flax breeding program developed ND Hammond. It is a brown-seeded flax variety that is adapted to the north-central flax-growing region of the U.S. ND Hammond has high yield potential and medium maturity. It also has good oil drying quality and resistance to flax wilt. The

variety was named in honor of longtime NDSU flax breeder James Hammond, who made significant contributions to flax research.

ND Eagle Lentil. Seed was available for the first time in 2018 for ND Eagle, the NDAES 2016 lentil release. The NDSU pulse breeding program developed ND Eagle. It is an Eston-type small green lentil that has excellent agronomic performance. The variety has high yield potential in North Dakota environments and is simlar to CDC Viceroy. ND Eagle also has high seed quality, with no observations of speckled variants. To ensure genetic purity, these varieties are protected under Plant Variety Protection Title V and must be sold as a class of certified seed.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #2

1. Outcome Measures

Number of farmers adopting new practices to achieve highly productive crops in a changing environment.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Crop producers, crop consultants, nutritionists, crop consultants, commodity groups, Extension personnel, Crop Improvement Associations, and end users are directly impacted by a changing environment. Adoption of scientifically proven techniques and methods increases wheat production and enhances the economic sustainability of the region.

What has been done

NDSUE organizes meetings designed to provide the best and latest information on wheat production practices and marketing. One of these key educational programs that is specifically focused on wheat issues is: The Best of the Best in Wheat Production and Marketing. This meeting is offered in two locations in western North Dakota each year. In these meetings, research-supported recommendations that address the major production challenges of spring and durum wheat growers are presented. Furthermore, important principles and skills are reinforced with hands-on sessions. An effort is made to include the most recent research findings and focus on the most relevant topics that impact the profitability of wheat production. A similar meeting is held in eastern North Dakota that focuses on wheat and soybean.

Results

Based on the average annual yield increase that has been achieved in the last 15 years, we can estimate that more than 4 million bushels of wheat were produced in 2018 above that which was produced the previous year as a result of the adoption of improved varieties and management practices. At today's price cash price for wheat of $5.87 per bushel, this means that nearly 23.5 million additional dollars were earned by farmers in North Dakota over what would have been earned the previous year as a result of using better varieties.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #3

1. Outcome Measures

Number of farmers adopting new practices to improve pest management in a changing environment.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	3000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Each year, there are numerous crop pests (insects, diseases and weeds) and agronomic problems (early frost, drought, flooding and other situations) that can negatively impact North Dakota's crop production. Producers, agronomists of fertilizer/chemical/seed companies, crop consultants, state and federal agencies, field scouts and university extension and research workers need timely updates and the latest research on field crop pests, agronomy and weather problems to maximize crop yields and quality.

What has been done
The NDSUE Crop & Pest Report is a weekly summer newsletter, which includes many articles on the occurrence and management of crop pests, and agronomic updates on crops and soil conditions. These articles are written by NDSUE specialists. Valuable and timely information is described on crop pests, integrated pest management strategies, pesticide updates, agronomy, soil and fertility issues, new pest detections, important Extension meetings/Field Days, local field reports from 'Around the State' and weather forecasts. Anyone can easily access it via internet, Facebook, or sign up for the weekly electronic mail list.

Results
Readers of the Crop & Pest Report were comprised primarily of producers, agronomists of fertilizer/chemical/seed companies, university extension/research workers and crop consultants from 10 countries on five continents! The number of readers has increased 20 times to almost 5,000 readers today. As a result of this timely information, producers are making profitable crop management decisions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems
405	Drainage and Irrigation Systems and Facilities

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

There were no affects from external factors in 2018.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Acreage data for durum and spring wheat with NDSU released varieties was determined using a report published by the USDA-NASS.

