



THE UNIVERSITY OF NEBRASKA
INSTITUTE OF AGRICULTURE
AND NATURAL RESOURCES:

A GENERATOR OF POSITIVE ECONOMIC IMPACTS FOR NEBRASKA

PREPARED FOR:
The University of Nebraska Institute of
Agriculture and Natural Resources

PREPARED BY:
Battelle
Technology Partnership Practice

February 2007

Battelle
The Business of Innovation

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List of Abbreviations

BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
BNF	Building Nebraska Families
BQA	Beef Quality Assurance
Bt	<i>Bacillus thuringiensis</i>
CASNR	College of Agricultural Sciences and Natural Resources
DNA	deoxyribonucleic acid
ECB	European corn borer
ERS	Economic Research Service
FEMA	Federal Emergency Management Agency
FTE	full-time equivalent
FY	fiscal year
HACCP	Hazards Analysis and Critical Control Points
IANR	Institute of Agriculture and Natural Resources
IAPC	Industrial Agricultural Products Center
IENICA	Interactive European Network for Industrial Crops and Their Applications
IRM	integrated resistance management
kg	Kilogram
NASS	National Agricultural Statistics Service
NCA	Nebraska Cattlemen’s Association
NCBA	National Cattlemen’s Beef Association
NDMC	National Drought Mitigation Center
NebraskaEDGE	Enhancing, Developing, and Growing Entrepreneurs
RAAT	Reduced Agent and Area Treatment
UN	University of Nebraska
UNL	University of Nebraska-Lincoln
USDA	U.S. Department of Agriculture
WCR	western corn rootworm

Executive Summary

INTRODUCTION

The citizens of Nebraska understand that agriculture, agribusiness, and the communities that sustain these industries, are of great importance to the economic and social health of Nebraska. However, it is perhaps less well known that the importance of these industries to the State of Nebraska has been growing in recent years. Analysis by the Nebraska Policy Institute concluded that:

*In 1990, 25 percent of the state's total employment was directly or indirectly the result of agribusiness activity. In 2002, agribusiness supported nearly 366,000 full and part-time jobs, representing 31 percent of the state's total employment. No doubt, agriculture and agribusiness remains firmly entrenched as Nebraska's number one industry.*¹

Agriculture and agribusiness are key drivers of Nebraska's economy—accounting for 31 percent of state employment.

With Nebraska's economic and social health so strongly tied to agriculture and agribusiness productivity and profitability, it is not surprising that the University of Nebraska Lincoln (UNL) has dedicated the Institute of Agriculture and Natural Resources (IANR) to sustaining, growing, and improving agriculture and agriculture-related enterprise in the state. Today, IANR provides dedicated research, education, and extension activities relating directly and indirectly to agriculture, agricultural processing, food processing, natural resources, and the sustainability of Nebraska's communities and families. The extent of UNL's commitment in this regard through IANR is evidenced by the fact that fully 47 percent of UNL's fiscal year (FY) 2005 sponsored projects supported by external funds were conducted under the umbrella of IANR—a total of \$52.7 million.²

IANR affiliated researchers and research teams conduct almost half of all research volume at UNL.

The Institute's mission states that:

IANR focuses its research, teaching, and extension education expertise in agriculture and food programs, natural resources, families, and communities to help Nebraska grow an environmentally sound, economically viable, and socially responsible future.

As this mission statement illustrates, IANR strives to be a holistic organization—working to integrate research, teaching, and extension activities to provide pragmatic programs that sustain, expand, and develop the agriculture-based economy and social fabric of the state. IANR achieves its mission by working to solve an array of critical issues affecting Nebraskans' daily lives and the state's future. The advanced research, educational offerings, and programmatic activities of IANR empower people and communities to solve problems, stimulate economic development,

¹ Lamphear, C. "The Importance of Agriculture and Agribusiness to Nebraska's Economy." Nebraska Policy Institute. March, 2006.

² Institute faculty and staff can have appointments in the following: Agricultural Research Division, College of Agricultural Sciences and Natural Resources, College of Education and Human Sciences, Extension Division, Conservation and Survey Division, Nebraska Forest Service, and Nebraska Statewide Arboretum.

and improve lives. Specifically, IANR works to improve the economy and quality of life for all Nebraska citizens by helping to:

- ***Create a knowledgeable workforce*** with significant intellectual capacity within scientific fields that drive the economic progress and productivity of the agbioscience industry
- ***Improve profitability and productivity*** of agricultural producers, processors, and food industries in Nebraska
- Research, develop, and ***create new and improved products*** for Nebraska producers and industry
- Research and develop ***value-added applications*** for agricultural products, by-products, and waste streams
- Research and undertake extension activities to ***ensure animal and plant health and promote Nebraska biosecurity***
- Research and undertake extension activities to ***promote human nutrition and health***
- Research and undertake extension activities to help ***ensure the sustainability of the state's natural resources***
- Research and undertake extension activities focused ***on developing improvements in food safety***
- Research and undertake extension activities for ***strengthening Nebraska's children, youth, and families***
- Undertake extension activities focused on ***sustaining and revitalizing Nebraska's communities and stimulating economic development and quality-of-life improvements.***

IANR works to improve the economy and quality of life for all Nebraska citizens.

Through its research, teaching, and extension activities, IANR has a substantial track record in contributing to Nebraska's overall quality of life and positively influencing the state's economy. Furthermore, as knowledge, intellectual capacity, and technology become the foremost drivers of modern economies, IANR's teaching activities within the College of Agricultural Sciences and Natural Resources (CASNR) likely will continue to grow in their importance to Nebraska's economic progress. Strengthening the lives and communities of Nebraska through research, teaching, and extension activities is key to the long-term competitive sustainability of Nebraska's high standard of living.

Through its research, teaching, and extension activities, IANR has a substantial track record in contributing to Nebraska's overall quality of life and positively influencing the state economy.

IANR's past and present contributions to economic progress in the State of Nebraska are the subject of this study and report. In evaluating IANR's broad range of impacts, Battelle has used both quantitative and qualitative approaches, including IMPLAN³ software that determines the effect of economic variables through input-output analysis. In evaluating specific research programs and extension initiatives conducted by IANR, Battelle conducted multiple in-depth interviews with IANR administrators, directors, faculty, and key stakeholders. The goal of this study is to provide

a detailed examination of the economic and social impacts that IANR is generating for the State

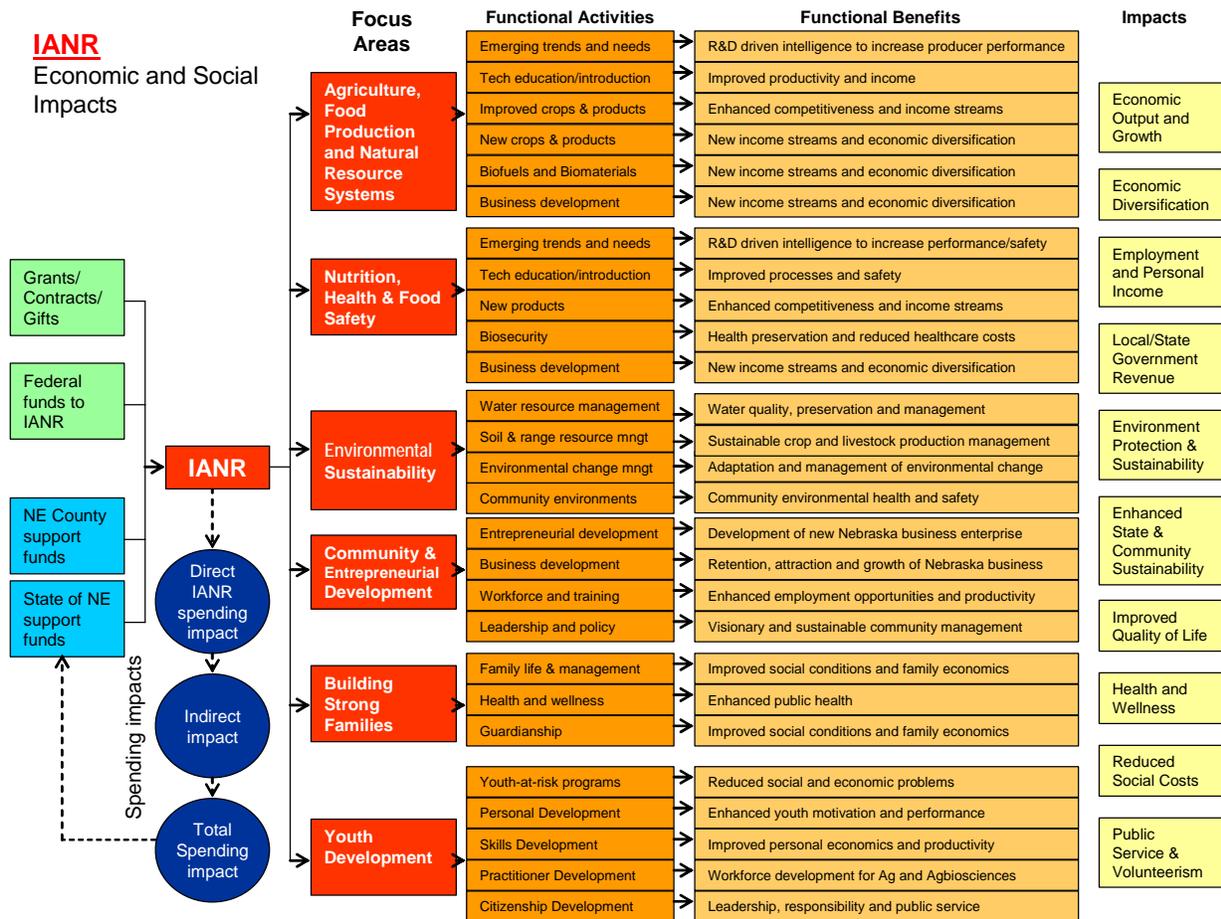
³ Minnesota IMPLAN Group, 1725 Tower Drive West, Suite 140, Stillwater, MN 55082.

of Nebraska. As Battelle’s review of IANR will indicate, the Institute is positively impacting the State of Nebraska in significant ways through its diverse activities.

THE IMPACT OF IANR’S PROGRAMS AND ACTIVITIES

Figure ES-1 graphically illustrates the multiple dimensions of IANR’s widespread impact on Nebraska. IANR’s daily activities in **research, teaching, and extension** provide what economists term “forward linkage impacts”—impacts that accrue from the actual scientific, education, and extension activities undertaken by the Institute.

Figure ES-1: The Scope of IANR Impacts



IANR’s forward linkage impacts can be defined in two ways:

- First, as IANR’s contributions to maintaining the health of the economic and social fabric of the state. IANR programs and activities maintain the economic viability of Nebraska’s agriculture, associated processing, and value-added industries and sustain the quality of life within the State of Nebraska.

- Second, as IANR’s impact on expanding Nebraska’s economy, diversifying the Nebraska economic base, and building community and individual wealth. IANR programs and activities focus on critically important activities such as the development and introduction of improved crop varieties, new alternative crops, and new value-added products and processes, including work in biofuels, biobased materials and products, and advanced food and nutraceutical products.

The substantial forward linkage impacts of IANR are delivered through six primary focus areas of activity:

1. Work to sustain, expand, and develop new products around agriculture, food production, and natural resource systems
2. Programs to improve nutrition, health, and food safety
3. Initiatives designed to sustain the health of Nebraska’s environment
4. Actions focused on community-level economic development
5. Programs that help to build strong and sustainable Nebraska families
6. Initiatives to encourage development of Nebraska’s children and youth.

Each area contains multiple individual programs and initiatives that build and sustain Nebraska’s economic and social well-being. These functions and their associated benefits and impacts are illustrated in Figure ES-1, and the many impacts being achieved in these areas are highlighted throughout this report.

Overall, it is readily apparent that IANR is dedicated to sustaining and enhancing agriculture and agriculture-related economic activity in Nebraska, and that IANR is significantly impacting the economy of the state through its research, teaching, and extension activities. Given the University of Nebraska’s long-standing land-grant track record in the agriculture and natural resource sectors and the dedicated resources of IANR applied to improving and growing the agriculture and agribusiness sectors of the state economy, IANR’s work has a powerful annual impact on state output in these sectors.

IANR’s research, teaching, and extension activity works to sustain the economic viability of Nebraska industries and communities and to expand the economy via the development of new products and technologies for Nebraska producers.

For example, Battelle analyzed the effect that every 1 percent increase in total agricultural production would have on the State of Nebraska. As highlighted within the report, while it is highly likely that IANR’s programmatic activities and research endeavors would generate considerably more than a 1 percent gain in agricultural output in the state on an annual basis, a conservative 1 percent estimate serves as a baseline for considering the significant effects of agricultural productivity on the Nebraska economy. Therefore, the impact of a 1 percent agricultural production increase in Nebraska is shown in the following text box.

The Economic Impact of a 1 Percent Increase in Agricultural Output in Nebraska

Using the IMPLAN input-output analysis system to calculate on an annual basis the impact of a 1 percent increase in agricultural production, the following is determined:

- A direct 1 percent increase in agricultural production in the Nebraska economy would equate to **\$117.3 million annually.**
- **Total (direct and indirect) economic output would increase by \$215.1 million annually.**
- Total value added would equate to \$80.9 million annually.
- Labor income generated for Nebraskans would be \$46.6 million annually.
- **1,544 jobs would be created in the state annually.**

It also should be noted that expanding the agricultural sector could benefit every county in the state. Agriculture and associated processing industries are highly diffused across every Nebraska county; therefore, the direct and indirect effects of expansion in the sector are felt much more widely than with more narrow, geographically focused sectors.

It is important to note that, in addition to IANR’s research and extension activities that result in the economic impacts outlined above, IANR’s teaching mission fulfilled through CASNR provides the knowledge-based workforce that meets the needs of the agbioscience industry’s 1,544 jobs created by each 1 percent increase in agricultural production. For instance, in the 2006–2007 academic calendar year, CASNR enrolled 1,303 students in its undergraduate program, 72 percent of whom were in-state residents, and an additional 660 graduate students in both its master’s and doctoral programs.⁴ These highly trained graduates are providing the knowledge base for Nebraska’s agbioscience economy, with 78 percent of graduates remaining within the State of Nebraska upon completion of their degrees.⁵

78 percent of CASNR’s graduates are retained within the State of Nebraska, providing a highly skilled, cutting-edge workforce for the state’s agbioscience industrial base.

Finally, it is important to note that the State of Nebraska’s annual appropriation to IANR in FY 2005 totaled \$71.6 million, indicating that IANR has to positively impact state agricultural output by only 0.33 percent per year to cover its state appropriation. As shown in some of the categorized IANR impact examples below, the impact of IANR’s activities is likely many times higher than this—thereby providing the state with a very significant return on its investment.

Impact Category: Agriculture, Food Production, and Natural Resource Systems

From basic science in molecular biology, biochemistry, and genetics to highly applied work in plant breeding, agricultural engineering, and biomaterials, IANR focuses on the science and further development of agriculture and agribusiness. **In this functional impact area, IANR undertakes fundamental work to ensure the economic viability and sustainability of existing Nebraska agriculture and ag-related sectors and to expand the agriculture-based economy in the state by introducing new technologies, crops, and value-added products.**

⁴ UNL Admission’s website.

⁵ “Annual Report of UNL Graduates 2004-2005.” Prepared by UNL Career Services.

IANR's many activities in the area of agriculture, food production, and natural resource systems can be separated into six subcategories:

- **Emerging Trends and Needs**—IANR scientists, researchers, and extension professionals provide intelligence, planning, and strategic advice to producers of agricultural and related products. Through research and extension activities, IANR boosts agricultural and related industry profitability by providing timely advice on crop varieties, crop management issues and strategies, agricultural and market economics, water resource and environmental management, emerging livestock health issues, and potential new technologies and value-added products.

IANR provides state-of-the-art advice and insight regarding emerging trends, opportunities, and issues.
- **Technology Introduction and Education**—Agriculture operates at the confluence between environmental sciences, the biosciences, and engineering disciplines. As such, progress in agriculture and ag-based industry is highly influenced by technological advancements in these disciplines. Researchers at IANR are constantly working to develop new crop varieties, disease and pest management tools, animal and livestock health products, agricultural equipment, irrigation technologies, and agricultural processing technologies. IANR is critically important to developing, understanding, and introducing those technologies best suited to increasing agricultural productivity in Nebraska. Through the unique combination of research and extension, IANR develops and evaluates the latest technologies and innovations and educates and trains Nebraska's producers in their adoption and use.

IANR develops, introduces, and trains Nebraskans in new R&D-based technologies to keep Nebraska producers at the forefront of modern industry practice.
- **Improved Crops and Products**—Nebraska has a highly diverse agricultural environment, characterized by a wide range of climate, soil, and other factors influencing ag production. IANR is important functionally to developing, evaluating, and introducing improved crops and technologies to keep Nebraska's producers at the leading edge of productivity. Through improved crop varieties, crop and livestock management technologies, and agricultural and production equipment, IANR ensures consistent progress in productivity enhancement in agricultural production, processing, and value-added activities.

