The annual productivity growth rate in ND agriculture was 2.29 percent per year based on the crop and livestock output production growth from 2000-2010. The ROI to agriculture research in ND over the period 1960-2011 was 24.9%. These results, comparable to other studies, are very robust and suggest that agriculture research in ND is attractive and exceeds that of most of the rest of the country. The ROI has some variability for numerous reasons. The distribution of returns is shown in Figure 1, and this reflects a 95% confidence interval between 13 to 37%.
Estimates of the internal rate of return to public investments in agricultural research

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<tr>
<th>Study</th>
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<th>Publication</th>
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(‘Innovation, Agricultural Productivity and Sustainability in the United States,’ OECD Food and Agricultural Review 2016, p. 242)
Estimates of the internal rate of return to public investments in agricultural research

- Significant and high returns to research, with median estimate of 40%, with a range of 21-67%
- Spending on ag research generates benefits averaging 40% per year, lasting several decades
- Present value: benefit-cost ratio of 20:1
- The studies also found benefits of public ag research were widely shared among farmers and consumers, in more abundant and lower-cost food

(‘Innovation, Agricultural Productivity and Sustainability in the United States,’ OECD Food and Agricultural Review 2016, p. 243)
Flows of research costs and benefits over time


(‘Innovation, Agricultural Productivity and Sustainability in the United States,’ OECD Food and Agricultural Review 2016, p. 241)
Examples of NDAES research impacts:

• In the 1990s Extension agent Keith Brown and producer Dick Roland did studies on replacing the ½ wheat ½ fallow rotation in Western North Dakota - at that time, there were over 6 million acres of summer fallow in the region

• AES specialists Blaine Schatz (CREC) and Kent McKay (NCREC) added additional research

• Today Western North Dakota is a thriving, diverse ecosystem with small grains and legumes and less than 300,000 acres of summer fallow, adding soil health, longevity and dollars to Western ND

• 6 million acres in production adding $200 per acre to the economy is $1.2 BILLION per year
Examples of NDAES research impacts:

• Research efforts on beef cattle nutrient requirements have impacts on production and economic efficiencies for all beef cattle in ND. ‘2016 Nutrient Requirements of Beef Cattle’ was utilized world-wide by producers, nutritionists, and scientists to more accurately formulate beef cattle diets. Conservative estimates in ND indicate a 5% improvement in feed efficiency could save ND producers over $25 million in feed costs, annually.

• In 2015, 53% of ND’s spring wheat acreage was sown to varieties developed by NDAES. A variety released from NDSU’s spring wheat breeding program has an estimated economic impact to the state ranging from $69 to $284 million over the period it remains in the marketplace, compared to other varieties. (Dr. Bill Wilson)

(North Dakota Agricultural Experiment Station, Main Research Station Impacts)
• 50% of ND acres sown to two-rowed barley were done so with varieties developed by NDAES in 2015 (American Malting Barley Assoc. survey)

• Changes in U.S. brewing industries are resulting in increased demand for two-rowed barley; 25% of ND’s 1.12 million barley acres were sown to two-rowed barley

• $2.24 million additional dollars in revenue could be earned by two-rowed barley growers in North Dakota if 50% of those 1.12 million acres were sown with NDAES varieties at a $0.25/bu premium over six-rowed barley

• According to a study done by the University of Minnesota, this work has advanced NDAES ahead of them by approx. 30 years

(North Dakota Agricultural Experiment Station, Main Research Station Impacts)
• 4 years ago Sarah and Jason Lovas started raising wheat again; good yields but only 12% protein content

• Talked to local Extension agent, learned of ‘88-91 study by Schatz and Endres: applying 10 gpa of 28% + 10 gpa of water at post-anthesis boosts protein 0.5-1.0 points

• Implemented this 3 years ago

• Average about 88 bu/acre, 14.5% protein

• Average protein increase of 0.8% over the check strips

• Average profit $10 per acre
Varieties owned by NDSU Research Foundation (RF), recently entered into agreement with NDCSIA