Participants at recent Extension meetings were asked where they obtained information they used in selecting new wheat varieties. The three most common responses were: annual reports from the Research Extension Centers; a printed copy of the variety selection guide published by the Extension Service; and information obtained from meetings sponsored the Extension Service.
A yearly Qualtrics Survey on the **Crop & Pest Report**revealed the following results:

• 87% of readers state that **Crop & Pest Report** is the major source of information on pests, integrated pest management and crop production.
• 95% of readers indicated that the **Crop & Pest Report**provided timely information, and was a reliable source of unbiased science-based information.
• More than 97% of readers reported sharing information from the **Crop & Pest Report**with other professionals.
• An average of 82% of readers said that they i**ncreased their knowledge**on pests, integrated pest management or crop production.
• Readers indicated that they increased their **knowledge and/or changed their behavior**on the following topics:
  • 90% of respondents conducted pest identification;
  • 84% conducted pest scouting and used economic thresholds before making pesticide applications;
  • 80% used crop production guidelines;
  • 78% used and relied on NDSU's pesticide guides;
  • 75% used fertility management;
  • 70% used weather information; and
  • 64% used harvest guidelines.
• 63% of readers used additional NDSU resources to further research topics. Some

examples include: NDAWN, disease forecasting models, annual crop pest management guides, and extension publications.

• 59% of readers said that there was at least one article in the **Crop & Pest Report** that increased their profitability.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Natural Resources

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	25%		25%	
103	Management of Saline and Sodic Soils and Salinity	25%		25%	
205	Plant Management Systems	25%		25%	
405	Drainage and Irrigation Systems and Facilities	25%		25%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	16.0	0.0	14.0	0.0
Actual Paid	15.5	0.0	24.3	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
495859	0	690772	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
495859	0	690772	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
661565	0	1803419	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

1. Determine thresholds for salinity and sodicity to serve as management goals on affected soils
2. Produce systems to reclaim saline and sodic areas within farm fields
3. Determine the strengths and weaknesses of saline and sodic soil reclamation methods
4. Determine the interaction of salinity, sodicity and soil microorganisms
5. Survey and improve management recommendations for insect pests on the major crops
6. Devise improved range management methods to allow increased soil health in saline or sodic threatened soils
7. Provide improved guidelines to growers on best choice of crops for lands affected by salts or sodium
8. Translate scientific findings into practical producer applications and provide transformational education through workshops, field days and conferences, and resource materials
9. Conduct research on controlled drainage and subsurface irrigation to improve crop yield
10. Translate scientific findings into practical producer applications and provide transformational education through workshops, field days and conferences, and resource materials

2. Brief description of the target audience

The targeted audience will include but not be limited to:

1. Crop producers in North Dakota and surrounding states
2. Crop consultants and agricultural advisors
3. Commodity groups
4. Crop improvement associations
5. Extension personnel
6. Agribusiness and agricultural finance personnel
7. Government agencies

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	59309	2973079	1483	30031

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	12	6	18

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of farmers and landowners who understand the source of salinity and sodicity, and take steps to prevent their spread.
2	Number of farmers and ranchers who better understand the relationship between range plants, crop plants, ground water management, and salinity and sodicity management.
3	Number of farmers and landowners who better understand surface and sub-surface moisture management and how it impacts soil health and crop production management.

Outcome #1

1. Outcome Measures

Number of farmers and landowners who understand the source of salinity and sodicity, and take steps to prevent their spread.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1500

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil salinity and sodicity adversely affects farm productivity and profitability. Increasing farmer/landowner knowledge of how to reduce salinity and sodicity is very important to their future viability as farmers and productivity of the land.

What has been done
The Soil Health team maintains an active website and Twitter account that promotes ongoing programs, contains results of research and demonstration projects that are directed towards salinity and sodicity and advertises upcoming events, such as county meetings, regional meetings, and 'café talks' that farmers and others can attend. Active participation and sharing with other farmers and ag-consultants is encouraged at these events. Field days are hosted on farmer's farms who have incorporated recommended management strategies and demonstrate their effectiveness to others.