IANR research constantly works to improve existing Nebraska crops and products, helping to keep the state ahead of growing international and domestic competition.
- **New Crops and Products**—With the increasing impact of globalization affecting commodity agriculture prices, IANR must engage in research leading to the introduction of new crops and value-added products for Nebraska, thereby providing fresh income streams for producers and processors and diversifying the agriculture-related economic base in the state.

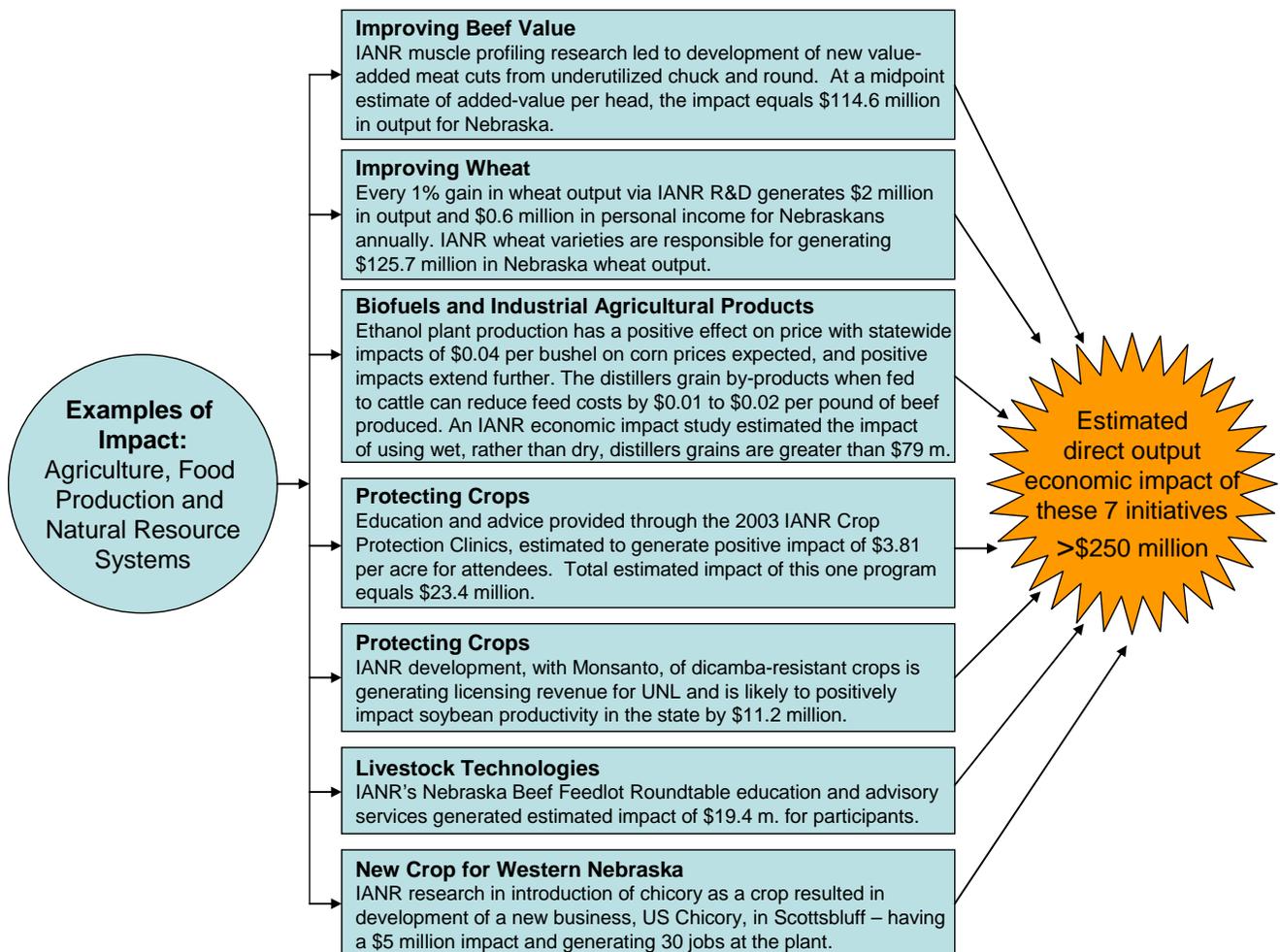
IANR generates entirely new products and technologies helping to expand and diversify Nebraska's economic base.

- **Biofuels and Biomaterials**—While agriculture is still primarily focused on food production, the finite nature of fossil fuels and fossil-fuel-based materials (such as plastics) combined with rising fossil-fuel prices are spurring activity in applying agricultural output to fuel and materials production. Nebraska has a strong position in ethanol production from corn, and IANR is working to develop and evaluate more efficient biofuel production pathways and technologies and to develop value-added products from agricultural waste streams and by-products.
- **Business Development**—IANR is also working with producers and processors to develop enhanced productivity and profitability from existing business operations and to assist in developing new lines of business.

IANR is leading the way for Nebraska to be at the forefront of advancements in biofuels and renewable bio-based resources.

While it would be impossible to quantify the economic impact of every program and activity that IANR undertakes, it is important to highlight key examples of programmatic impact. Examples of IANR research, teaching, and extension activities within agriculture and food production leading to readily observable impacts are shown in Figure ES-2.

Figure ES-2: Examples of IANR Economic Impacts from the Agriculture, Food Production, and Natural Resource Systems Focus Area



The agricultural bioscience (agbioscience) sector is a knowledge-based industry cluster driven by innovation in the life sciences. When researchers, scientists, and engineers make new discoveries in plant and animal genetics, healthcare, ecology, or nutrition, the entire industry can change. Continuous innovation and change characterize this dynamic industry and lead to economic opportunities. Nebraska's agbioscience sector is a vibrant, robust, and extremely important component of the state's economy. IANR is also focused on cutting-edge research within new growth opportunity areas to help increase Nebraska's economic diversity and wealth. The ability of IANR to transfer its scientific, technical, and research capabilities to the state's agbioscience industrial base has significant impact on the health and vibrancy of the economy.

For example, IANR scientists and researchers are currently pushing Nebraska forward in the biorenewables arena—whereby agricultural crops form the basis of new industries and new forms of bio-based economic development. Biorenewable resources represent a new pathway to realizing economic development and higher-value products from plant and animal biomass, and the following examples show that IANR is playing an important and expanding role in the development and growth of biorenewable industries for Nebraska.

Furthermore, this vibrant industrial sector must have a knowledgeable and skill-based workforce in order to maintain its competitiveness. In response to this growing need, CASNR has revised 18 of its 22 majors in the past 5 years, with the revisions reflecting changes in industry's ever-evolving needs.

Biofuels and Industrial Agricultural Products

Nebraska has established a solid foothold in the ethanol production industry (using predominantly corn as the feedstock); and IANR is working on biodiesel, biobased value-added chemicals, and biobased materials. IANR is engaged in this endeavor through multiple scientific pathways, including working in plant sciences on desirable characteristics in feedstock crops; improving production engineering; developing value-added uses for production by-products and waste materials; and investigating the impacts of ethanol, biofuels, and biomaterials on commodity prices and agricultural economics.

Currently, Nebraska is at a production cost advantage in ethanol versus competing states (except for Iowa which it is at a production cost parity). Key advantages for Nebraska are its strong corn production and beef livestock production industries, allowing for a very efficient biofuel production operation to be developed whereby livestock and ethanol operations can be located near one another to benefit from by-product synergies. Beef operations produce waste products that can produce methane gas to power the ethanol refining process. In turn, the wet distillers grains can be fed to the proximate cattle (with the feeding of wet grains removing the cost of drying grains for shipment). Other states have far less congruency in their cattle and corn production and thus have less potential to realize the benefits of an integrated operation using methane and wet distillers grains for efficiency gains.

The potential for the integrated operation model is being pursued next to the ARDC in Mead, in collaboration with the Mead Cattle Company. At Mead, the development is called the E3 BioFuels Complex (operated by E3 BioFuels, LLC), which incorporates an ethanol plant powered by biogas from the adjacent cattle operation. The ethanol production plant is sized to precisely match the cattle operation and, with the input of 7 million to 10 million bushels of corn, will produce 20 million to 24 million gallons of ethanol each year. By powering the biorefinery with 100 percent biogas, the net energy balance of ethanol is greatly increased versus traditional production methods—again indicating the opportunity for Nebraska to consolidate its natural agricultural advantages to build a significant and efficient industry.

Development of Agricultural Value-Added Products

IANR's Food Processing Center works to advance the value-added food manufacturing industry by partnering on technical and business development from idea through ongoing market support. The Center works with the agbioscience industry of the State of Nebraska by offering technical assistance in areas such as:

- **Product Development**, including concept/prototype development, ingredient functionality and development, line extensions and reformulations, and shelf life extension.
- **Laboratory Testing**, including bromate analysis, starch analysis, printed microarrays, and mycotoxin analysis.
- **Market, Business, Entrepreneurial, and Economic Analysis Assistance**, including market research, funding proposal assistance, economic and feasibility analyses, and strategic planning.
- **Pilot Plant Assistance**, which includes services such as extrusion, dehydration, dairy production, modified atmosphere and vacuum packaging, tortilla and chip processing, meat and poultry processing, wet products processing, and bakery processing.

Through its array of activities, the Food Processing Center is transferring value-added scientific knowledge to Nebraska agbioscience companies, helping them to maintain a comparative advantage over their ever increasing global competition. Mark Haskins, Founder and President of MBA Poultry, has stated "The Team at the UNL Food Processing Center has been an integral part of MBA Poultry's success story to say the least. They have been with us in the beginning, aiding us in pioneering the air-chilled process that is unique to not only Nebraska but the United States as well. They have provided us the data to substantiate many of the claims and attributes of our niche product. They have been instrumental in identifying challenges and in turn have designed processes to control and manage these types of issues."

Biofiber-Based Textiles

Synthetic fibers, such as nylon, rayon, dacron, and acetate, are major consumers of scarce oil resources in their production. However, natural organic fibers are available as substitutes, and more are being developed. IANR researchers are focusing on the use of agricultural by-products to produce alternative natural fibers. Considerable progress has been made in using cellulose-rich material (such as corn stalks and husks, sorghum, and soybean plants) as sources of such fiber. A proprietary process for fiber extraction has been developed by IANR researchers that results in fibers with greater quality and durability versus cotton, the standard natural product.

The new Nebraska by-product-based biofiber is predicted to cost \$0.57 per pound to produce and carry a retail value of \$1.00 per pound. The research team has calculated that enough agricultural by-product materials are produced each year in Nebraska to produce 1 million pounds of the biofiber. Thus, **enough feedstock exists to potentially fuel a \$2 billion value-added business for Nebraska from waste products.**

Impact Category: Nutrition, Health, and Food Safety

IANR not only expands the bioagricultural-based economy of Nebraska, it also has many initiatives that work to protect agriculture, agribusiness, and consumers from biological, toxicological, and even terrorist threats to food security and consumer health. Maintaining a safe and secure supply chain, from production to consumption, is a prime objective of IANR. Food safety problems, such as pathogen outbreaks in the meat industry, can severely damage major components of the Nebraska economy—so IANR is on the frontlines of prevention, with

research, teaching, and extension related programs focused on food safety, biosecurity, and advanced processing technologies.

Nutrition and health are also exceptionally important areas of focus for research, teaching, and extension activities. Within agricultural production, IANR works, for example, to optimize livestock nutrition and health. IANR is also active in food science and nutrition work focused on maximizing nutrient retention in processing and in advanced activities related to producing functional foods, nutraceuticals, and potentially pharmaceuticals through plant and animal pathways. Thus, IANR's work in nutrition, health, and food safety works to secure and protect the existing agriculture and food industry in the state and to expand the sector's productivity and product output through the introduction of new food and nutrition products and value-added opportunities.

IANR's work in nutrition, health, and food safety works to secure and protect the existing agriculture and food industry in the state and to expand the sector's productivity and product output through the introduction of new food and nutrition products and value-added opportunities.

IANR research and extension teams also ensure that Nebraska's producers and processors receive up-to-date information and technological insight surrounding food safety, nutrition, and health impacts. IANR undertakes research activities to develop new technologies and processes to enhance existing food and nutrition products and to introduce new products to diversify and expand the economic base. Plus, IANR provides a range of programs dedicated to enhancing business processes and developing new businesses in the nutrition, health, and food safety arenas.

Examples of IANR research, teaching, and extension activities related to nutrition, health, and food safety leading to readily observable impacts are many. The following examples illustrate some of the positive impacts being generated for Nebraska.

Food Safety and Security Training

Held in 2002, IANR training was provided to 114 food industry representatives and two regulatory agency representatives. Participants contacted the IANR program leaders noting that the information from this program **saved an estimated \$500,000 in potential recall costs and unknown amounts of potential lawsuit payouts from consumer reactions.** Subsequent to completion of the program, 19 attending companies continued to work with IANR for further information and follow-up on allergen control strategies. It should also be noted that IANR's internationally regarded allergen research program has had successes resulting in intellectual property generated at the university, most notably in allergen testing products.

Beef Quality Assurance

Bolstering consumer confidence in the quality of beef is a high priority. Programs on Beef Quality Assurance (BQA) provide training on production and management techniques that help avoid quality defects and safety issues with beef and boost consumer confidence in beef and beef products. IANR reports that, since 1998, demand for BQA-certified beef has increased threefold. **In 2000 meat packers contracted for 52,000 head of BQA-certified Nebraska corn-fed beef and agreed to pay a premium of \$16 per head for these certified cattle (an impact of \$832,000).** Premium quality, certified beef programs have now spread further; and positive economic impacts for Nebraska producers have no doubt increased significantly.

Negative Economic Impacts of Foodborne Illnesses

U.S. Food and Drug Administration research indicates that seven of the most common foodborne pathogens cause between 3.3 million and 12.3 million illnesses each year in the United States and result in up to 3,900 deaths. If foodborne pathogens caused illness in Nebraska at a rate proportional to its share of the U.S. population (0.59 percent), between 19,470 and 72,570 foodborne illnesses would harm Nebraskans each year and about 23 would die. In a 1995 study, U.S. Department of Agriculture (USDA) researchers estimated the negative monetary losses of the seven leading pathogens at between \$6.5 billion and \$13.3 billion annually, or between \$19.5 million and \$38.4 million annually in Nebraska. **It is clear, from these estimates, that the work of IANR in promoting a safer food supply holds significant value for the state in terms of offsetting negative costs and human suffering.**

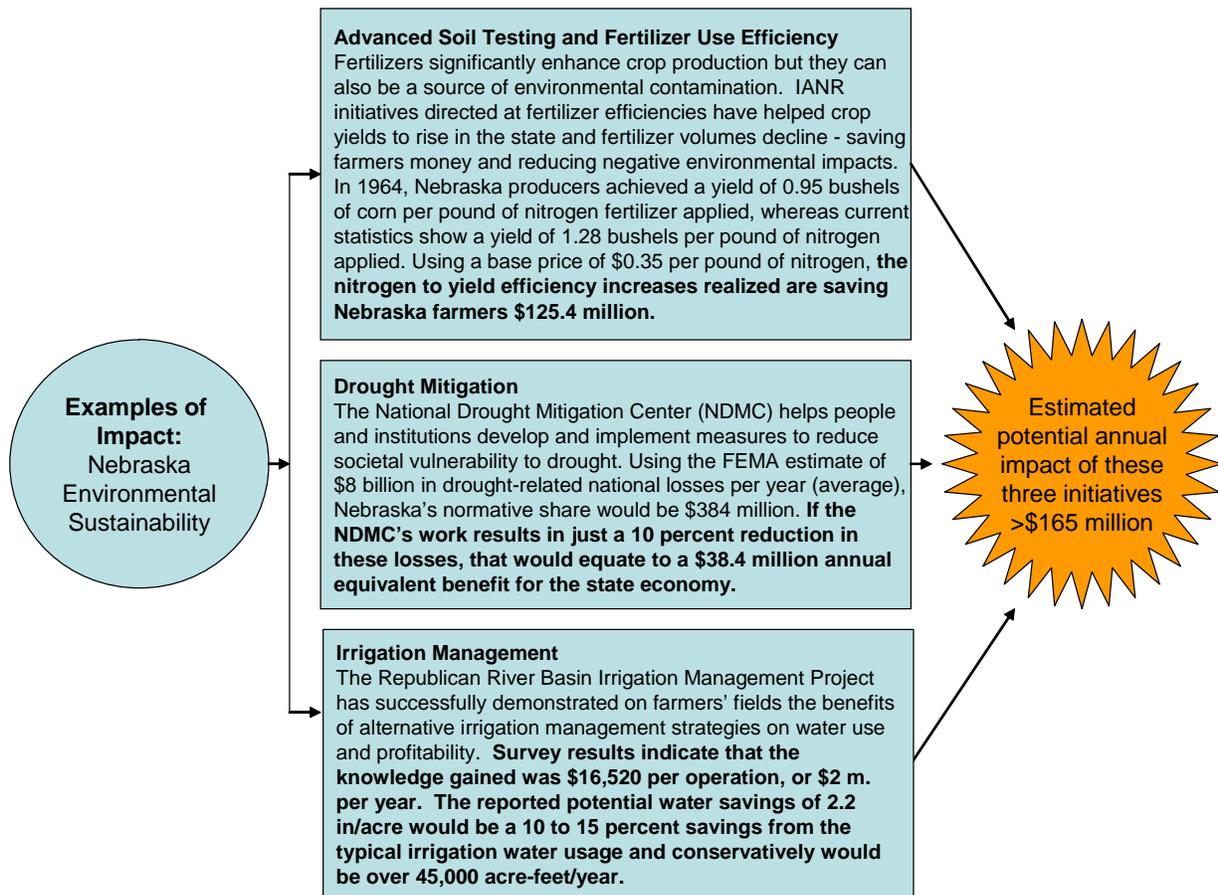
Impact Category: Environmental Sustainability

In a state that depends on its environment, not only for quality of life but also as the underpinning of its agriculture-based economy, the work of IANR in environmental sustainability and preservation is of critical importance. IANR is highly active in this area, with initiatives focused on such issues as water availability and quality, agricultural waste management, and fertilizer and pesticide reduction opportunities. IANR work is not only focused on the broad rural environment, but also on the urban environment and associated community sustainability issues.