- Desire to enhance market penetration
- Requires NDCSIA to expand marketing and promotion of licensed varieties
- Exclusive license of varieties
  - Specialty crops excluded
- NDCSIA working with commodity groups to develop promotion fees
- Amount retained by RF remains same (no increase)
One in four people are employed in the ag sector

- Farmers
- Ranchers
- Veterinarians
- Sale barns
- Grain elevators
- Fertilizer plants
- Chemical applicators
- Arial applicators
- Feed companies
- Seed companies
- Seed cleaners
- Seed treatment companies
- Chemical companies
- Vet supply companies
- Veterinary clinic staff
- Farm implement dealers
- Farm equipment manufacturers
- Agricultural parts suppliers
- Oil seed processors
- Sunflower processors (bird food, kernels)
- Soybean processors (edible)
- Food ingredient processors
- Dry edible bean processors
- Pea & Lentil processors
- Steel bin manufacturers
- Ag facility manufacturers
- Ag lenders
- Ag insurance
- Federal ag – USDA
- State agricultural Extension
- Trucking and Transportation companies
- Railroads
- Pharmaceutical companies
- Ag research / contract research companies
- Ethanol companies
- Byproduct brokers & merchandizing companies
SBARE Priorities for NDSU Extension

**Extension Operational Support**

Additional operating funds to sustain local delivery of Extension programs and services and to maintain the effectiveness and efficiency of Extension specialists in delivering high impact programs for North Dakota.

**Extension Web and Digital Delivery**

One-time funding request will add temporary support to overhaul and reimagine NDSU Extension’s online presence.

*Extension websites:*

- 953,897 users
- 3,546,916 page views
Agribiome Initiative

- Knowledge of the human microbiome has revolutionized medicine and nutrition and fueled the $45 billion probiotics industry. A similar revolution is happening in agriculture, where the microbiomes of crops, soils, and livestock (the Agribiome) are being harnessed to increase productivity, efficiency, safety, and quality. Food production must double to meet the global population demand by 2050, despite depleting water resources, shrinking farmland, and rising input costs. The inputs that drove intensive crop production in the 20th century have diminishing returns and may lead to unintended environmental consequences, so the next agricultural revolution must be based on a more sustainable approach that harnesses microbiomes to increase water- and nutrient-use efficiency, stress tolerance, disease resistance, and production of high quality food and agricultural products.
• Microbes were an untapped resource until recently, with just a tiny fraction of the microbial world accessible by traditional research methods. Major scientific breakthroughs now allow all microbes to be readily identified, creating a platform for innovation through the discovery of microbes with desirable traits in agriculture (agricultural probiotics). While all sectors of agriculture can benefit from the development of probiotics, the potential gains in crop and livestock production are as exciting as they are highly relevant to North Dakota. The North Dakota Agricultural Experiment Station (NDAES) has several areas of strength that can support an Agribiome initiative focused on crop and livestock production. These include:

• Strong programs in plant breeding, genetics, and genomics; plant nutrition; plant pathology; soil health; and water quality.
• Strong programs in animal nutrition, physiology, husbandry, genetics, and health as well as range sciences and forages.
• Facilities to study microbiomes from lab to field or herd scale.
• Infrastructures to connect researchers with producers across the state to understand problems, identify solutions, and translate discoveries into practical applications.
Precision Agriculture

• The future of farming will be ‘smart farming’ that incorporates computer systems to make real-time decisions based on digital data (artificial intelligence) of the conditions in the field. The smart farm is expected to have increased production efficiency, reduced labor costs, and better net return, while providing more protection to the environment. These technological innovations in precision Ag are taking place at a fast place, with new technologies coming to market every year. A 2018 survey by Glacier Farm Media (www.farmmedia.com) indicates that 89-90% of farmers surveyed felt that using sensors, digital data, and autonomous systems can decrease production cost, increase yield, and/or save time. Unmanned Aerial Systems (UAS), for example, used in precision agriculture are expected to contribute up to 80% of the $80 billion UAS market by 2025.