Results
These programs have reached over 1,500 farmers each year, and the number of growers adopting management practices to contain and reduce salinity and sodicity increases each year. There is still much to do, but the momentum continues to build.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
205	Plant Management Systems

405 Drainage and Irrigation Systems and Facilities

Outcome #2

1. Outcome Measures

Number of farmers and ranchers who better understand the relationship between range plants, crop plants, ground water management, and salinity and sodicity management.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1500

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Crop choice makes a difference in water use. Poor crop choice increases area of salinity, while more tolerant crops help keep saline areas in check and begin to reduce their effect to subsequent crops.

What has been done
The important of crop choice has been included in major events such as the Conservation Tillage Conference, Advanced Crop Advisor Workshop, Corn and Soybean grower meetings and the Soil and Soil Water Workshops, as well as the series of winter 'café talks' conducted last winter.

Results
Growers are beginning to understand that cultivating crops more tolerant to salinity in saline field areas is crucial to reducing salinity in fields.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
205	Plant Management Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #3

1. Outcome Measures

Number of farmers and landowners who better understand surface and sub-surface moisture management and how it impacts soil health and crop production management.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1200

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Excess rain has raised water tables, increased soil salinity and affected crop production in many areas of ND. Farmers have lost soil productivity, yields and economic return thus the interest in the use of subsurface drainage and water management.

What has been done
As in past years, a 2-day tile drainage design workshop was conducted in conjunction with the University of Minnesota Extension Service. Ten (10) presentations on subsurface drainage and sub-irrigation were presented at various venues across ND plus there were 5 farm and 6 office visits to solve site-specific problems.

Results
Over 650 people were educated on subsurface drainage and sub-irrigation issues. One of the presentations was testimony to the Agriculture Committee of the ND Senate, another presentation was made to Legislative Council, comprised of elected representatives from ND, SD, MN, Manitoba and Saskatchewan.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
405	Drainage and Irrigation Systems and Facilities

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities

Brief Explanation

There were no external factors which affected the outcomes of the planned programs.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Attendees indicated an increased understanding of how to address salinity and sodicity on farms and indicated a desire to improve their management strategies.
Growers are more knowledgeable regarding crop choices better suited for saline soils. Economics of crop choice is a driving force in grower decisions. Their grasp of the yield drag of salinity on certain crops and its effect on the profitability is a force that moves them to less profitable crops on paper that are more profitable when they grow them in saline-distressed acres.
Drainage design workshops were evaluated by the participants on a scale of 1-4.. Overall, the participants rated them 3.6 out of 4. The participants were asked to rate each design session and/or presentation using this rating scale:

1. Nothing was presented that I didn't already know.
2. Familiar with the topic but the review was useful.
3. I learned something new and useful.
4. I gained important insights and information that I can use on the farm or my job.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Livestock Systems

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
121	Management of Range Resources	25%		15%	
301	Reproductive Performance of Animals	30%		35%	
302	Nutrient Utilization in Animals	30%		35%	
305	Animal Physiological Processes	15%		15%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	21.0	0.0	21.0	0.0
Actual Paid	20.1	0.0	16.4	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
537933	0	354925	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
537933	0	354925	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
760840	0	1632329	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Educational programming will be conducted using a variety of methods including: face to face meetings, webinars, news releases, media interviews, in-service training programs, needs assessments, advisory boards, and social media. Research activities include livestock and forage research, laboratory activities, and pursuit of grant funds.

2. Brief description of the target audience

The targeted audience will include but not be limited to:

1. Livestock producers in North Dakota and surrounding states
2. Livestock consultants and agricultural advisors
3. Veterinarians
4. Commodity groups
5. Livestock improvement associations
6. Extension personnel
7. Agribusiness and agricultural finance personnel
8. Government agencies

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	115055	2415723	38352	24401

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	13	35	48

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of ND livestock producers with increased technical knowledge of practices to improve the efficiency of livestock production systems. Technical areas include reproduction, nutrition, environmental stewardship, and animal health.
2	Number of ND livestock producers with increased knowledge of practices to improve livestock stewardship practices and reproduction.