IANR work focuses on rural and urban environmental sustainability and is of critical importance to the state.

Examples of IANR research, teaching, and extension activities related to environmental sustainability leading to readily observable impacts are illustrated in Figure ES-3.

Figure ES-3: Examples of IANR Economic Impacts from the Environmental Sustainability Focus Area



Impact Category: Community & Entrepreneurial Development

IANR is focusing its research, teaching, and extension efforts to help local business communities, current and emerging community leaders, and elected and appointed government officials investigate and create viable options for economic and community development by

- Increasing the knowledge base for individual and community decisions;
- Developing clientele skills necessary to achieve their individual business and community goals;
- Fostering entrepreneurial opportunities within the agriculture industrial sector; and
- Helping create an inclusive decision-making environment.

Examples of IANR research, teaching, and extension activities related to community and entrepreneurial development leading to readily observable impacts are captured in the following program summaries.

The NebraskaEDGE Program

The NebraskaEDGE—Enhancing, Developing, and Growing Entrepreneurs—Program provides community-based entrepreneurial education for individuals interested in starting or managing a small business. Since 1993, EDGE has provided training for more than 2,000 people. Survey results of participants indicate the following:

- 71 percent of the existing or new businesses have increased their business volume, and 55 percent increased the types of products sold or services rendered to customers.
- 33 percent increased the number of employees, 34 percent increased hours of operation, and 16 percent increased number of locations.
- 42 percent of the participants had a business idea when they enrolled in EDGE. Of these, 43 percent have since opened that business or anticipate it in the near future.
- 26 percent used their business plan completed during the EDGE program to apply for financing. Of those, 93 percent obtained a loan. The average loan amount was just over \$151,000, with amounts ranging from \$4,800 to \$1.2 million.
- The average gross annual sales for 2003 were just over \$486,000.
- 73 percent of the businesses that reported increased gross annual sales from 2002 to 2003 attributed this change to their participation in the EDGE program.
- 45 percent believe their business provides them with a higher standard of living since they took the EDGE course.
- 98 percent said the EDGE program should continue to provide business and management educational programs to Nebraska's small business owners.

Overall, the program has proven to be a very effective way to influence the economy of rural Nebraska by supporting entrepreneurial development and growth, which in turn increases the number of jobs in the state and the wealth of the citizens of Nebraska.

Impact of Nebraska e-Commerce Education

Many small businesses need specialized training to capitalize on new technology advancements. To meet this need, IANR has established Electronic Retailing—Selling on the Internet workshops. As a result of these workshops, just over one-third of the businesses that participated currently have a Web site. Most of the others plan to create one soon. When asked how they would adapt e-tailing to their businesses, participants responded as follows:

- 54 percent plan to determine how to facilitate e-business in their current operations.
- 45 percent plan to include e-mail as a marketing tool.
- 38 percent plan to submit domain names to search engines.
- 34 percent plan to contract with Web designer to build store.
- 16 percent plan to learn Web design software program to build and maintain store.
- 14 percent plan to use a template to build a Web site.
- Only 3 percent said they won't create a Web store.

By developing this training, IANR is helping to ensure that these local Nebraska businesses are able to reach new markets, remain competitive, and benefit from the expanded opportunities.

Impact Category: Building Strong Families

Given the importance of the family in child development and thereby the inherent strength of Nebraska's communities, IANR has focused on programming aimed at building stronger families. The Building Strong Families program helps Nebraska families build strengths, face challenges, and make choices. IANR's Building Strong Families program aims to develop accessible resources to conduct research-based youth and family programming in communities across the state. This research, based on the Family Strengths Perspective, identifies those qualities that strengthen family well-being, including appreciation and affection, positive communication, spiritual well-being, commitment, enjoyable time together, and the ability to manage stress and crisis effectively.⁶

The Building Strong Families program is designed as a grass-roots effort to meet local-level needs. The goals of the program, and their related activities, are as follows:

- Goal 1: Teach families to strengthen and improve relationship skills in family and community.
- Goal 2: Help communities identify family needs and design and implement plans to meet those needs.
- Goal 3: Teach families to access, use, and manage resources wisely.

Examples of IANR research, teaching, and extension activities related to building strong families leading to readily observable impacts are captured in the following program summaries.

Impact of the Building Nebraska Families Program

Building Nebraska Families (BNF) provides education for the hard-to-employ rural clients of Nebraska's welfare-to-work program. By learning family management and life skills through IANR programs, participants are better able to manage their families and resources while securing and sustaining employment.

In FY 2004, 51 BNF graduates entered the program with a mean average monthly income of \$483.43 and graduated from the program with a mean average monthly income of \$1,202.27. This increase of more than \$700 a month can be directly attributed to the participants indicating upon graduation that they feel more positive about their life and, as a result,

- Are setting goals and paying bills on time and in full;
- Are keeping a record of how they spend their money;
- Have a plan of how they will spend or save their money each payday;
- Use exercise to work off stress; and
- Feel less stressed.

⁶ Stineet, N., and DeFrain, J. *Secrets of Strong Families*. Boston: Little Brown. 1985.

Preventing the Credit Card Blues at 22

This program is a classroom-based educational initiative directed at high school seniors. The program was initially created as a result of a need expressed through focus group interviews conducted by IANR throughout southeast Nebraska in 2001. The focus groups identified credit card use as an item of great concern to local residents. IANR's desire to reach youth with information about credit is supported by studies conducted by a national lender, Nellie Mae, which surveyed student applicants in 2000 and found that 78 percent of those applying for loans already had at least one credit card. The average number of cards held by these students was three, and the average amount of credit card debt was \$2,748. Approximately 13 percent of card holders were found to owe between \$3,700 and \$7,000, and 9 percent owed more than \$7,000.

Within the first 3 years of the program, with a conservative estimate of modifying the behavior of only 10 percent of the student body reached through the program, Nebraska youth have the potential to decrease their average debt by more than \$1.15 million in comparison with their national peers. Also, since this number continues to grow with each class that participates in the program, this economic benefit will continue to increase annually as more youth are taught these important credit concepts.

Medicare-Approved Prescription Drug Card Educational Program

The 2003 Medicare Reform Act created dramatic changes in Medicare, including the first-ever prescription drug benefit. Changes prompted questions, confusion, and concerns for Medicare recipients and their families. They needed information about the Medicare-approved Prescription Drug Discount Card Program. This program was designed as a temporary response that provided transitional prescription cost assistance before the first-ever prescription benefit program in January 2006.

Evaluations completed by staff who participated in this quick-response effort, as well as information collected about the program, show that it helped hundreds of Nebraskans understand and enroll in the drug card program from November 2004 to September 2005. For example,

- At least 530 Medicare recipients enrolled for Medicare-approved drug cards due to this effort.
- Nebraska Medicare recipients realized a potential savings of at least \$820,320 as a result of this educational campaign.
- More than 430 Medicare recipients received individual assistance with the enrollment process.
- More than 200 civic groups and organizations were contacted about the Medicare-approved Prescription Drug Discount Card Program.
- About 840 people requested worksheets and used them to enroll themselves or others, including more than 450 adult children or caregivers.
- At least 28 on-site sessions helped Medicare recipients complete worksheets and submit information.

Impacts of Nutrition Training Programs

IANR administers two federal programs, the Family Nutrition Program and the Expanded Food and Nutrition Education Program (EFNEP). Both assist Nebraska citizens in acquiring the knowledge, skills, attitudes, and changed behavior necessary for nutritionally sound diets and in contributing to their personal development and the improvement of the total family diet and nutritional well-being. As a result of this educational intervention, participants adopt new behaviors that improve the nutritional quality of their diets, reduce the incidence of chronic disease, increase safe food-handling practices, and stretch their food dollars.

National studies⁷ have found that these activities successfully deliver an educational program that leads to sustainable behavior change. EFNEP impact data from 1997 showed that 89 percent of adults improved nutrition practices, 84 percent improved food resource management practices, and 67 percent improved food safety practices. The benefits are far reaching, not only improving the nutrient intake of a vulnerable population, but also building the basic life skills of those moving into the workforce. In addition, **improvements in early childhood nutrition will allow children to achieve their full cognitive-development potential. Results of a cost-benefit analysis showed that, for every \$1 spent on EFNEP, a potential health care savings of \$2 to \$17 may result from the prevention or delayed onset of nutrition-related chronic diseases and conditions among participants.**⁸

Impact Category: Youth Development

Through youth development activities, adolescents acquire the cognitive, social, and emotional skills and abilities required to navigate life. The experiences of adolescence vary for every youth; and his or her development is influenced by culture, gender, and socioeconomic class, as well as by formal and informal settings, such as home, church, and school, and extracurricular activities and similar relationships, such as with peer friends, work colleagues, parents, teachers, and mentors. Young people develop their personalities and life skills based on these early adolescence experiences.

As a time of rapid change in young people, early adolescence offers an excellent opportunity for positively influencing their development. IANR focuses its research, teaching, and extension activities, such as 4-H, school enhancement, and other related programs, on helping youth in Nebraska to become productive, contributing members of society. Furthermore, IANR's efforts influence youth from all ethnic, racial, and socioeconomic backgrounds who live in rural, suburban, and urban communities.

IANR's efforts influence youth from all ethnic, racial, and socioeconomic backgrounds who live in rural, suburban, and urban communities.

Through its efforts to assist youth in developing the knowledge, skills, and attitudes necessary to perform adult responsibilities, IANR is affecting the future well-being and sustainability of the State of Nebraska. Examples of IANR research, teaching, and extension activities related to youth development leading to readily observable impacts are captured in the following vignettes.

⁷ Multiple EFNEP cost-benefit analysis examples are provided in the EFNEP section of the CSREES Web site at <http://www.csrees.usda.gov/nea/food/efnep/impacts.html>.

⁸ *Applying Cost Benefit Analysis to Nutrition Education Programs: Focus on the Virginia Expanded Food and Nutrition Education Program.* Virginia Cooperative Extension, Virginia Polytechnic Institute and State University, and Virginia State University. March 1999.

Impact of Educational Attainment

By working to keep youth feeling positive about themselves and their abilities and instilling a desire to learn and improve, 4-H can lead to greater personal and societal economic success. Research has proven that there are increasing personal returns from educational attainment, with greater levels of education being rewarded with higher median earnings (and benefiting society through higher taxation receipts). While research has not yet confirmed that 4-H has a positive impact on decisions to pursue higher education, findings have shown that 4-H does build more self-confident youth, which match other research results that point to faith in personal abilities as a good indicator of college success.

Therefore, it is reasonable to assume that at least a portion of the 111,524 youth between the ages of 5 and 19 that 4-H positively influences each year are developing the personal abilities that would lead them to pursue advanced education opportunities. If only 5 percent of the Nebraska 4-Hers were encouraged by their 4-H educational experience to achieve a bachelor's degree, rather than ending their formal education after receiving their high school diploma, this would equate to 5,576 bachelor's degrees. At a median earnings differential of an additional \$19,100 per year for the degree over and above a diploma, this equates to increased annual earnings for this group of \$106.5 million. If 5 percent gained an associate's degree beyond a high school diploma, this would generate additional personal income of \$37.9 million annually.

The 4-H experience also may keep students from dropping out of high school. Again, if 5 percent of Nebraska 4-Hers stayed and received their high school diploma, rather than dropping out of high school, their annual personal earnings gain would be \$51.3 million.

Skills Development for Youth

4-H in Nebraska operates a range of project-oriented programs designed to build youth skills. Some of these include the following:

- Robotics
- Aerospace
- Computers
- Embryology
- GPS/GIS Programs
- Entrepreneurship
- Healthy Lifestyles
- Crop Production Horticulture
- Unicameral Youth Conference
- Sportsmanship Programs
- Theater Arts
- Veterinary Science
- Photography
- Money FUNdamentals
- Career Exploration Camps.

Linked to 4-H programs in skills development are programs specifically directed at helping youth to become future practitioners in specific careers. 4-H historic roots in agriculture and agribusiness are reflected in multiple initiatives aimed at producing a pipeline of well-skilled, productive leaders for farming, horticulture, aquaculture, agricultural processing, environmental preservation, and other important areas of focus.

THE ECONOMIC IMPACT OF IANR’S RESOURCE EXPENDITURES ON THE STATE OF NEBRASKA

As an operating entity, irrespective of the benefits of its transfer of scientific knowledge and functional expertise, IANR generates a significant economic impact for the State of Nebraska via its direct and indirect spending. IANR receives funds from the federal government, extramural sources, industry contracts, and allocations from the State of Nebraska—and it invests these funds in human capital, resources, and infrastructure to benefit the state. In turn, the expenditures of IANR and its faculty and staff within Nebraska generate significant economic impact. Battelle’s analysis of IANR using input-output analysis techniques shows that, on an annual basis, the Institute’s direct and indirect expenditures generate the following:

- **\$338.4 million in total Nebraska economic output (sales)**, divided almost evenly between direct and indirect economic output
- **3,743 jobs in Nebraska**, comprising 2,074 direct jobs and 1,169 jobs generated in the Nebraska economy by the employment multiplier effect
- **Personal income for Nebraska residents amounting to \$117.3 million annually**, divided between direct income of \$70.6 million and indirect income of \$46.7 million
- **\$12.8 million in annual tax revenues** through Institute-generated taxes.

IANR’s institutional spending impact generates \$338.4 million in economic output and more than 3,700 jobs in Nebraska.

These are simply the impacts realized by the annual expenditures of IANR and its associated faculty and staff and by the follow-on multiplier effect of these expenditures. The impact generated by IANR’s programs and activities is, of course, far greater, as discussed in previous sections of this Executive Summary.

CONCLUSION: IANR—A GENERATOR OF POSITIVE ECONOMIC IMPACTS FOR NEBRASKA

In the 21st century, challenges such as globalization, competitive market pressures, technological advances, and the preeminent importance of innovation and talent are restructuring the economy. Against such a background of rapid and dramatic change, can a system such as agricultural research and extension, established in the late 1800s, be relevant? The surprising answer—that agricultural research and extension institutions may well be *more* necessary and relevant than ever before—is a testimony to the foresight of those who ensured the creation of IANR in 1973 through the passage by the Nebraska Legislature of LB149, which recognized the importance of agricultural development and scientific advancement to the State of Nebraska’s economy. **Much of what is required for 21st century success (innovation, technology transfer, human capital enhancement, productivity improvement, networking, and quality of environment and place) is directly addressed through the mission and operations of IANR.**

As clearly illustrated, IANR is dedicated to fulfilling multiple functions of critical importance to economic and social progress in Nebraska—and these functions relate directly to the needs and challenges of the New Economy:

- **IANR is an innovation engine for the state**, using science to develop and test new technologies and bioscience innovations to sustain the current agriculture economy and **powering a new economy based on bioscience discoveries**.
- **IANR is a pragmatic disseminator of the latest in research and technologies to enhance productivity and expand the economic base of Nebraska**. IANR works to ensure that its research discoveries are translated into practical, on-the-ground and in-the-field technologies to enhance productivity in Nebraska.
- **IANR**, with its history of agricultural production, **has a track record in applying technology and enhancing productivity** to ensure Nebraska’s performance in the highly competitive, global marketplace.
- **IANR is focused on education, seeking to significantly enhance human capital**, generate new scientists and well-educated practitioners, and promote lifelong learning across the state.
- **IANR provides a statewide network**—with a presence in every county—linking communities, businesses, and the general population to the intensive research and technical resources of the University of Nebraska.
- **IANR is flexible**, using integrated cross-disciplinary approaches in **tackling complex problems in scientific, economic, and social areas**.
- **IANR works to enhance and sustain the environment and quality of place in Nebraska**, ensuring the attractiveness of the state for human capital and new ventures.
- **IANR emphasizes youth development and leadership**, helping to provide the next generation of New Economy workers and leaders.

IANR has been, is, and will continue to be a primary engine for economic and social sustainability and growth in the State of Nebraska. Ultimately, IANR is an institution focused on improving and sustaining Nebraska—improving its economy, preserving its environment, growing a skilled workforce, and contributing to continuing social sustainability and responsibility. As clearly indicated throughout this report, IANR is positively impacting the State of Nebraska in significant ways through both its diverse array of activities, as well as its close partnerships with producers and community stakeholders—without these partnerships, much of IANR’s accomplishments could not be achieved.