• North Dakota has a large concentration of companies involved in precision Agriculture that seek partnerships with NDSU to expand and field validate their technologies. Agricultural producers need research-based information on profitable precision Ag technologies to adopt, best utilize, or optimize these technologies on individual farms, and learn how to convert the huge amount of data collected in the field to appropriate decisions.
SBARE Priorities for the Agricultural Experiment Station

*Precision ag (continued)*

• Precision Ag research at NDSU will benefit the North Dakota agricultural industries by increasing crop yield and efficiency of food production, and reducing inputs. Adopting precision Ag can result in economic benefit of as much as $165/A in North Dakota (Schimmelpfennig, USDA, 2016)

• Precision Ag can improve both soil health and water quality by minimizing runoff of inputs. It also can improve grain quality through the timely and precise application of inputs to the developing crops, resulting in additional benefits to the producers and environment.
SBARE Priorities for the Agricultural Experiment Station

Enhancing Research Capacity
- Support for Operations to Offset Inflationary Costs

• Agricultural research is a labor-intensive effort spanning a number of disciplines to improve the profitability or farming, ranching, and agribusiness enterprises. A strong focus of the research effort at the NDAES is to work on providing solutions to problems that affect crop and livestock production, improve production efficiency, product quality, and environmental sustainability.

• Operating costs for research activities continue to increase. Scientists at the RECs and the Main Station receive high levels of grant funding from a variety of agencies. However, inflationary pressures on operating costs, such as state motor pool leasing, equipment repairs, and supplies, reduce our ability to respond to current and future production-related issues affecting crop and livestock producers. In addition, it is critically important that our scientists remain relevant by incorporating new technologies into our research programs, which allows the NDAES to emulate the rapidly changing technology environment that exists in 21st Century Agricultural systems.
SBARE Priorities for Capitol Improvement Requests

- **Agronomic, Pathology, and Soils Field Lab facility**  
  (Waldron Hall replacement) - Waldron Hall was built in the mid-1950’s to house the field laboratories for the wheat breeding programs in the Department of Agronomy. An addition was built in the mid-1960’s to house approximately another 16 scientists from the Departments of Agronomy and Plant Pathology. The building now houses field labs and wet labs for nearly 60 scientists, each with numerous projects, at the Main Station involving a number of disciplines. Many of these labs are shared and the seed drying, cleaning, and storage facilities needed by our scientists are now grossly insufficient and a health hazard to anyone working in the facility. A new facility is needed to provide our scientists a safe environment to conduct their research, as well as processing, cleaning, and storing seed.

- **Seed cleaning facility WREC** - Seed cleaning facilities at WREC need to be replaced. Current facilities are antiquated, lack reliable capability to ensure high quality seed, are slow, and inefficient. Current facilities were designed to handle cereal crops and have limited/no capability of cleaning pulse crops and other fragile seed that are in high demand. These facilities pose considerable worker safety issues. A fundraising effort is underway.

- **Equipment Storage Sheds** – Purchasing and/or leasing expensive field equipment is an investment that the AES needs to protect. Storing expensive research plot equipment, such as tractors, seeders, and combines, outdoors reduces the life of the machines and can compromise the sophisticated electronics typically used on equipment.

- **Precision Ag/ ABEN Facility** - A field lab with large indoor space and accessibility to perform research, demonstration and field testing of Ag equipment and technology. Additional infrastructure would include a 100-ft long soil bin to test soil-tool interaction of tillage equipment and a high speed wind tunnel to test nozzles for spray drift and droplet size distribution of active ingredients under various weather conditions. The facility would be critical in conducting research and training on agricultural technologies such as unmanned aerial surveillance, variable rate application systems, precision planting, and other technology used in crop and livestock systems.