Outcome #1

1. Outcome Measures

Number of ND livestock producers with increased technical knowledge of practices to improve the efficiency of livestock production systems. Technical areas include reproduction, nutrition, environmental stewardship, and animal health.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The aftermath of sustained drought condition over the past few years impacted nearly every livestock operation in North Dakota in 2018. Severity ranged from slightly affected to extreme drought. Livestock producers, allied industry personnel, and main street businesses were all adversely affected. Local communities were impacted by reduced economic activity and psychological stressors related to drought conditions.

What has been done
Extension programming efforts included face to face meetings, news releases, farm and ranch visits, development of phone apps to estimate grazing capacity, and coordinating a variety of sample testing (feed and water) for affected livestock producers.

Results
Over 400 forage samples underwent nitrate quick tests, over 300 forage samples were collected and analyzed for nutrient content, and over 125 water samples were tested for total dissolved solids. Follow up consultations and recommendations prevented over 16,000 cattle from being exposed to toxic forages and over 8,000 cattle from being exposed to toxic water. This likely saved affected producers several million dollars in losses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
301	Reproductive Performance of Animals

302	Nutrient Utilization in Animals
305	Animal Physiological Processes

Outcome #2

1. Outcome Measures

Number of ND livestock producers with increased knowledge of practices to improve livestock stewardship practices and reproduction.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	40000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Livestock and environmental stewardship are important to the sustainability of farming and ranching in this region. Consumers are increasingly interested in understanding where their food is produced and that the food was produced in manner that shows care for the animals and the environment.

What has been done
Face to face meetings were held, bulletins were prepared, and social media (Facebook and Twitter) were used to inform livestock producers, consumers, and allied industry personnel about the importance of livestock and environmental stewardship. An advisory board offers guidance to the specialists involved in this program area.

Results
We have communicated this message to well over 40,000 people through the use of face-to-face, print, radio, tv, Facebook and website material. Over 90% of attendees reported the likelihood of using information that was presented, and participants reported movement from moderate and high level of knowledge. Our Feedlot evaluation tool indicates positive feedback with scores in the 4.1-4.3/5 range as to usefulness of disease and treatment education materials.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources

302	Nutrient Utilization in Animals
305	Animal Physiological Processes

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

There were no external factors that prevented the completion of the program.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Overall evaluation results indicated NDSU Extension was very responsive to producers adversely affected by drought conditions. Stewardship education continues to be a need. Producers are keenly interested in improved methods to manage their resources for improved sustainability and production.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Economic and Community Vitality

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
602	Business Management, Finance, and Taxation	35%		100%	
608	Community Resource Planning and Development	15%		0%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	50%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	22.5	0.0	13.5	0.0
Actual Paid	16.2	0.0	10.9	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
426741	0	205894	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
426741	0	205894	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
744736	0	1553687	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Educational programming will be conducted using a variety of methods including: face to face meetings, webinars, new releases, media interviews, in-service training programs, needs assessments, advisory boards, and social media. Research activities include develop new risk management tools for under served commodities. Educational activities include use of the real-time commodity training room, and training through the Rural Leadership North Dakota (RLND) program.

2. Brief description of the target audience

1. Crop producers in ND and surrounding states
2. Livestock producers in ND and surrounding states
3. Small business entrepreneurs
4. Agribusiness and agriculture finance personnel
5. Civic leaders
6. Commodity groups
7. Government agencies
8. extension communities of practice
9. Extension personnel

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	96977	1881500	2425	19005

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	5	0	5

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

Number of growers and industry personnel who utilize price risk management strategies, production risk management strategies, and financial risk management strategies.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	10500

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Risk management training is needed for lenders to make informed lending decisions, producers to mitigate declining commodity prices, and industry stakeholders to minimize risks and increase revenues.

What has been done
Agricultural Lenders Outlook: A one day conference was held in four locations within North Dakota. This Outlook is comprised of professional development sessions that help to prepare lenders for the upcoming agricultural loan renewal season.