Taken together, it is evident that IANR’s research, teaching, and extension activities are having powerful impacts on Nebraska’s economic growth and on economic and social sustainability in the State of Nebraska. In FY 2005, IANR received an annual appropriation of \$71.6 million from the State of Nebraska. As illustrated throughout this report, the estimated annual impacts of IANR programs far exceed \$750 million in direct economic output and savings benefits for Nebraska, a leverage ratio conservatively estimated to be greater than ten to one. This number does not include the impact of IANR’s direct and indirect expenditures (salaries, benefits, capital improvements, etc.) as highlighted in the preceding section, which represents an additional leverage ratio of approximately five to one. Taken together, the impact of IANR’s programs and expenditures represents a leverage of state funding that exceeds fifteen to one. Based on the impact examples examined by Battelle, it is the conclusion of this study that the State of Nebraska is receiving an excellent return on its investment in IANR.

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Introduction

HISTORY, VISION, AND MISSION OF THE INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES AT THE UNIVERSITY OF NEBRASKA

As one of the nation’s land-grant colleges and universities, the University of Nebraska (UN) is one of the nation’s elite research universities. The largest campus of UN is the University of Nebraska-Lincoln (UNL), founded in 1869 as the original location for the University. Since its creation, the UN has grown significantly, in terms of both size and mission. Colleges, departments, and programs have changed to reflect established and emerging trends in research and education. By the 1970s, the University, typical of America’s land-grant universities, was far from focused only on agriculture; rather, it was a well-established comprehensive research university with expertise in arts, sciences, humanities, and medicine.

In 1973, in reaction to the diversification of UN’s educational and research focus, the Nebraska Legislature reiterated the tremendous ongoing importance of agriculture and natural resources to the economy of the state and passed LB149, which led to the formation of the Institute of Agriculture and Natural Resources (IANR) the following year. A coalition of activists, concerned that attention to agriculture was declining at the UN, acted as the impetus. IANR was established with a vice chancellor as its chief administrator and its operations headquartered on the East Campus within Lincoln. Although it is statutorily a part of the UN system, it has been placed under the administrative structure of the UNL.

Today, the State of Nebraska’s economy is firmly rooted in its agricultural heritage. Not surprisingly, a considerable volume of UNL’s resources is dedicated through IANR to teaching, research, and extension in areas relating directly and indirectly to agriculture, agricultural and food processing, natural resources, and the sustainability of Nebraska’s communities. For instance, 47 percent of UNL’s fiscal year (FY) 2005 sponsored projects supported by external funds were conducted under the umbrella of IANR, totaling \$52.7 million.⁹ In addition, as a land-grant university, the service mission of UNL runs deep and is formalized with the work of extension. “Extension” means “reaching out,” and UNL uses extension to “extend” its resources, solving public needs with university-based research and intellectual capital through a range of activities. Furthermore, as knowledge, intellectual capacity, and technology become the foremost drivers of modern economies, IANR’s teaching activities within the College of Agricultural Sciences and Natural Resources (CASNR) are of critical importance to ensuring Nebraska’s economic progress.

IANR-affiliated researchers and research teams conduct almost half of all research volume at UNL.

⁹ Institute faculty and staff can have appointments in the following: Agricultural Research Division, College of Agricultural Sciences and Natural Resources, College of Education and Human Sciences, Extension Division, Conservation and Survey Division, Nebraska Forest Service, and Nebraska Statewide Arboretum.

IANR's vision statement is as follows:

IANR will be the premier provider of educational, research, and outreach programs essential for shaping Nebraska's future as a leader in the 21st century in the areas of food, agriculture and agribusiness systems, natural resources, and human resources. IANR is dedicated to providing the highest quality programs that are ecologically sound, economically viable, socially responsible, and scientifically appropriate.

The Institute's mission statement reflects this vision:

IANR focuses its research, teaching, and extension education expertise in agriculture and food programs, natural resources, families, and communities to help Nebraska grow an environmentally sound, economically viable, and socially responsible future.

Thus, IANR is a holistic organization, integrating research, teaching, and extension activities to provide pragmatic programs that sustain, expand, and develop the agriculture-based economy and social fabric of the state.

IANR works on an array of critical issues affecting Nebraskans' daily lives and the state's future. The advanced research and educational technologies of IANR empower people and communities to solve problems, stimulate economic development, and improve lives. Specifically, IANR works to improve the economy and quality of life for all Nebraska citizens by helping to

- Improve the profitability and productivity of agricultural producers, processors, and food industries in Nebraska
- Research, develop, and create new and improved products for Nebraska producers and industry
- Research and develop value-added applications for agricultural products, by-products, and waste streams
- Research and undertake extension activities to ensure animal and plant health and promote Nebraska biosecurity
- Research and undertake extension activities to promote sound human nutrition and health
- Research and undertake extension activities to help ensure the sustainability of the state's natural resources
- Research and undertake extension activities focused on developing improvements in food safety
- Research and undertake extension activities to strengthen Nebraska's children, youth, and families
- Undertake extension activities focused on sustaining and revitalizing Nebraska's communities and stimulating economic development and quality-of-life improvements.

Through its research, teaching, and extension activities, IANR has a substantial track record in contributing to Nebraska's overall quality of life and positively influencing the state's economy. Strengthening the lives and communities of Nebraska through research, teaching, and extension activities is key to the long-term competitive sustainability of Nebraska's high standard of living.

IANR's past and present contributions to economic progress in the State of Nebraska are the subject of this study and report.

STUDY GOALS AND METHODS

UNL requested the Technology Partnership Practice of Battelle Memorial Institute to analyze the array of impacts generated by IANR's research, teaching, and extension activities within the State of Nebraska. Specifically, the project provides the following:

- Measures of the quantitative impact of IANR operations and activities on key economic metrics such as Nebraska business volume, personal incomes, and employment
- An understanding of the broad range of social and community benefits provided by IANR's activities in the state
- Illustrations of the positive impacts generated in the state as a result of IANR's activities as they relate to agriculture and natural resources, community development, family and consumer sciences, and youth development
- A "tool" for IANR to estimate annual economic impacts.

In evaluating IANR's broad range of impacts, Battelle uses both quantitative and qualitative approaches, including IMPLAN¹⁰ software that determines the effect of economic variables through input-output analysis and Battelle interviews with IANR administrators, directors, faculty, and key stakeholders.

THE IMPORTANCE OF AGRICULTURE AND THE AGRICULTURE-BASED ECONOMY TO THE STATE OF NEBRASKA

Agriculture, agbioscience, and agribusiness sectors underpin a very substantial component of the Nebraska economy. Before IANR can be evaluated as an organization that sustains and enhances the agriculture-related economy and the way of life that economy supports in the state, it is important to understand how economically significant this sector is to the vitality of the state's economy.¹¹

The citizens of Nebraska have an inherent understanding that agriculture, agribusiness, and the communities that sustain these industries are of great importance to the economic and social health of Nebraska. However, it is perhaps less well known that the importance of these industries to the State of Nebraska has been growing in recent years. Analysis by the Nebraska Policy Institute concluded that:

¹⁰ Minnesota IMPLAN Group, 1725 Tower Drive West, Suite 140, Stillwater, MN 55082.

¹¹ Additional details regarding the agriculture-based economy of the State of Nebraska can be found in the complete Economic Analysis contained in Appendix A.

*In 1990, 25 percent of the state’s total employment was directly or indirectly the result of agribusiness activity. In 2002, agribusiness supported nearly 366,000 full and part-time jobs, representing 31 percent of the state’s total employment. No doubt, agriculture and agribusiness remains firmly entrenched as Nebraska’s number one industry.*¹²

Agriculture and agribusiness are key drivers of Nebraska’s economy—accounting for 31 percent of state employment.

Technology is transforming the agricultural bioscience (agbioscience) economy of the State of Nebraska, spurring innovation and productivity gains. When researchers, scientists, and engineers make new discoveries in plant and animal genetics, healthcare, ecology, or nutrition, the entire industry can change. Continuous innovation and change characterize this dynamic industry and lead to economic opportunities. Technological breakthroughs and scientific insights are applied to new products, delivering both economic and social benefits around the world. Today, agriculture has a new role, acting not only as a producer of food and other goods, but also as a leader in affecting public health and the environment.

ROLES AND RESPONSIBILITIES OF IANR (THE SCOPE OF BENEFITS PROVIDED BY IANR TO NEBRASKA)

With Nebraska’s economic and social health so strongly tied to agriculture and agribusiness productivity and profitability, it is not surprising that the UNL has dedicated IANR to sustaining, growing, and improving agriculture and related-enterprise in the state. Through an unparalleled network of expertise composed of personnel at UNL, the University’s four research and extension centers across the state, at a UN-affiliated lifelong learning site at Norfolk, and in 83 local extension offices that deliver programming to Nebraska’s 93 counties, IANR has focused its activities within six major focus areas:

- Agriculture, Food Production, and Natural Resource Systems
- Nutrition, Health, and Food Safety
- Environmental Sustainability
- Community & Entrepreneurial Development
- Building Strong Families
- Youth Development.

Thus, IANR’s activities positively impact the State of Nebraska through multiple avenues. Figure 1 illustrates the primary IANR focus areas. Each primary focus area is discussed below.

¹² Lamphear, C. “The Importance of Agriculture and Agribusiness to Nebraska’s Economy.” Nebraska Policy Institute. March, 2006.

Figure 1: IANR Focus Areas

Agriculture, Food Production, and Natural Resource Systems

From basic science in molecular biology, biochemistry, and genetics to highly applied work in plant breeding, agricultural engineering, and biomaterials, IANR focuses on the science and application of agriculture. In this functional impact area, IANR undertakes fundamental work to ensure the economic viability and sustainability of existing Nebraska agriculture and ag-related sectors and to expand the ag-based economy in the state by introducing new technologies, crops, and value-added products.

IANR's many functional activities in the area of agriculture, food production, and natural resource systems can be separated into six subcategories:

- **Emerging Trends and Needs**—IANR scientists, researchers, and extension professionals provide intelligence, planning, and strategic advice to producers of agricultural and related products. Through research, teaching, and extension activities, IANR boosts agricultural and related industry profitability by providing timely education and information on crop varieties, crop management issues and strategies, agricultural and market economics, water resource and environmental management, emerging livestock health issues, and potential new technologies and value-added products.

- **Technology Introduction and Education**—Agriculture operates at the confluence between environmental sciences, the biosciences, and engineering disciplines. As such, progress in agriculture and ag-based industry is highly influenced by technological advancements in these disciplines. Researchers at IANR, and within other research institutions in the nation, are constantly working to develop new crop varieties, disease and pest management tools, animal and livestock health products, agricultural equipment, irrigation technologies, and agricultural processing technologies. IANR is critically important to developing, understanding, and introducing those technologies best suited to increasing agricultural profitability in Nebraska. Through the unique combination of research and extension, IANR develops and evaluates the latest technologies and innovations and educates Nebraska’s producers in their adoption and use.
- **Improved Crops and Products**—Nebraska has a highly diverse agricultural environment, characterized by a wide range of climate, soil, and other factors influencing ag production. IANR is important functionally to developing, evaluating, and introducing improved crops and technologies to keep Nebraska’s producers at the leading edge of productivity. Through improved crop varieties, crop and livestock management technologies, and agricultural and production equipment, IANR ensures consistent progress in productivity enhancement in agricultural production, processing, and value-added activities.
- **New Crops and Products**—With the increasing impact of globalization affecting commodity agriculture prices, IANR must engage in R&D leading to the introduction of new crops and value-added products for Nebraska, thereby providing fresh income streams for producers and processors and diversifying the agriculture-related economic base in the state.
- **Biofuels and Biomaterials**—While agriculture is still primarily focused on food production, the finite nature of fossil fuels and fossil-fuel-based materials (such as plastics) combined with rising fossil-fuel prices are spurring activity in applying agricultural output to fuel and materials production. Nebraska has a strong position in ethanol production from corn, and IANR is working to develop and evaluate more efficient biofuel production pathways and technologies and to develop value-added products from agricultural waste streams and by-products.
- **Business Development**—IANR is also working with producers and processors to develop enhanced productivity and profitability from existing business operations and to assist in developing new lines of business.

Nutrition, Health, and Food Safety

Because agriculture and related food-processing industries are important to Nebraska, the safety of agricultural products must be maintained from production to consumption. Food safety problems such as pathogen outbreaks in the meat industry can severely damage major components of the Nebraska economy. IANR is extremely important to R&D related to food safety, biosecurity, and processing technologies to secure the food chain in Nebraska.

Nutrition and health are also exceptionally important areas of research, development, and extension for IANR. Within agricultural production, IANR works, for example, to optimize livestock nutrition and health. IANR is also active in food science and nutrition work focused on maximizing nutrient retention in processing and in advanced activities related to producing functional foods, nutraceuticals, and potentially pharmaceuticals through plant and animal

pathways. Thus, IANR's work in Nutrition, Health, and Food Safety works to secure and protect the existing agriculture and food industry in the state, and to expand the sector's productivity and product output through the introduction of new food and nutrition products and value-added opportunities.

Finally, within the nutrition, health, and food safety functional area, IANR also provides programs similar to those outlined in the agriculture, food production, and natural resource systems functional area. IANR research and extension teams ensure that Nebraska's producers and processors receive up-to-date market and technological insight. IANR provides R&D activities to develop new technologies and processes to enhance existing food and nutrition products, and to introduce new products to diversify and expand the economic base. Plus, IANR provides a range of programs dedicated to enhancing business processes and developing new businesses in the nutrition, health, and food safety arenas.

Environmental Sustainability

In a state that depends on its environment not only for quality of life but also as the underpinning of its agriculture-based economy, the work of IANR in environmental sustainability and preservation is of critical importance. IANR is highly active in this area, with initiatives focused on such issues as water availability and quality, agricultural waste management, and fertilizer and pesticide reduction opportunities. IANR work is not only focused on the broad rural environment, but also on the urban environment and associated community sustainability issues.

Community & Entrepreneurial Development

IANR is focusing its research, extension, and teaching efforts to help local business communities, current and emerging community leaders, and elected and appointed government officials investigate and create viable options for economic and community development by

- Increasing the knowledge base for individual and community decisions;
- Developing clientele skills necessary to achieve their individual business and community goals;
- Fostering entrepreneurial opportunities within the agriculture industrial sector; and
- Helping create an inclusive decision-making environment.

For the State of Nebraska, these efforts lead to improved job creation and retention, small and medium-sized business development, workforce education, and public policy planning.

Building Strong Families

Given the importance of the family in developing Nebraska's children and thereby the inherent strength of Nebraska's communities, IANR has focused on programming aimed at building stronger families. The Building Strong Families program helps Nebraska families build strengths, face challenges, and make choices. IANR's Building Strong Families program aims to develop accessible resources to conduct research-based youth and family programming in communities across the state. This research, based on the Family Strengths Perspective, identifies those qualities that strengthen family well-being, including appreciation and affection,

positive communication, spiritual well-being, commitment, enjoyable time together, and the ability to manage stress and crisis effectively.¹³

IANR is focusing its research, extension, and teaching efforts on a grass-roots effort to meet local-level needs by

- Teaching families to strengthen and improve relationship skills in family and community;
- Helping communities identify family needs and design and implement plans to meet those needs; and
- Teaching families to access, use, and manage resources wisely.

Youth Development

Through youth development activities, adolescents acquire the cognitive, social, and emotional skills and abilities required to navigate life. The experiences of adolescence vary for every youth; and his or her development is influenced by culture, gender, and socioeconomic class as well as by formal and informal settings such as home, church, school, and extracurricular activities and similar relationships, such as with peer friends, work colleagues, parents, teachers, and mentors. Young people develop their personalities and life skills based on these early adolescence experiences.

As a time of rapid change in young people, early adolescence offers an excellent opportunity for positively influencing their development. IANR focuses its research, teaching, and extension activities, such as 4-H, school enhancement, and other related programs, on helping youth in Nebraska to become productive, contributing members of society. Furthermore, IANR's efforts influence youth from all ethnic, racial, and socioeconomic backgrounds who live in rural, suburban, and urban communities.

Through its efforts to assist youth in developing the knowledge, skills, and attitudes necessary to perform adult responsibilities, IANR is affecting the future well-being and sustainability of the State of Nebraska.

SUMMARY

This study seeks to ascertain the impact of the IANR on the economy and citizenry of the State of Nebraska. Through the following narrative, the report seeks to uncover:

- The impact of IANR research, teaching, and extension on Nebraska's economic and community sustainability (including illustrations of the positive impacts generated in the state as a result of IANR's activities);
- The impact of IANR research, teaching, and extension on increasing Nebraska's wealth and economic diversity (including illustrations of the positive impacts generated in the state as a result of IANR's activities);
- The impact of IANR expenditures on the State of Nebraska.

¹³ Stineet, N., and DeFrain, J. *Secrets of Strong Families*. Boston: Little Brown. 1985.

Specifically, this study examines the impact of IANR today in terms of the unique role that it plays through its activities and programs throughout the State of Nebraska. These activities and programs are broad and economically relevant, with its various functional areas positively impacting Nebraska's economy and quality of life.