Crop Insurance Conference: A one day conference was held for crop insurance agents from North Dakota, South Dakota and Minnesota for professional development.
Commodity Trading training sessions: Focused training in an actual commodity trading environment is provided for stakeholder groups and their members for professional development and market forecasts.

Results
Respondents to multiple surveys indicate that 84% of attendees utilized information gained at these training in their day-to-day activities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
602	Business Management, Finance, and Taxation
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #2

1. Outcome Measures

Number of individuals involved in new leadership roles as a result of leadership programs.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	200

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Dakotans have been concerned with the shortage of leaders in communities and organization across North Dakota, especially in rural areas. Over 8,300 volunteer organizations need leaders in North Dakota at the local, regional and state levels.

What has been done
Since 2003, the 18-month Rural Leaders North Dakota cohort program has been offered to increase leadership skills. A total of 144 alumni of this program provide support to their communities and serve in leadership roles across the state. These alumni continue to meet to network, learn and address North Dakota issues.

The Growing Leaders Short Course, a five-session leadership training was provided in one North Dakota community in 2017. This program includes the completion of a community or organizational betterment project.

Lead Local, a one-day 'boardsmanship' training was provided in five communities in 2017. This program is designed to build confidence in participants who serve on boards, councils and committees by helping them understand meeting basics, parliamentary procedure, and handling conflict in groups.

Youth Lead Local, a one-day 'boardsmanship' training for youth was developed and provided in the tri-county region of southeastern North Dakota. Youth learned basic leadership skills and completed local projects.

Building Tomorrow's Leaders, an eight-session youth leadership training was developed and piloted in one location before extending statewide. This program helps young people understand their leadership style, effective communication, managing conflict, team building, the political

process and networking.

Two statewide conferences were held in 2017; Inspiring Legendary Leaders and the 2017 Rewriting the Rural Narrative conference. These conferences were designed to help inspire, educate and provide networking opportunities to participants. Over 200 people attended these two conferences in 2017.

Results

A total of 144 individual have completed the 18-month RLND program. The most recent cohort evaluated shared goals of getting more involved in the community, serving on additional boards, running for public office and having a better understanding of issues.

Eight Growing Leaders Short courses have been held in 15 communities with 163 participants since inception. The session held in 2017 included 23 participants who developed action plans for six community projects including a fishing derby, community garden and community event promotion for adults and youth. A community organization and event document was then developed to help citizens identify the opportunities in the community.

Lead Local was held in five sites in North Dakota in 2017 with 94 participants. Participants reported being involved in 246 volunteer groups to assist their local communities and organizations. As these organizations are run more efficiently based on new knowledge and skills, the value of the time saved (based on one hour per organization per monthly meeting x independent Sector Value of Volunteer hour) is $74,981 for participants involved in the program last year.

Youth Lead Local and Building Tomorrow's Leaders trained over 65 youth and encouraged them to get involved.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)
- Other (Available capital)

Brief Explanation

There were no external factors that prevented completion of the program.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

A total of 383 ag lending professionals attended the 2018 conference. Of these, 281 were from North Dakota, 97 from Minnesota, three from South Dakota and one from Texas. Attendees represented commercial banks, credit unions, Farm Credit Services, USDA-Farm Service Agency, North Dakota and Minnesota Farm Business Management instructors, NDSU Extension agents, and crop insurance agents. Of evaluation respondents, 100% those attending indicated they were either likely or very likely to use the crop market update, 95% were either likely or very likely to use the farm financial information, 91% were likely or very likely to use the land value information and 82% were likely or very likely to use the farm bill information.

As of the end of 2018, 170+ individuals have completed the 18-month RLND program. Over $4 million has been invested in the 100+ RLND projects, five businesses have been started, and nine individuals have run for public office. Over 80% of alumni have taken leadership for various community projects and 20 of them have been asked to serve on boards and councils they had not served on before. During the 2016 election, three RLND participants were elected to statewide offices and are currently serving

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

4-H Youth Development

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	50%		0%	
806	Youth Development	50%		0%	
	Total	100%		0%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	22.5	0.0	0.0	0.0
Actual Paid	22.5	0.0	0.0	0.0
Actual Volunteer	53.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
474470	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
474470	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
851041	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

A variety of different programs and methods are used to reach North Dakota youth, including after school programming, 4-H military partners, club learning experiences and science related events such as the 4-H Aerospace Event, Geospatial and Robotics Technologies for the 21st Century (GEAR-Tech-21) Camp, 4-H Camps, Kids Power, Children, Youth and Families at Risk (CYFAR) Project, 4-H Robotics Event, 4-H Film Festival and National 4-H Youth Science Day.

In an effort to increase the science related knowledge and confidence level of county staff and volunteer leaders several trainings are offered. These trainings have used the inquiry based and experiential learning methods for youth.

2. Brief description of the target audience

North Dakota 4-H Science programs reach more than 12,000 youth with hands-on learning experiences to prepare the next generation of science, engineering, and technology leaders. A special effort is made where Native American youth on four reservations are targeted as an underserved audience.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	18431	286568	276477	1432839

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of 4-H youth indicating they would like to have a job related to science.
2	Number of 4-H youth indicating that they think science will be important in their future.

Outcome #1

1. Outcome Measures

Number of 4-H youth indicating they would like to have a job related to science.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	587

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Dakota's situation parallels that of the United States. There are opportunities to hold a job in a science related field. However, there is a shortage of individuals to fill these positions. Thus, the job market is turning to educational entities to assist them in generating a pool of young people who may be interested in holding science related positions. However, in order to interest youth in science, they must first be engaged in science. Consistent with 4-H's mission and purpose, this engagement should be done through hands-on, experiential learning opportunities. Therefore, 4-H is the perfect fit to provide non-formal, experiential learning opportunities to educate youth about science. Hopefully this engagement will encourage them to pursue science related career opportunities.

What has been done
The North Dakota 4-H program offers several science related educational opportunities. They include National 4-H Youth Science Day, Agriculture in the Classroom type programs, Robotics challenges, Aerospace Camp, Scratch computer programming, Rube Goldberg Challenge, and other science based 4-H project work. Additionally, there are hands-on science trainings for agents and adult volunteers.

Results
Adult volunteers reported from program evaluations that they plan to use more science activities at 4-H club meetings. Afterschool program staff reported that youth were more motivated because they were involved in hands-on, active learning activities as part of the program. Youth who completed 4-H science Common Measures surveys reported that they like to do science activities outside of school, would like a career in science, and that 4-H science programs have helped them work as a team and be leaders.

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

Outcome #2

1. Outcome Measures

Number of 4-H youth indicating that they think science will be important in their future.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	675

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Dakota's situation parallels that of the United States. There are opportunities to hold a job in a science related field. However, there is a shortage of individuals to fill these positions. Thus, the job market is turning to educational entities to assist them in generating a pool of young people who may be interested in holding science related positions in the future. However, in order to interest youth in science, they must first be engaged in science. Consistent with 4-H's mission and purpose, this engagement should be done through hands-on, experiential learning opportunities. Therefore, 4-H is the perfect fit to provide non-formal, experiential learning opportunities to educate youth about science. Hopefully this engagement will encourage them to pursue science related career opportunities and understand that science will be important in their future.

What has been done
The North Dakota 4-H program offers several science related educational opportunities. They include National 4-H Youth Science Day, Agriculture in the Classroom type programs, Robotics challenges, Aerospace Camp, Scratch computer programming, Rube Goldberg Challenge, and other science based 4-H project work. Additionally, there are hands-on science trainings for agents and adult volunteers.