The Impact of IANR’s on Nebraska’s Economic and Community Sustainability

INTRODUCTION

IANR provides a range of important activities and benefits centered on research, teaching, and extension. These activities result in “forward linkage impacts”—impacts that accrue from the actual scientific, education, and extension activities undertaken by IANR. In other words, the transfer of R&D discoveries and know-how from IANR into industry and the communities it serves throughout the State of Nebraska produces technologies, expertise, and programs that increase the efficiency and productive capacity of clients and client industries, which in turn impact the economy of the state.

In this chapter, Battelle analyzes the contributions being made by IANR in *maintaining the health of the economic and social fabric of the state*. Many IANR programs and activities work to maintain the economic viability of Nebraska’s agriculture, associated processing, and value-added industries and to sustain quality of life within the State of Nebraska. In the third chapter, Battelle assesses the impact of IANR on *expanding Nebraska’s economy, diversifying the Nebraska economic base, and building community and individual wealth*. This assessment focuses on critically important activities such as the development and introduction of improved crop varieties, new alternative crops, and new value-added products and processes, including work in areas such as biofuels, biobased materials and products, and advanced food and nutraceutical products.

These categories of benefits (sustaining the economy and expanding it for the future) were envisioned and embodied in the original Smith-Lever Act of 1914 that established extension programs. The Act specified that

Cooperative agricultural extension work shall consist of the development of practical applications of research knowledge and giving of instruction and practical demonstrations of existing or improved practices or technologies in agriculture, home economics, and rural energy, and subjects relating thereto to persons not attending or resident in said colleges in the several communities, and imparting information on said subjects through demonstrations, publications, and otherwise and for the necessary printing and distribution of information in connection with the foregoing; and this work shall be carried on in such manner as may be mutually agreed upon by the Secretary of Agriculture and the State agricultural college or colleges or Territory or possession receiving the benefits of this Act¹⁴.

As the Act made clear, extension was part of an action-oriented system comprising R&D, education and training, and the practical application of advancements. IANR, operating under these guiding principles, is thus deliberately structured as a pragmatic organization dedicated to research discovery, diffusion of research knowledge, and practical training and skills development for Nebraskans. Thus, IANR is purposely designed to produce positive economic and social impacts for the State of Nebraska. These impacts, produced within the integrated teaching, research, and extension programs of the IANR, include the following:

¹⁴ Smith-Lever Act. Section 2. 1914.

- Sustaining the economic competitiveness of Nebraska agriculture and associated enterprises
- Enhancing the productivity and profitability of Nebraska agriculture and business enterprises
- Expanding product lines and generating new business categories to increase Nebraska's economic output
- Enhancing state and local government revenues and economic sustainability through expansion of the Nebraska economy
- Increasing employment opportunities and enhancing the workforce skills of Nebraskans
- Improving the social conditions and quality of life for residents of urban and rural Nebraska
- Protecting Nebraska's environment and promoting environmental and natural resource sustainability in the state
- Protecting and improving the health of Nebraskans.

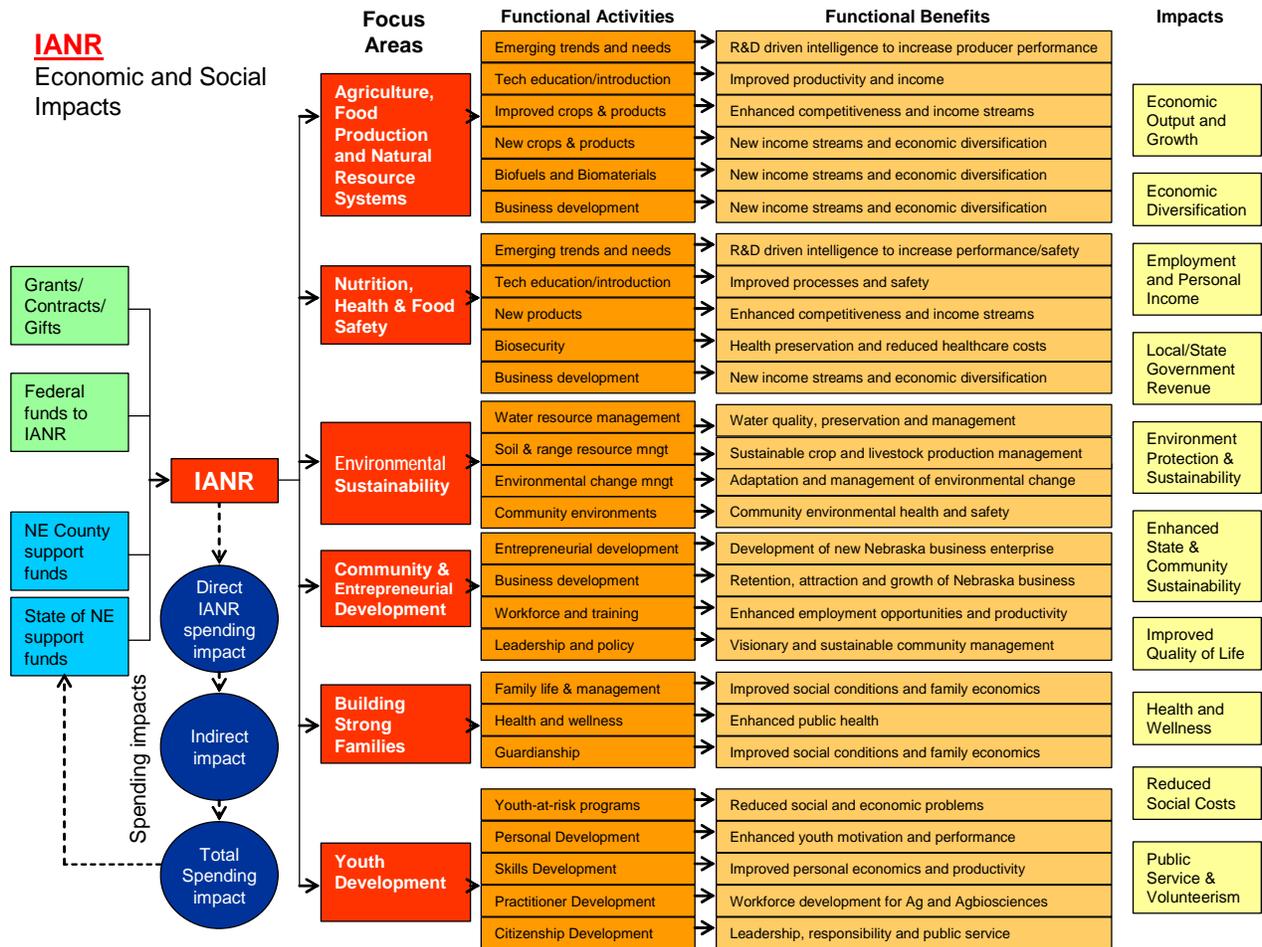
These forward linkage impacts are generated by institutional mission and function, rather than institutional spending. Congress envisioned them as benefits provided through land-grant universities and state extension programs. They constitute a broad and multifaceted array of positive economic and social impacts for Nebraska.

As previously identified, the substantial forward linkage impacts of IANR are delivered through six primary focus areas of activity:

1. Work to sustain, expand, and develop new products around agriculture, food production, and natural resource systems
2. Programs to improve nutrition, health, and food safety
3. Initiatives designed to sustain the health of Nebraska's environment
4. Actions focused on community-level economic development
5. Programs that help to build strong and sustainable Nebraska families
6. Initiatives to encourage development of Nebraska's children and youth.

Each area contains multiple individual programs and initiatives that build and sustain Nebraska's economic and social well-being. These functions and their associated benefits and impacts are illustrated in Figure 2 and discussed in the following sections of the report.

Figure 2: The Scope of IANR Impacts



IANR—MAINTAINING THE HEALTH OF THE ECONOMIC AND SOCIAL FABRIC OF NEBRASKA

Within the rapidly changing and highly competitive global marketplace, Nebraska’s agriculture and related industries must operate at peak competitive efficiency—and must do so in a uniquely unpredictable production environment impacted by such significant and wide-ranging variables as

- Climatic conditions, including rainfall, amount of sunlight, high and low temperatures, etc.;
- Bacterial, fungal, and viral diseases and pathogens;
- Insects and other pests;
- Soil fertility, drainage, and retention; and
- Production of farmers in other regions, countries, and continents. Their production will be affected by the above variables and will affect commodity prices and the Nebraska producer’s return on investment.

In the 21st century, with globalization of markets and production introducing new competition and complexity to agriculture and agribusiness, the activities of IANR have become perhaps more important than ever. Local problem solving is influenced by global and national conditions requiring considerable sophistication. In this context, the Nebraska farmer faces almost overwhelming decisions each year that may make or break his or her bottom line:

- *What new crop cultivars have researchers developed that I should use this year?*
- *What varieties will grow best and yield the highest returns?*
- *Which commodities will be in oversupply or scarce supply this year, and what effect will this have on prices?*
- *What predictive computer models should I use to guide my planting?*
- *What diseases will my crops and animals face, and what is my best approach to offset the threat of these?*
- *Should I invest in precision agriculture technology this year, and what would be my return on investment?*
- *What fertilizers and soil improvement strategies should I adopt based on my soil characteristics, crop rotation history, and recent environmental factors?*
- *What irrigation, planting, harvesting, and processing technologies should I invest in to enhance my bottom line?*
- *What new crops, products, and varieties should I be considering based on changing consumer and market demands?*

No other category of business faces such variable and risky decisions year after year—agriculture, agribusiness, and those sectors that depend on them are unique in this regard.

Those working in these highly competitive sectors can, however, turn to IANR as a professional resource in Nebraska for advice, analysis, and access to the very latest in applied research. IANR serves every county in Nebraska, providing local, on-the-ground, applied programs and a full-service gateway to the intensive intellectual and R&D resources of UN. Through IANR’s extension work, those in agriculture and related industries have access to research, education, and training—access that introduces new crops, value-added products, and production technologies; improves profitability and processing efficiency; reduces losses to environmental and disease threats; and enhances marketing strategies and management skills.

IANR is dedicated to sustaining and enhancing agriculture and agriculture-related economic activity in Nebraska and significantly impacts the economy of the state through its research, teaching, and extension activities. Given the UN’s long-standing land-grant track record in the agriculture and natural resource sectors and the dedicated resources of IANR applied to improving and growing the agriculture and agribusiness sectors of the state economy, IANR’s work has a powerful annual impact on state output in these sectors.

IANR’s research, teaching, and extension activity works to sustain the economic viability of Nebraska industries and communities and to expand the economy via the development of new products and technologies for Nebraska producers.

For example, Battelle analyzed the effect that every 1 percent increase in total agricultural production would have on the State of Nebraska. As highlighted within the report, while it is highly likely that IANR’s programmatic activities and research endeavors would generate considerably more than a 1 percent gain in agricultural output in the state on an annual basis, a conservative 1 percent estimate serves as a baseline for considering the significant effects of agricultural productivity on the Nebraska economy. Therefore, the impact of a 1 percent agricultural production increase in Nebraska is shown in the following text box.

The Economic Impact of a 1 Percent Increase in Agricultural Output in Nebraska

Using the IMPLAN input-output analysis system to calculate on an annual basis the impact of a 1 percent increase in agricultural production, the following is determined:

- A direct 1 percent increase in agricultural production in the Nebraska economy would equate to **\$117.3 million annually.**
- **Total (direct and indirect) economic output would increase by \$215.1 million annually.**
- Total value added would equate to \$80.9 million annually.
- Labor income generated for Nebraskans would be \$46.6 million annually.
- **1,544 jobs would be created in the state annually.**

It also should be noted that expanding the agricultural sector could benefit every county in the state. Agriculture and associated processing industries are highly diffused across every Nebraska county; therefore, the direct and indirect effects of expansion in the sector are felt much more widely than with more narrow, geographically focused sectors.

It is important to note that, in addition to IANR’s research and extension activities that result in the economic impacts outlined above, IANR’s teaching mission fulfilled through CASNR provides the knowledge-based workforce that meets the needs of the agbioscience industry’s 1,544 jobs created by each 1 percent increase in agricultural production. For instance, in the 2006–2007 academic calendar year, CASNR enrolled 1,303 students in its undergraduate program, 72 percent of whom were in-state residents, and an additional 660 graduate students in both its master’s and doctoral programs.¹⁵ These highly trained graduates are providing the knowledge base for Nebraska’s agbioscience economy, with 78 percent of graduates remaining within the State of Nebraska upon completion of their degrees.¹⁶

78 percent of CASNR’s graduates are retained within the State of Nebraska, providing a highly skilled, cutting-edge workforce for the state’s agbioscience industrial base.

Finally, it is also important to note that the State of Nebraska’s annual appropriation in FY 2005 to IANR totaled \$71.6 million, indicating that IANR has to positively impact state agricultural output by only 0.33 percent per year to cover its state appropriation. As shown in some of the following categorized IANR impact examples, the impact of IANR’s activities is likely many times higher than this—thereby providing the state with a very significant return on its investment.

¹⁵ UNL Admission’s website.

¹⁶ “Annual Report of UNL Graduates 2004-2005.” Prepared by UNL Career Services.

As clearly illustrated, the activities of IANR working to sustain the economic and social viability of Nebraska, faced with the economic and societal challenges wrought by globalization and other forces, are crucially important. These IANR activities are discussed below.

IANR Activities and Programs Focused on Sustaining a Profitable and Healthy Agriculture-Based Economy

Land-grant universities, agricultural research stations, and extension activities were originally established to improve American agriculture and the ag-related economy through research, teaching, and extension. IANR, incorporating these functions for the UN, is dedicated to sustaining and improving the agriculture-based economy for the State of Nebraska. These sustaining activities are critically important given the variable nature of the production agriculture environment. Each year producers are faced with issues such as water availability, emerging pests and diseases, soil preservation and fertility, emerging production technologies, international and domestic competitive forces, and fluctuating commodity market prices. IANR helps producers, processors, and others dependent on the agricultural economy navigate these variables and make informed decisions.

In meeting the needs of sustaining Nebraska agriculture, agribusiness, and associated sectors, IANR provides the following diverse programs.

Identifying Emerging Trends and Needs (Economic and Producer Intelligence)

Agricultural practitioners have so many tasks that it is impossible for them to stay abreast of all relevant developments in crops, livestock, value-added products, biotechnology, soil science, irrigation, the worldwide agriculture operating environment, emerging and declining market opportunities, etc. Yet, the correct information can help ensure a successful and profitable production season. A key role of IANR is thus information collection, consolidation, and dissemination customized to the specific needs of Nebraska agriculture and related-industries. IANR provides critical intelligence to producers and processors through a range of activities and publications, including the following extension examples:

IANR provides state-of-the-art advice and insight regarding emerging trends, opportunities, and issues.

- ***Crop Watch***—This publication provides timely information produced by IANR researchers and extension specialists throughout the crop production season.
- ***Market Journal***—IANR’s cable and satellite television programming focuses on current market and commodity prices and projections, farm management, product marketing, and a range of topics for agricultural producers.
- ***Web Video***—Online continuing education and course materials that provide detailed information on specific topics such as crop and livestock production technology, rural entrepreneurship, and water management issues.
- ***Special Web Topics***—IANR’s Web site, and the Web site of affiliated departments and programs, contain a broad range of specialty information in areas such as entomology and insect management, plant diseases, drought, and soil fertility and nutrient management.
- ***UNL Extension Publications Catalogue***—This catalogue categorizes hundreds of IANR publications by subject matter for immediate access.

It should also be noted that IANR has four research and extension centers located in Nebraska and an agricultural research and development center that facilitate the provision of specific regional information, advice, and research findings. These centers are the Northeast Research and Extension Center, the Panhandle Research and Extension Center, the Southeast Research and Extension Center, the West Central Research and Extension Center, and the Agricultural Research and Development Center at Mead (north of Lincoln).

Agricultural Economics at IANR also contributes to the knowledge base of producers and processors in Nebraska. Affiliated organizations, such as the Center for Agricultural and Food Industrial Organization, undertake specific research and extension aimed at developing a more informed agriculture and ag-industry base in Nebraska in regards to market forces, agribusiness markets, trade development, and the economics of farm management and marketing.

Introducing Technology and New Techniques

For American agriculture and agribusiness to survive against intense global competition, they must sustain increasing productivity returns from scarce land and production resources. Only by sustaining high levels of productivity can American industry compete against low-cost international producers and earn the revenues required to sustain high incomes and a high standard of living. Increasingly, the U.S. economy's productivity is being driven by "knowledge" and technology. Major R&D-based discoveries in fields such as plant and animal sciences, information technology, engineering, and chemistry are being applied to agbioscience and agriculture to achieve increasing returns from resources. Agriculture and agribusiness in the United States have become "high-science" industries, dependent on access to the latest research and technologies to maintain their competitive edge.

IANR develops, introduces, and trains Nebraskans in new R&D-based technologies to keep Nebraska producers at the forefront of modern industry practice.

IANR plays a critical role in this 21st century operating environment—developing new technologies and providing access to R&D-based technological innovations, experienced research faculty and applied scientists, and a variety of training and education programs designed to keep Nebraska's producers at the leading edge of high-productivity technologies and innovations.

Technology provides one set of competitive advantages, but IANR's R&D, and the R&D of other land-grant and research institutions throughout the United States, also provides important breakthroughs in the technique and science of agricultural production and processing. Concepts such as crop rotation strategy, soil quality management, the timing of planting, the application of fertilizers, and the use of biologics in animal husbandry are knowledge-diffusion and education issues, not purely technology issues. IANR thus serves as an educator and advisor to the agricultural and processing sectors in Nebraska, working to keep Nebraska's producers well-informed in terms of practical skills and modern production techniques.