Results
Adult volunteers reported from program evaluations that they plan to use more science activities at 4-H club meetings. Afterschool program staff reported that youth were more motivated because

they were involved in hands-on, active learning activities as part of the program. Youth who completed 4-H science Common Measures surveys reported that they like to do science activities outside of school, would like a career in science, 4-H science programs have helped them work as a team and be leaders, and science will be important in their future.

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

There were no external factors that prevented the completion of the 4-H science program.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The North Dakota 4-H program is in the early stages of fully utilizing the 4-H Common Measures resources to evaluate program impact. 4-H Common Measures is a national library of evaluation instruments available to 4-H staff nationwide. The instruments are applicable to a broad range of programs and have been tested for reliability and validity. One of the "libraries" of instruments includes items specifically addressing science programming. 4-H Common Measures instruments were used to assess National 4-H Youth Science Day, and they are now being used to assess all science programs. This will allow us to conduct a complete evaluation of science programs for 2018.

• 75% of North Dakota youth who participated in the Incredible Wearable/ National 4-H Youth Science Day experiment reported it made them more interested in science.

• 80% of North Dakota youth who participated in the Incredible Wearable/ National 4-H Youth Science Day experiment reported the experiment helped them work as a team.

• After attending an aerospace day camp, 90% of youth reported that they would be interested in an aerospace career.

• 85% of youth who attended a Rube Goldberg day camp reported that they would be interested in a career in engineering.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Health and Human Development Education

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
607	Consumer Economics	20%		0%	
703	Nutrition Education and Behavior	30%		0%	
724	Healthy Lifestyle	30%		0%	
806	Youth Development	20%		0%	
	Total	100%		0%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	33.0	0.0	0.0	0.0
Actual Paid	30.4	0.0	0.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
378645	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
378645	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1716892	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Educational programming will be conducted using a variety of methods including: face to face meetings, webinars, news releases, media interviews, in-service training programs, needs assessments, advisory boards, and social media.

School-based curricula, including "On the Move to Better Health", "Banking on Strong Bones", and "Go Wild for Fruits and Vegetables" will continue to be used with children. Community-based programs, including the "Nourish Your Body" series of lessons will be implemented for adults. A "Designing Your Succession Plan" curriculum will be developed and used at multiple sites across ND, eventually culminating in a succession planner "certification" program.

2. Brief description of the target audience

The targeted audience will include but not be limited to:

1. Children, teens and adults targeted in educational programming related to nutrition, food safety and health.
2. Crop and livestock producers in North Dakota and surrounding states
3. Agricultural, agribusiness and financial advisors
4. Accountants and attorneys
5. Commodity groups
6. Extension personnel
7. Government agencies

3. How was eXtension used?

eXtension has been used in the "Nourish Your Body" program; the "Ask an Expert" function has been used by practioners to find information.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	197307	3032918	30361	183813

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	19	0	19

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

Number of adults and children participating in education curricula conducted in formal and informal situations reporting improvements in one or more healthy lifestyle behaviors.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	11000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Childhood obesity has more than tripled in the past 30 years. According to the Youth Behavior Risk Surveillance Survey (2015), 42 percent of North Dakota students in grades nine to 12 consumed vegetables less than one time daily, 75 percent of adolescents were not physically active at least 60 minutes per day, and about 12 percent were not physically active 60 minutes on at least one day during the seven days prior to the survey. Some researchers consider children to be "overfed" but "undernourished." Obese children are at higher risk for cardiovascular disease, with 70 percent showing at least one risk factor for cardiovascular disease. Obesity also increases the risk for diabetes, stroke, cancer and osteoarthritis.

What has been done
On the Move to Better Health is a five-week school-based curriculum for fifth-graders. It is based on MyPlate, the current icon for good nutrition. The curriculum aims to increase fruits, vegetables and calcium-rich foods in the diets of children and improve fitness habits. Parents receive newsletters and participate in goal setting and other family-based activities. "On the Move Junior" is a five-week school-based curriculum for second-graders. It is based on MyPlate, the current icon for nutrition, and includes children's storybooks and hands-on activities. The curriculum aims to improve the variety of healthful foods that children consume, especially the amount of fruits and vegetables they consume. It also aims to improve fitness habits. Parents receive newsletters and participate in goal setting and other family-based activities. "On the Move" Cooking School and "On the Move After School" were added to the series.