Example: Introducing New Technology and Techniques on the Farm

Background: IANR has conducted specific research programs relating to no-till agriculture and shared this knowledge with producers through publications, events, and extension education. No-till agriculture is the practice of leaving soil undisturbed from harvest to

planting except for nutrient injection. Planting or drilling is accomplished in a narrow seedbed or slot created by coulters, row cleaners, disk openers, in-row chisels, or roto-tillers. Weeds are controlled primarily with herbicides.

Impact: The 2004 Corn/Soybean Profitability Workshops focused on making no-till systems work in a corn/soybean rotation. These events were attended by 99 participants who farmed 178,662 acres. Using post-event follow-up surveys, IANR estimated that the value per acre of the program was \$13.02 and the benefit per attendee with a respondent average of 1,805 acres was \$23,501. Based on participant responses, the total estimated benefit of the workshops was \$2,326,179.

Example: Protecting Nebraska's Crops

Background: One of IANR's key functions pertains to research, development, education, and extension relating to the protection of Nebraska's crops, including protection from plant diseases, insects and other pests, and weeds and management of environmental factors such as drought or soil nutrient depletion.

Crop management research and programs are an important component of IANR's work, and key to this work is the development and introduction of new crop protection technologies and strategies as illustrated in the following examples:

Impact:

- **Crop Protection Clinics**—UNL has a 30-year history of providing up-to-date information on pest management for crop production systems and advisory and certification programs relating to pesticide application. In 2003, it is estimated that the advice provided by the Crop Protection Clinics influenced producer management of 6,139,000 acres in Nebraska, and re-certifications for agricultural-plant pesticide applicator licenses were awarded to 799 individuals. Post-clinic surveys indicated that more than 75 percent of respondents felt that their relevant knowledge related to crop protection was “moderately” or “very much” improved in terms of weed management, plant diseases, insect management, and pesticides. The surveys also asked respondents to place a value per acre on the application of what they had learned. **Participants on average valued the knowledge at \$3.81 per acre. With 6,139,000 impacted acres, this \$3.81 per acre equates to \$23.4 million in attributable impact value.**
- **Range and Field Grasshopper Management**—Periodic grasshopper infestations can result in very serious crop losses for Midwestern farmers and ranchers. IANR has dedicated considerable resources to proactively tackling this problem and informing producers about grasshopper management. IANR educational activities emphasized the use of a cost-reduction treatment system called RAAT (Reduced Agent and Area Treatment) designed to make grasshopper treatments far more cost effective for farmers and ranchers. **By using the program, it is estimated that per-acre application savings averaged \$4 over a total of 750,000 treated acres, for a combined cost savings of \$3 million.** Reduced negative costs otherwise attributable to unmanaged grasshopper crop and rangeland damage would add more to this \$3 million savings. It is estimated that the grasshopper management information presented by Extension at more than 50 statewide meetings over 2 years reached at least 2,500 participants. IANR has also been active in

“train-the-trainer” sessions serving to further leverage specialized expertise and know-how in the field.

- ***Bacillus thuringiensis* (Bt) Toxicity Preservation**—Transgenic corn hybrids using Bt to resist the European corn borer (ECB) have been adopted widely in Nebraska (accounting for about one-third of Nebraska’s planted corn acreage). IANR is educating producers to set aside acreage for planting non-Bt corn as a pest refuge, reducing the likelihood that ECB will develop resistance to the Bt toxin. Termed by the U.S. Department of Agriculture (USDA) as integrated resistance management (IRM), it is anticipated that the refuge approach will greatly extend the window of corn toxicity and the increased crop yields of these transgenic varieties. IANR-facilitated education has yielded significant results. A survey by Marketing Horizons, Inc., an independent survey research firm, found that more than 90 percent of Midwestern corn farmers now understand the importance of establishing refuge plots and, **in Nebraska, more than 2 million corn acres are fully compliant with IRM recommendations.**
- **Adapting to Rootworm Pesticide Resistance**—IANR researchers have helped corn producers in south central Nebraska adapt to emerging resistance to the standard control agent methyl parathion in western corn rootworms (WCR). They have developed laboratory bioassays to identify resistant WCR populations and produced alternative pest-control strategies. The resulting strategies deploy existing soil insecticides to control the rootworms, and an education program was deployed to inform producers of their control options in affected areas. Independent crop consultants in Nebraska have confirmed that the **IANR strategies and associated teaching and extension have helped convince farmers to adopt recommended changes.**
- **Timely Information for a Changing Crop Production Environment**—Nebraska’s farmers do not grow their crops in a static environment; rather, farmers must be vigilant in responding to pests, diseases, and other threats exacerbated by changing weather and other variables. IANR responds to the need for timely advice and solutions through the *CropWatch* newsletter (also available on the Web), of which IANR publishes 26 editions during March through November. As in other areas, IANR has evaluated its own performance through surveys, soliciting feedback from Nebraska’s producers. Survey findings show that *CropWatch* is useful, with more than **96 percent of respondents noting that they had changed at least one crop-related practice because of advice and information contained in the newsletters.** Changes predominantly were made in the areas of pesticide selection; pesticide application timing; crop rotation practices; and the monitoring of weeds, insects, and plant diseases.
- **Crop Management and Diagnostics Clinic 2005**—This series of crop management training programs was held on-site at the UNL Agricultural Research and Development Center. The audience comprised farmers, crop consultants, and agribusiness professionals. The 2005 Clinic had 393 participants from 60 Nebraska counties. Event data show that attendees manage or influence almost 5.4 million acres of crops. **Post-event surveys asked participants to evaluate the usefulness of information received and put into practice, which they valued at \$5.74 per acre. Given the 5,392,527 acres farmed, this equates to an estimated \$30,957,690 impact.** While these figures constitute producer estimates (rather than measured yield data), it is quite clear that a

substantial value is placed on the pragmatic, hands-on advice provided at the Clinic events.

- Soybean Solution and Management Days**—These constitute another series of pragmatic events aimed at transferring research-based knowledge and advice from IANR to producers and crop consultants. They focus specifically on soybeans, a crop that in 2004 was planted on 4.8 million acres in Nebraska, yielding 46 bushels per acre, and resulting in a total production value for the year of more than \$1.1 billion. Operated in conjunction with the Nebraska Soybean Board, these Extension one-day events have been held at multiple locations around Nebraska. 2004 events focused on soybeans with high oil and protein content, maximizing profits from soybeans, disease and insect management, and no-till soybean cultivation. As with other Extension events, participants place a comparatively high value on the practical information they learn and put to use on their farms and in their businesses. **Participants in the 2004 events represented more than 687,000 acres of cropland; the average value of \$6.65 per acre was placed on the information obtained. Thus, direct users of the soybean information may have realized a combined \$4.6 million in positive economic impacts.**

Sustaining and Improving Crops Production

At its core, IANR is an applied science institution focused on R&D and the transfer of this R&D to achieve improved outcomes, profitability, and sustainability for Nebraska agriculture and related industry (and the social structures in Nebraska that depend on this economy). While IANR certainly offers a broad suite of research, teaching, and extension programs in a range of fields, it is, at its core, using scientific research to reinforce agricultural sustainability and growth in the state. Key functions under this mission are the conducting of R&D designed to improve and sustain current crops, livestock, and agriculture-based products in the state and the dissemination of recommendations through extension to farmers, producers, and processors.

IANR research constantly works to improve existing Nebraska crops and products, helping to keep the state ahead of growing international and domestic competition.

Research in this area includes the following:

- The development and breeding of enhanced and new crop varieties displaying enhanced characteristics suited to Nebraska’s diverse growing and production environment. These characteristics may be enhanced yields, quality, or nutritional value; improved disease, pathogen, or pest resistance; and special traits designed to add market value (such as enhanced texture, processibility, color, flavor). This area is developed through traditional plant breeding techniques or genetic modification/transgenics.
- Approaches to the diagnosis, prevention, and treatment of livestock and crop diseases, thereby enhancing/preserving productivity, protecting the food chain, and preserving food safety.
- Work to improve growing media and growing conditions in Nebraska through soil quality and preservation techniques, water and irrigation, and crop and livestock management technologies and techniques.

Agricultural production takes place in a dynamic, changing environment. New diseases emerge, diseases and pests evolve resistance to treatments, climatic conditions change and cycle, and market demands and preferences change. Within this changing environment, IANR predicts issues and needs and proactively works to develop new crop varieties (corn, soybeans, wheat, etc.), forage varieties, diagnostic tools, treatment chemistries, livestock therapeutics, and specific strategies to keep Nebraska at the leading edge of agricultural productivity despite its many challenges. Without IANR, Nebraska producers would have to rely on commercial research and the research of out-of-state universities—research that would not be specific and customized to the specialized needs of the Nebraska environment and its agricultural characteristics (and, therefore, likely not as effective as IANR in addressing Nebraska’s needs). Examples of the many specific projects undertaken by IANR to sustain and improve agricultural crops, livestock, and products include the following:

Example: Wheat Breeding

Background: Wheat is one of the most important agricultural crops to the Nebraska economy. In 2004 Nebraska’s farmers produced 61 million bushels of wheat, which, at \$3.20 per bushel, yielded a total production value of \$195.2 million. IANR has long contributed to the wheat industry in the state, most notably in the focused breeding of wheat varieties suited to Nebraskan growing conditions. Through the development of specialized wheat cultivars bred for optimum yield, disease resistance, and quality characteristics, the University is making strong contributions to agricultural sustainability and profitability in the state.

Impact: Developing and breeding new wheat cultivars require a long-term commitment to R&D and field trials. A new variety of wheat takes 12 years to develop; and, as such, the longevity of IANR as a stable force in agricultural R&D for the state is highly important. The IANR program develops high-yield/high-quality wheat varieties customized to the soil, climate, disease, and pest characteristics of the Nebraska growing environment. Special resources at the University, such as the wheat quality laboratory and the program’s own baker for quality testing, enable university faculty and research scientists to commit to the long-term development of varieties with enhanced quality characteristics.

In quantifying the impacts of UNL wheat, Battelle examined production statistics reported by the USDA’s National Agricultural Statistics Service (NASS) and tracking statistics maintained by UNL on the harvested acreage of UNL-bred wheat cultivars in the state. These statistics illustrate the considerable importance of UNL wheat cultivars to Nebraska farming, with fully 60 percent of 2004’s Nebraska’s harvested wheat acreage being UNL-originated varieties (a consistent testimony by farmers as to the perceived value of UNL-developed varieties). Given the introduction of commercial and university-derived wheat cultivars each year, the amount of UNL wheat acreage varies from year to year (e.g., it ranged from 72.8 percent in 1999 to 54.7 percent in 2005), but consistently accounts for well over half the production wheat acreage in Nebraska. To provide a “smoothed” analysis of UNL wheat data, Battelle examined wheat harvesting data for the state for 1999 through 2005 (Table 1). The results show that, from 1999 to 2005, UNL wheat varieties were grown on an average of 1.077 million acres of production land in Nebraska (64.6 percent of all wheat production land in Nebraska). If the UNL varieties yield at the standard statewide level of 39 bushels per acre, this production acreage accounts for 42.8 million bushels of wheat, which, at an average of \$3.00 per bushel, amounts to \$125.7 million in wheat output for the state.

The above figures are based on an assumption that UNL varieties produce only at a state average yield. However, the work of UNL focuses on developing highly customized cultivars best suited to Nebraska growing conditions. The alternative for a farmer is to use more “generic” commercial varieties developed for multi-state environments to achieve higher commercial viability levels for seed producers. Thus, it is anticipated that special UNL varieties, given their Nebraska customization, are more likely to attain higher yields than more broadly distributed national varieties. The wheat breeding program at UNL has been achieving some startling results in yield improvement in its wheat cultivars. Scout 66, one of the early UNL variety releases, has served as a benchmark for evaluating wheat variety production improvements and has illustrated the yield advances being made through more recent UNL variety releases. Field trials have shown the recent varieties of Millennium, Goodstreak, and Alliance to average 1.29 times the baseline yield of Scout 66 (a 29 percent increase)—a highly significant performance gain.

These metrics beg the question: “What would be the economic impact of every 1 percent increase in Nebraska wheat that might be due to higher-yield UNL-developed wheat varieties?” Table 2 shows the results of calculations to measure these effects; a 1 percent yield increase would result in a statewide wheat output increase ranging from \$1,049,580 in 2000 to \$1,690,257 in 2003 (fluctuations are related to wheat commodity prices and other variables in each individual year). Adopting a yield increase of 29 percent results in output benefits ranging from \$30,437,825 in 2000 to \$49,017,440 in 2003.

Table 1 illustrates only the direct sales effects of a 1 percent increase in wheat yield (i.e., the dollar sales amount returned to the primary producer). Using the IMPLAN input output modeling system, it is possible to investigate the overall economic impacts of a 1 percent wheat yield increase by calculating effects on total economic output in Nebraska (by direct and indirect effects). Table 3 presents the results of this analysis in terms of total Nebraska economic output, value added, labor income, and jobs created.

Table 1: Wheat Production Statistics for Nebraska, 1999–2005
UN and Non-UN Wheat Varieties
(Red = UNL-developed or co-developed variety)

Variety	% '99	Acres 1,700,000	% '00	Acres 1,650,000	% '01	Acres 1,600,000	% '02	Acres 1,520,000	% '03	Acres 1,820,000	% '04	Acres 1,650,000	% '05	Acres 1,760,000
2137	3.6	61,200	8.2	135,300	10.4	166,400	8	121,600	10.3	187,460	7.8	128,700	4.3	75,680
Agripro														
Abilene	2.7	45,900	2.7	44,550	2.5	40,000	1.3	19,760	1.4	25,480	1.7	28,050	1.7	29,920
Agripro Hondo		0		0	1.2	19,200		0		0		0		0
Agripro Laredo		0		0		0		0		0		0		0
Agripro Ogallala	1.2	20,400	1.4	23,100	2.2	35,200	1.5	22,800	3.6	65,520	2.4	39,600	2	35,200
Agripro Thunderbird	3.9	66,300	2.8	46,200	1.9	30,400		0	1.8	32,760		0		0
Agripro Thunderbolt		0		0		0		0	2	36,400	3	49,500	1.9	33,440
Agripro Tomahawk	1.6	27,200	1	16,500		0	1.8	27,360		0		0		0
Agripro Jagalene		0		0		0		0		0	4.5	74,250	16.8	295,680
Akron	1.6	27,200	1.5	24,750		0	1.8	27,360	1.2	21,840		0		0
Alliance	10.4	176,800	15.1	249,150	16	256,000	16.6	252,320	11.5	209,300	13.6	224,400	10.1	177,760
Arapahoe	25	425,000	19.8	326,700	13.4	214,400	13	197,600	8.7	158,340	6.8	112,200	5.2	91,520
Buckskin	5	85,000	2.9	47,850	4.7	75,200	6.2	94,240	7.3	132,860	4.9	80,850	3.7	65,120
Centura	7.7	130,900	6.9	113,850	3.7	59,200	3.4	51,680	1.8	32,760	2.1	34,650	2.4	42,240
Culver		0		0	3.1	49,600	2.8	42,560	2.5	45,500		0		0
Goodstreak		0		0		0		0		0		0	1.7	29,920
Ike		0		0		0		0		0		0		0
Jagger	1.1	18,700	2.9	47,850	2.4	38,400	3.4	51,680	3.9	70,980	2.8	46,200	3.1	54,560
Karl/Karl 92	5.5	93,500	4.4	72,600	4.1	65,600	3.3	50,160	3.8	69,160	3.3	54,450	2.7	47,520
Millennium		0		0		0	3.5	53,200	6.1	111,020	11.1	183,150	10.7	188,320
Niobrara	11.4	193,800	10.3	169,950	9.3	148,800	6.9	104,880	5.4	98,280	3.5	57,750	2.2	38,720
Platte		0		0		0		0	1	18,200	1.3	21,450	1.6	28,160
Pronghorn	7.8	132,600	6.9	113,850	10.9	174,400	10.8	164,160	10.3	187,460	10.4	171,600	11.4	200,640
Redland		0		0		0		0		0		0		0
Scout Scout 66	1	17,000		0		0		0	1.1	20,020		0		0
Siouxland	1.1	18,700	1.5	24,750		0		0	1.4	25,480		0		0
Vista	2.1	35,700	2.7	44,550	1.7	27,200	3.1	47,120	1.2	21,840		0		0

Table 1: Wheat Production Statistics for Nebraska, 1999–2005 (continued)
UN and Non-UN Wheat Varieties
 (Red = UNL-developed or co-developed variety)

Variety	% '99	Acres 1,700,000	% '00	Acres 1,650,000	% '01	Acres 1,600,000	% '02	Acres 1,520,000	% '03	Acres 1,820,000	% '04	Acres 1,650,000	% '05	Acres 1,760,000
Wahoo		0		0		0		0	1.8	32,760	1.7	28,050	1.8	31,680
Wesley		0		0	1.1	17,600	2.2	33,440	3.6	65,520	5.9	97,350	5.5	96,800
Windstar	1.3	22,100	1.6	26,400	1.6	25,600		0		0		0		0
Other public varieties	4.1	69,700	5.4	89,100	7.6	121,600	6.5	98,800	4.9	89,180	8.8	145,200	7.2	126,720
Other public varieties	1.9	32,300	2	33,000	2.2	35,200	3.9	59,280	3.4	61,880	4.4	72,600	4	70,400
	100	1,700,000	100	1,650,000	100	1,600,000	100	1,520,000	100	1,820,000	100	1,650,000	100	1,760,000
Yield for Yr (Bu/Acre)		48		36		37		33		46		37		39
Total Production (Bu)		81,600,000		59,400,000		59,200,000		50,160,000		83,720,000		61,050,000		68,640,000
Yr Price per Bu (\$)		\$2.20		\$2.61		\$2.75		\$3.60		\$3.22		\$3.20		\$3.40
Value of Production (All)		\$179,520,000		\$155,034,000		\$162,800,000		\$180,576,000		\$269,578,400		\$195,360,000		\$233,376,000
UNL Production Acres		1,237,600		1,117,050		1,048,000		1,041,200		1,141,140		990,000		962,720
% UNL Production Acres		72.8%		67.7%		65.5%		68.5%		62.7%		60.0%		54.7%
Yield (at standard level) Bu/Acre		48		36		37		33		46		37		39
UNL Production (Bu)		59,404,800		40,213,800		38,776,000		34,359,600		52,492,440		36,630,000		37,546,080
Yr Price per Bu (\$)		\$2.20		\$2.61		\$2.75		\$3.60		\$3.22		\$3.20		\$3.40
Value of Production (UNL)		\$130,690,560		\$104,958,018		\$106,634,000		\$123,694,560		\$169,025,657		\$117,216,000		\$127,656,672
Value of Non UNL Production \$ Production Value per Acre (All)		\$48,829,440		\$50,075,982		\$56,166,000		\$56,881,440		\$100,552,743		\$78,144,000		\$105,719,328
		\$105.60		\$93.96		\$101.75		\$118.80		\$148.12		\$118.40		\$132.60

Source: UNL.