Results
In the 'On the Move to Better Health' program, which reached more than 3,000 children during the year, 55 percent drank less pop, 52 percent chose more healthful snacks, 50 percent ate more fruits and vegetables and 57 percent increased their daily physical activity. In surveys with

parents, 80 percent read the newsletter, 37 percent of families increased fruit consumption, 28 percent increased their vegetable consumption and 33 percent set a weekly goal.

In the 'On the Move Junior' programs, 85 percent of children ate more fruit, 75 percent ate more vegetables, 80 percent tried a new food and 87 percent engaged in more physical activity. About 79 percent of parents read the weekly newsletter, 60 percent reported their children were asking questions about food, 47 percent were requesting healthy snacks and 40 percent tried a new food at home.

After participating in the 'On the Move Cooking School', 96 percent of 455 children from 18 counties indicated confidence in reading a recipe, 94 percent were confident using measuring tools and 79 percent used nutrition labels to guide choices.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle
806	Youth Development

Outcome #2

1. Outcome Measures

Number of participants in the "Succession Planning" program initiating the development a succession plan for their business.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	300

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Farm and ranch transition planning is a critical need for North Dakota producers. Surveys completed by commodity groups, producers and financial institutions place a high priority on meeting the need for educational programs addressing farm and ranch succession planning which encompasses business, retirement, transition and estate planning. Our state's farmers and

ranchers now average roughly 60 years of age, and many are looking toward retirement and transitioning their business.

What has been done
NDSU Extension Service held Design Your Succession Plan workshops in 11 North Dakota counties. Seventy-two percent of participants were 50 years and older. This program emphasizes the need to start a succession plan, communicate with family, and be prepared to work with professionals to create a customized succession plan that secures the farm/ranch legacy.

Results
Participants Reported:
-"I appreciate the efforts taken by the staff as it is important for those who have someone to transfer their farm to. More farmers should do this."
-"It was very informative and will be extremely useful to get us started. Thanks."
-"I really feel that this is a great course! I'm looking forward to a second round with other family members."

4. Associated Knowledge Areas

KA Code	Knowledge Area
607	Consumer Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

There were no external factors that prevented the completion of the program outcomes.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The "On the Move to Better Health" nutrition and physical activity-based intervention program successful in promoting healthful behavior changes, specifically increases in fruit and vegetable intake, among students. Data analysis showed a significant difference between pre- and post-survey means and responses for both fruit and vegetable intake. After the program, 51.95% (n=1,446) of participants reported increasing their consumption of fruits and vegetables, while 42.98% (n=1,213) reported that their fruit and vegetable consumption stayed the same.

The "Succession Planning" program has been very successful. Evaluation data included:

• Of 129 participants eligible to give feedback, 96 evaluations were completed for a response rate of 74%.
• 63% of all participants intend to transition their business in under five years with 91% planning to transition in under ten years.
'Succession Planning' participants were asked to rank their confidence level regarding certain items pertaining to succession planning on a scale of 1-4 (1=strongly disagree and 4=strongly agree) in a retrospective pre/post-survey, mean scores are reported below:

• I have confidence in my ability to evaluate the viability of my business by using future projections. (before: 2.54 / after: 3.35)
• I have confidence in my ability to shape the future of the farm/ranch. (before: 2.5 / after: 3.41)
• I have confidence in my ability to plan and conduct a family business meeting. (before:2.6 / after: 3.4)
• I have confidence in my ability to problem-solve if there is a conflict. (before: 2.61 / after: 3.32)
• I have confidence in my ability to gather the information I'll need when meeting with a professional. (before: 2.72 / after: 3.7)

Key Items of Evaluation

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
0	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.