Table 2: Estimated Averaged Values (\$ Outputs) of Incremental Percentage Increases in Nebraska Wheat Yield, 1999–2005

Estimated Value of Additional UNL Yield	1999	2000	2001	2002	2003	2004	2005	Average
1% better than non-UNL	\$1,306,906	\$1,049,580	\$1,066,340	\$1,236,946	\$1,690,257	\$1,172,160	\$1,276,567	\$1,256,965
2% better than non-UNL	\$2,613,811	\$2,099,160	\$2,132,680	\$2,473,891	\$3,380,513	\$2,344,320	\$2,553,133	\$2,513,930
3% better than non-UNL	\$3,920,717	\$3,148,741	\$3,199,020	\$3,710,837	\$5,070,770	\$3,516,480	\$3,829,700	\$3,770,895
4% better than non-UNL	\$5,227,622	\$4,198,321	\$4,265,360	\$4,947,782	\$6,761,026	\$4,688,640	\$5,106,267	\$5,027,860
5% better than non-UNL	\$6,534,528	\$5,247,901	\$5,331,700	\$6,184,728	\$8,451,283	\$5,860,800	\$6,382,834	\$6,284,825
6% better than non-UNL	\$7,841,434	\$6,297,481	\$6,398,040	\$7,421,674	\$10,141,539	\$7,032,960	\$7,659,400	\$7,541,790
7% better than non-UNL	\$9,148,339	\$7,347,061	\$7,464,380	\$8,658,619	\$11,831,796	\$8,205,120	\$8,935,967	\$8,798,755
8% better than non-UNL	\$10,455,245	\$8,396,641	\$8,530,720	\$9,895,565	\$13,522,053	\$9,377,280	\$10,212,534	\$10,055,720
9% better than non-UNL	\$11,762,150	\$9,446,222	\$9,597,060	\$11,132,510	\$15,212,309	\$10,549,440	\$11,489,100	\$11,312,685
10% better than non-UNL	\$13,069,056	\$10,495,802	\$10,663,400	\$12,369,456	\$16,902,566	\$11,721,600	\$12,765,667	\$12,569,650
11% better than non-UNL	\$14,375,962	\$11,545,382	\$11,729,740	\$13,606,402	\$18,592,822	\$12,893,760	\$14,042,234	\$13,826,614
12% better than non-UNL	\$15,682,867	\$12,594,962	\$12,796,080	\$14,843,347	\$20,283,079	\$14,065,920	\$15,318,801	\$15,083,579
13% better than non-UNL	\$16,989,773	\$13,644,542	\$13,862,420	\$16,080,293	\$21,973,335	\$15,238,080	\$16,595,367	\$16,340,544
14% better than non-UNL	\$18,296,678	\$14,694,123	\$14,928,760	\$17,317,238	\$23,663,592	\$16,410,240	\$17,871,934	\$17,597,509
15% better than non-UNL	\$19,603,584	\$15,743,703	\$15,995,100	\$18,554,184	\$25,353,849	\$17,582,400	\$19,148,501	\$18,854,474
16% better than non-UNL	\$20,910,490	\$16,793,283	\$17,061,440	\$19,791,130	\$27,044,105	\$18,754,560	\$20,425,068	\$20,111,439
17% better than non-UNL	\$22,217,395	\$17,842,863	\$18,127,780	\$21,028,075	\$28,734,362	\$19,926,720	\$21,701,634	\$21,368,404
18% better than non-UNL	\$23,524,301	\$18,892,443	\$19,194,120	\$22,265,021	\$30,424,618	\$21,098,880	\$22,978,201	\$22,625,369
19% better than non-UNL	\$24,831,206	\$19,942,023	\$20,260,460	\$23,501,966	\$32,114,875	\$22,271,040	\$24,254,768	\$23,882,334
20% better than non-UNL	\$26,138,112	\$20,991,604	\$21,326,800	\$24,738,912	\$33,805,131	\$23,443,200	\$25,531,334	\$25,139,299
21% better than non-UNL	\$27,445,018	\$22,041,184	\$22,393,140	\$25,975,858	\$35,495,388	\$24,615,360	\$26,807,901	\$26,396,264
22% better than non-UNL	\$28,751,923	\$23,090,764	\$23,459,480	\$27,212,803	\$37,185,644	\$25,787,520	\$28,084,468	\$27,653,229
23% better than non-UNL	\$30,058,829	\$24,140,344	\$24,525,820	\$28,449,749	\$38,875,901	\$26,959,680	\$29,361,035	\$28,910,194
24% better than non-UNL	\$31,365,734	\$25,189,924	\$25,592,160	\$29,686,694	\$40,566,158	\$28,131,840	\$30,637,601	\$30,167,159
25% better than non-UNL	\$32,672,640	\$26,239,505	\$26,658,500	\$30,923,640	\$42,256,414	\$29,304,000	\$31,914,168	\$31,424,124
26% better than non-UNL	\$33,979,546	\$27,289,085	\$27,724,840	\$32,160,586	\$43,946,671	\$30,476,160	\$33,190,735	\$32,681,089
27% better than non-UNL	\$35,286,451	\$28,338,665	\$28,791,180	\$33,397,531	\$45,636,927	\$31,648,320	\$34,467,301	\$33,938,054
28% better than non-UNL	\$36,593,357	\$29,388,245	\$29,857,520	\$34,634,477	\$47,327,184	\$32,820,480	\$35,743,868	\$35,195,019
29% better than non-UNL	\$37,900,262	\$30,437,825	\$30,923,860	\$35,871,422	\$49,017,440	\$33,992,640	\$37,020,435	\$36,451,984
30% better than non-UNL	\$39,207,168	\$31,487,405	\$31,990,200	\$37,108,368	\$50,707,697	\$35,164,800	\$38,297,002	\$37,708,949

Source: Battelle calculations based on UNL data.

Table 3: Economic Impact of a Percentage Increase in Wheat Output for 2004 and 2005

Years	% Change	Sales	Impacts			
			Total Output	Value Added	Labor Income	Employment
2004	1%	\$1,172,160	\$1,823,875	\$975,667	\$581,084	17
2005	1%	\$1,276,567	\$1,986,332	\$1,062,572	\$632,843	19
2004	29%	\$33,992,640	\$52,892,375	\$28,294,343	\$16,851,436	493
2005	29%	\$37,020,435	\$57,603,628	\$30,814,588	\$18,352,447	551

Source: Battelle calculations based on Minnesota IMPLAN Group, Inc., 2003 Nebraska state data files.

Table 3 illustrates the effects of every 1 percent increase in wheat production and the effects of a 29 percent increase, likely to be the average increase based on the higher-yielding cultivars developed as a result of IANR research. A 29 percent increase results in more than

\$57.5 million in terms of the total economic output gain in Nebraska (for 2005) and in more than \$18.3 million in terms of increased labor income to Nebraskans. A 29 percent output gain for 2005 also results in 551 jobs within the state.

Example: Biochemistry-led Initiatives

Background: UNL/IANR is well known for its biochemistry strengths, with academic work in basic biochemistry and molecular biology. Particularly well recognized are strengths in redox biology (redox reactions include all chemical processes in which atoms change their oxidation number/oxidation state) with direct application to plant improvement because crop plant productivity is associated with massive regulation of metabolic processes by redox (with one redox modulated function being photosynthesis). Another key strength in plant biochemistry is gene technology to improve crops, with especially notable activity occurring in dicamba herbicide resistance.

Impact: IANR's dicamba resistance work is likely to significantly impact not only Nebraska and Midwestern agriculture, but also the UN itself. The IANR discoveries have been patented by UNL and exclusively licensed recently to Monsanto under agreement to develop broadleaf crops tolerant to this low-cost, proven herbicide. IANR has several patents pending on dicamba-sensitive crops, such as soybeans, based on IANR researcher identification of genes that can increase crop plant tolerance to the herbicide.

Dicamba, which is economical and does not persist in soil, is effective against most broadleaf weeds, including weeds that are traditionally hard to control. Farmers use it to control broadleaf weeds in grassy-type crops such as corn and wheat. However, it is currently harmful to crops such as soybeans, canola, and cotton, which also are broadleaf plants. **The IANR technology is developing soybean and other crop varieties highly tolerant of dicamba.** While long-term yield impacts have not yet been calculated, there is little doubt that farmers will gain by using dicamba-resistant broadleaf crops—through increased per-acre productivity and increased production ease.

Potential benefits of this discovery can be understood by examining the value of the soybean crop to the Nebraska economy. In 2004 the value of soybean production in Nebraska was \$1.12 billion, with the crop harvested on 4.75 million acres of Nebraska farmland. **If yield improvements and production cost efficiencies through the dicamba resistance discovery resulted in only a 1 percent improvement in soybean productivity in Nebraska, the direct impact would be an increase of \$11.2 million in Nebraska farm output.**

While IANR does much to ensure profitability and sustainability of agriculture and related industries in Nebraska, its work also develops and introduces new crops and food and biobased products that enhance and diversify the Nebraska economy. These functions are discussed in more detail in the next chapter.

Sustaining and Improving Animal Production

While crop production is a major industry for Nebraska, the livestock industry is even larger in Nebraska.¹⁷ 2005 data indicate that the state has an inventory of more than 6.3 million head of cattle and calves. Livestock sales totaled \$5.4 billion (2002 Census of Agriculture data), ranking Nebraska third among states in livestock production. These figures, however, understate the importance of livestock to the state because they fail to account for the volume and value of inputs, such as feed crops grown on Nebraska farms, and the economic output of the meat processing and value-added meat and food products industry in the state. A productive and profitable livestock industry is thus critically important to maintaining the health of an economically important, vertically integrated production system in the State of Nebraska.

Example: Livestock Production Technologies

Background: IANR plays an important role in all stages of the livestock production and processing system. Institute scientists work on a range of relevant topics such as improving the nutritional value of feed; enhancing feed crop yields; breeding livestock with optimal meat characteristics; improving meat animal health; enhancing manure and waste management; fostering value-added processing; and developing improvements in meat products handling and food safety. Work at IANR ranges from basic science studies in cattle genetics, reproduction, and physiology to applied in-the-field work by IANR extension specialists with individual producers and processors.

Impact: With the range of livestock-focused research, training, and extension programs undertaken by IANR, many impact examples could be selected for illustration. Some examples of impacts include the following:

- **Feed cost reduction**—Feed costs are the single largest expense (60 percent) for beef cattle producers. IANR has researched alternative feed products, such as distillers grains from ethanol production, and educated ranchers and livestock producers in using these alternative feed products. One test project in Ainsworth, Nebraska, produced a distillers-grain-meal feed cube that has saved \$31 per ton in feed costs. Over a 5-month study, ranchers using the new feed cubes saved \$232,500.
- **Beef Productivity Workshops**—Workshops held in 2005 focused on various techniques and skills to increase producer productivity. Post-workshop evaluations identified that producers realized savings of \$11 per head through applying techniques and skills learned in the program. Attending producers managed 11,890 head of cattle, for an effective savings of \$131,780.
- **Feedlot Roundtables**—Nebraska ranks as one of the top two states in head of cattle in feedlots; thus, the productivity and profitability of feedlot operations are central to livestock industry economics in the state. Held annually, IANR’s Nebraska Beef Feedlot Roundtable is a well-attended event in which IANR researchers and extension educators expose feedlot producers to the latest tools, techniques, and technologies for efficient feedlot management. Post-event surveys of attendees including producers and allied

¹⁷ The 2002 Census of Agriculture State Profile for Nebraska reports the total market value of Nebraska agricultural products at \$9.7 billion, with \$3.4 billion comprising “crops, including nursery and greenhouses” and \$6.3 billion in “livestock, poultry, and other products.”

industry representatives showed that producers evaluated the information obtained at an economic impact of \$4 per head, with attendees having 750,000 head, for a \$3 million economic impact, while the allied industry representatives influenced more than 3 million head of cattle and estimated an economic impact of \$6.47 per head, for a total estimated impact of \$19.4 million.

Example: Bovine Viral Diarrhea Virus Diagnostic Tools

Background: Bovine viral diarrhea virus (BVDV) is widespread in cattle. It has been estimated that 80 percent of cattle in this country have been exposed to BVD, and that 70 to 90 percent of infections go undetected, without visible symptoms. It is the most costly viral disease in cattle, inhibiting conception, causing abortion and birth defects, and hindering the immune system—making the animals more susceptible to other diseases. In the U.S. cattle industry BVD is costing producers an estimated \$2 billion per year. For cattle producers the virus causes economic losses through decreased weight gains, decreased milk production, reproductive losses, and death.

Impact: Researchers at IANR have actively been working to develop diagnostic tools to detect persistent BVDV in cattle in order to be able to remove the infected animals from the herd before more widespread damage can be caused. A diagnostic application developed by IANR was used in the Veterinary Diagnostic Center to identify persistently BVDV infected animals. The assay was performed on 243,918 samples during FY 2006. Infection rates range from 0.3% to 0.05% of animals tested. Testing has resulted in more than 7,000 infected animals being identified in FY 2006.

Research suggests BVD virus contributes to 15 percent of primary feedlot respiratory disease and a 43 percent increase risk of disease in animals exposed to persistently infected calves. The economic losses can be as high as \$5 to \$12 per head when there are persistently infected calves present. Furthermore, costs of infection in breeding herds have been reported to be as high as \$14 to \$24 per head. Studies demonstrate that four percent of a random beef herd contains persistent BVDV infected calves. With 20,000 operations and 1.9 million cows in Nebraska, the potential savings is \$1.64 million dollars per year. In addition, with an estimated 2 million cattle on feed in Nebraska feedlots, there is an opportunity for additional savings by screening feeder calves upon entry.

Example: Development of Calving System to Reduce Calf Scours

Background: Calf scours is a leading cause of death in beef calves. Calf scours is a complex disease that is difficult to eliminate. It is caused by a variety of infectious agents and conditions, not just one single agent. In fact, almost any disease agent which attacks a calf during the first three weeks of life will result in some level of scours (diarrhea). The reason is because the calf's stomach is still so immature during that period and is the weakest point of the calf's system. In some herds, nearly all young calves develop scours and five to ten percent die of related illnesses. Treatment, performance, and death losses can cost individual ranchers thousands of dollars annually.

Impact: Researchers at IANR have developed a calving system to reduce calf scours on ranches in Nebraska. The system manages cow herds during calving season to prevent

transmission of diarrhea-causing germs. In field tests, the system drastically reduced calf illness and treatment costs and eliminated calf deaths from scours.

Ranchers who have adopted the calving system report significantly reducing calf sickness, death, and antibiotic use. The system also aids labor efficiency during the busy calving season. The estimated savings for a 900-head ranch was \$50,000 annually due to improved calf performance, greatly reduced treatments costs, and having more calves to sell. IANR is working with veterinarians and ranchers to implement this calving system across the state.

Other areas in which IANR is producing positive impacts relevant to the livestock industry include grazing management, employee management, beef ration balancing and mineral nutrition (\$5 to \$10 per head reported cost savings across multiple projects), and livestock reproduction/cow calf production (\$55 per cow in feed costs through changing calving dates).

It should be noted that, in each of the above cases, the impacts being realized are reoccurring in nature. In other words, if \$5 per head in increased livestock value is achieved in the first year of implementing IANR R&D-based recommendations, that same \$5 benefit continues to be realized in future years.

It is clear that IANR work related to livestock reproduction, nutrition, health, processing, and marketing has a significant impact per head on beef livestock. Given that the cattle production is a \$5.4 billion industry for Nebraska, even a \$1 per head increase in value through IANR programs yields a direct economic output benefit of more than \$54 million (at 2002 production levels).

Sustaining the Environment and Natural Resources

Agriculture's long-term vitality and prosperity depend on its ability to co-exist sustainably with the natural environment. Clearly, agriculture is not environmentally neutral—farming changes the structure and use of the landscape; uses water resources; and often requires fertilizers, pesticides, and other chemicals to sustain productivity. Natural ecosystems are affected by agriculture and agricultural practices, and backward and forward linkages exist between agroecosystems (crops, pastures, and ranchland) and the environment (including energy, air, water, and land). This interface is a knife that cuts both ways: agriculture influences the environment, and the environment influences agriculture.

IANR work focuses on rural and urban environmental sustainability and is of critical importance to the state.

At IANR multiple programs are engaged in individual and collaborative research covering such topics as the ecology of agricultural systems; response of agroecosystems to environmental stress (climate change, intensification, soil degradation, pollutants, waste materials, air and water quality, and changing land and water use); agricultural landscape ecology and processes; and characteristics of agroecosystems from a biological, physical, and environmental standpoint. Given the significance of agriculture to Nebraska's economy and the fact that farms and ranches account for more than 45.9 million acres of Nebraska land, ensuring an effective balance of agriculture and the environment is of critical importance to the state's economic and ecological sustainability.

Programs at IANR focused on agriculture, the environment, and natural resource preservation are examining issues from multiple perspectives. Examples of notable work include the following:

- **Conservation Tillage**—This and other work at IANR concentrates on maintaining soil resources for the state. Conservation tillage, in particular, uses tillage and planting systems that maintain at least 30 percent of the soil surface covered by residue after planting to reduce soil erosion by water.
- **Animal Waste Management**—With more than 6 million head of cattle in the Nebraska inventory, there are many beef feedlots across the state, in addition to the more than 2.9 million hogs and pigs and more than 12 million poultry animals. Consequently, animal waste management is a major focus for IANR research, teaching, and extension activities. An estimated 47 million tons of animal waste is generated in Nebraska per year, with the largest amount (41 million tons) generated by cattle. IANR is working on more than waste reduction; it is examining not only manure application for soil improvement but also new areas such as energy generation as productive uses for waste.
- **Fertilizer and Agricultural Chemicals**—Agrichemicals (fertilizers, pesticides, and insecticides) are necessary to maintain soil fertility and achieve the high levels of agricultural productivity necessary for Nebraska to compete in world commodity markets. The need is such that in 2002 commercial fertilizer, lime, and soil conditioners were applied to more than 13.3 million acres of Nebraska land, while herbicides were applied to more than 11.3 million acres. While necessary for achieving desired productivity levels, agricultural chemical use has a downside—the leaching of nitrates into groundwater and the runoff of chemicals into surface waters constitute environmental challenges. IANR is working to reduce runoff and chemical volumes used and positively influence other factors to ameliorate this situation.
- **Water Resource Management**—Water is a key input for all agriculture and livestock operations in Nebraska, yet it is a finite resource. It is critically important to manage both groundwater and surface waters in the state, especially in areas of Nebraska dependent on irrigation for profitable crop production. U.S. Geological Survey data show, for example, that irrigation in Nebraska uses on average 7,420 million gallons per day from groundwater resources. As a result, IANR focuses considerable research and education work on water resources, water management, and drought mitigation issues.
- **Biological Systems**—IANR researchers take a holistic and integrated approach to ensuring the sustainability of Nebraska ecosystems. Areas of study include conservation biology, windbreak management and ecology, ecological toxicology, pollution prevention, carbon sequestration, and preservation of aquatic and terrestrial habitats and ecosystems.

Examples of IANR’s work in environment and natural resource sustainability are provided below.

Example: Advanced Soil Testing and Fertilizer Use Efficiency

Background: Soil, and the nutrients contained therein, is a foundation for successful agriculture. Historically, soil fertility has been improved by applying nitrogen fertilizers. However, the widespread overuse of these fertilizers has caused environmental degradation because, as nitrates accumulate in groundwater and surface water, the release of nitrous oxide and greenhouse gas emissions increases. In addition to environmental issues, fertilizer constitutes a significant farm expense; thus, optimizing its use and reducing its overapplication can have significant financial as well as environmental benefits. IANR researchers have expertise in nitrogen cycling in agro-ecosystems and associated experience

in soil nitrogen capacity, use, and plan requirements. This has translated into expertise in soil analysis and fertilizer use planning incorporating soil testing at depths of 3 feet. IANR's research also extends to application techniques and the specific types of nitrogen product that are best to apply.

Impact: Multiple impact benefits are associated with this area of IANR work, including

- Increasing crop yield through enhanced soil productivity,
- Reduced fertilizer purchases for Nebraska producers, and
- Reduced environmental costs, such as water treatment to lower nitrate levels.

NASS data show that corn grain yields in Nebraska have steadily increased since 1965. Over this same time period, the application of nitrogen has increased at a significantly slower rate, thus demonstrating an increasing efficiency in nitrogen use. In 1964, Nebraska farmers achieved a yield of 54 bushels of corn per acre and applied 57 pounds of nitrogen per acre to support this yield—this equates to a yield of 0.95 bushels of corn per pound of nitrogen. By 2004, the corn yield had increased dramatically to 166 bushels per acre, with 130 pounds of nitrogen applied. This equates to 1.28 bushels of corn being produced per pound of nitrogen (a nitrogen-to-yield efficiency increase of 35 percent).

IANR researchers cite several factors for this substantial jump in nitrogen use efficiency, including recommendations for improvements in production practices (including soil test-based nitrogen application recommendations, application timing recommendations, and placement strategies) together with the introduction of corn hybrids that take-up and use nitrogen more efficiently. This information is disseminated through *CropWatch*¹⁸ as well as a myriad of other information means. The Institute provides worksheets and tools to determine the most profitable corn nitrogen rate recommended for a specific field situation, based on data from more than 80 research trials conducted across Nebraska and more than 85 replicated tests in northeast Nebraska.

NASS reports that Nebraska produced 1.32 billion bushels of corn for grain in 2004. At the 1964 nitrogen application efficiency rate, this would have required almost 1.39 billion pounds of nitrogen, but through the advancements cited above, only 1.03 billion pounds were actually needed in 2004 (a reduced demand of over 358,000 pounds of nitrogen). Given that nitrogen fertilizer sells on the open market for circa \$0.35 per pound, the nitrogen to yield efficiency increases realized are effectively saving farmers \$125.4 million.

It should also be noted that Nebraska has a substantial private sector environment and soil testing industry that benefits from IANR research and recommendations. Key Nebraska companies include AgSource Harris Laboratories, Midwest Laboratories, Ward Laboratories, Servi-Tech Laboratories, and Olsen's Agricultural Laboratory each linked to UNL through the founders, key employees, or the roots of the science and technology being used in their testing work. It is therefore likely that new tests and testing technologies developed at IANR can be transferred for commercialization into local Nebraska companies.

¹⁸ (<http://cropwatch.unl.edu/focusnitrogen.htm>)

Example: National Drought Mitigation Center

Background: The National Drought Mitigation Center (NDMC) helps people and institutions develop and implement measures to reduce societal vulnerability to drought, stressing preparedness and risk management rather than crisis management. Most of the NDMC's programs are directed to state, federal, regional, and tribal governments that are involved in drought and water supply planning.

Based in the School of Natural Resources at the UNL, the NDMC was established in 1995. The NDMC's activities include maintaining an information clearinghouse; monitoring drought, including participating in the preparation of the U.S. Drought Monitor and maintenance of the Web site (<http://www.drought.unl.edu/dm>); planning for and mitigating drought; establishing drought policy; advising policy makers; conducting collaborative research and K-12 extension; organizing and conducting seminars, workshops, and conferences for federal, state, and foreign governments and international organizations; and providing data to and answering questions for the media and the general public.

Impact: Drought mitigation helps the citizens of the state manage the negative costs, such as reduced farm yields, lost harvests, and economic hardship, that ripples through an agriculture-based economy like Nebraska if drought hits. During dry seasons, crops are more susceptible to insect infestation and plant diseases, and the need for irrigation and special pesticides increase the cost of crop production. Reduced crop yields and increased farming costs also bring about economic effects including depressed land values, income and employment losses in agriculture-dependent industries (e.g., machinery, food processors), strain on financial lending institutions, and increased social service costs. As productivity and income decline, so also do associated tax revenues for federal, state, and local governments.

By hosting the NDMC, Nebraska benefits from early access to mitigation tools, procedures, and technologies under development and in trials. While drought mitigation is intuitively beneficial, no formal impact studies have been undertaken of drought events or risks in Nebraska. The impact benefits can be drawn by association, however, with measures of impacts in other states and locations. In 2002, the value of drought-related loss in production within Canada for the six major grains and oilseeds (wheat, canola, barley, oats, flaxseed, and rye) was estimated at nearly \$2.8 billion.¹⁹ The U.S. Federal Emergency Management Agency (FEMA) estimates that, on average, drought costs the United States \$8 billion per year. The National Climatic Data Center in Asheville, NC, lists 57 weather-related disasters that have caused more than \$1 billion in losses in the United States between 1980 and 2003. Of those 57 disasters, 10 are drought-related, ranging from \$61.6 billion in 1988 and \$48.4 billion in 1980 to \$1.1 billion during the East Coast drought during 1999 (normalized to 2002 dollars).

While drought mitigation work cannot change the weather, it can significantly reduce the negative economic impacts of drought conditions. What would a modest estimate of the economic benefits of this work be for Nebraska? **2002 Census of Agriculture statistics show that the total market value of U.S. agricultural output was \$200.6 billion; Nebraska's contribution totaled \$9.7 billion or 4.8 percent. Using the FEMA estimate of**

¹⁹ Canadian Wheat Board, 2002.

\$8 billion in drought-related national losses per year (average), Nebraska’s normative share would have been \$384 million. If the NDMC’s work resulted in just a 10 percent reduction in these losses, that would equate to a \$38.4 million equivalent benefit for the state economy. These are, of course, gross estimates, and actual drought events could vary widely from these figures. However, they do illustrate of the magnitude of benefits that may occur.

Example: Republican River Basin Irrigation Management Project

Background: The Republican River Basin Irrigation Management Project, funded by the U.S. Bureau of Reclamation, has successfully demonstrated on farmers’ fields the benefits of alternative irrigation management strategies on water use and profitability. The ultimate purpose of the project, which was conducted in southwest Nebraska, an area that has experienced substantial groundwater declines and frequent seasons with less than adequate surface water supplies, was to positively influence farmers to adopt water-saving strategies.

Impact: Through the demonstration of three irrigation management strategies, it was discovered that a producer could expect comparable yields with significantly less water usage. Specifically:

- Fully Watered irrigation treatments obtained 101 percent of the yield using only 87 percent of the irrigation water.
- Water Miser irrigation treatments obtained 97 percent of the yield using only 69 percent of the irrigation water.
- Deficit Irrigation treatments obtained 89 percent of the yield using only 50 percent of the irrigation water.

The 2004 program survey results indicate that the Republican River Basin Irrigation Management Project has had a significant impact on southwest Nebraska. The average reported value of the knowledge gained was \$16,520 per operation. Conservatively, this would be more than \$2 million per year. The reported potential water savings of 2.2 in. per acre would be a 10 to 15 percent savings from the typical irrigation water usage and conservatively would be more than 45,000 acre-feet per year.

Catalyzing Farm Business Plan Development

The agricultural sector in Nebraska comprises many thousands of businesses, mostly small businesses. These businesses operate in a multitask environment—performing functions in soil science, environmental resource management, equipment maintenance and repair, planting, animal care and nutrition, chemical management, pest and disease management, harvesting, storage, and distribution. In some cases, producers also will be involved in product processing and other activities designed to realize added value from their initial output. On top of its scientific and engineering aspects, a farm also operates as a business. With this comes the issues and responsibilities of financial management, personnel management, and sales and marketing.

IANR provides important education, training, and support for those in agriculture, agribusiness, and associated sectors—working with producers and processors to help them grow, sustain, and enhance the profitability of their businesses.

Example: Business Planning for Agricultural Producers

Background: UNL was awarded a USDA Sustainable Agriculture Research and Education program grant to develop a curriculum for farm business plan development and marketing strategy implementation. A group of producers and IANR experts teamed to develop the *Tilling the Soil of Opportunity* curriculum for producers involved in sustainable, organic, or alternative agricultural production practices. The objectives of the program were to

- Provide locally based entrepreneurial marketing training for alternative, organic, and sustainable agriculturalists to increase their business viability and marketing potential, and
- Provide adequate household income for sustainable farm producers.

Impacts: IANR and small and agricultural business development organizations across the State of Nebraska partnered to train instructors, course coordinators, and, subsequently, producers on agricultural business planning. As a result, 43 *Tilling the Soil* courses were offered between fall 2000 and spring 2002 in 18 different states. Within the training, 52 percent of the participants completed the course with a business plan for their own agricultural business.

One producer who participated in a Nebraska course stated, “I had never looked at it (the opportunity costs) before, but we were losing the revenue we could have had with another customer for about \$20,000 per year. Over a 4-year period, I lost over \$80,000 in gross income. We moved those 80 bulls into one pen and we filled the other pen. As a result we increased our income over \$20,000 per year by having another pen available.”

Follow-up with more Nebraska participants indicate that others who had availed themselves of the training and completed their business plans are using them in their farm businesses. Outcomes have included farmers received refinancing and expansion loans that would not have been granted without the business plan. Others are using the business plan as part of a strategic planning process for their farms.

Example: Assisting the Next Generation

Background: IANR presents educational events to provide a forum where beginning farmers and ranchers can gather, network, and share ideas and information with IANR experts and other producers. In addition, information is provided to assist attendees in identifying and managing risks associated with their farming business. The educational forums include both large and small group settings, allowing participants to choose topics of interest for interaction and discussion.

Impacts: While the impacts of these sessions are difficult to quantify, with their significant impact to be felt in years to come as Nebraska’s farms are turned over to the next generation, conference attendees have commented as follows:

- “Tough issues were addressed with good advice and solid examples of success.”
- “It connected me with people that know about programs to begin farming.”
- “Meeting other young producers like myself was beneficial.”

- “I’m farming now and would like to get bigger so I can farm full time and this conference has helped give me some good ideas and directions to head.”

Maintaining Food Safety and Security

In an agriculture- and food-based economy, preserving product safety is crucially important—not only for human and animal health, but also for economic sustainability. Food product recalls can run to tens of millions of dollars and have negative effects that ripple through many sectors of the economy. One action in 1997, for example, by Hudson Foods’ plant in Columbus, Nebraska, recalled 25 million pounds of frozen ground beef, the largest meat recall in U.S. history up to that time. Accidental contaminations can occur at multiple stages in the agriculture and food chain, from contaminations on the farm to poor food handling by food preparers at a restaurant.

IANR’s work in nutrition, health, and food safety works to secure and protect the existing agriculture and food industry in the state and to expand the sector’s productivity and product output through the introduction of new food and nutrition products and value-added opportunities.

While accidental food contaminations have constituted the bulk of problems, deliberate tampering and terrorist acts designed to contaminate, infect, or otherwise disrupt the agriculture and food supply system are posing potential threats and increasing concern. In addition to these challenges, emerging diseases also threaten the food supply, most notably potential outbreaks of diseases such as scrapie, bovine spongiform encephalopathy, chronic wasting disease, and foot-and-mouth disease.

With such widespread potential for multimillion dollar economic damage and serious human health implications, agriculture and food safety and security are a major focus of IANR research, teaching, and extension. IANR research spans the full spectrum from “farm to table” and is particularly strong in food safety microbiology and concentrations in many forms of risk factors including: molds, mycotoxins, bacteria, natural toxicants, environmental contaminants, chemicals and chemical residues, and allergens. On a national basis, only the University of Georgia matches the breadth and depth of UNL’s programs in food safety and security. In total, UNL receives more than \$7 million in research grants and contracts for food safety and more than \$41 million in Extension grants, contracts, and fees.

In addition to research initiatives, IANR conducts major extension and education programs including work with primary agricultural producers, meat and food processors, and food handlers and preparers. IANR has, for example, been instrumental in training Nebraska meat and poultry processors to reach compliance with federally mandated Hazards Analysis and Critical Control Points (HACCP)—to the extent that Nebraska has been a leader in adopting the new regulations and meeting compliance requirements. IANR assisted in developing 125 HACCP plans for 95 companies, and specialized UNL training programs were attended by 650 persons from 350 companies.

Example: Food Safety and Security Training

Background: Many people suffer from severe allergic reactions to various food ingredients, and it is highly important that food manufacturers ensure the integrity of all ingredients in their labeled products. In response to a need for training in this area, IANR implemented a

program for the food industry to provide training in handling potentially hazardous residues of allergenic foods in manufacturing facilities.

Food companies and regulatory agencies use the information obtained from the IANR program to make decisions about the safety of food products for food-allergic consumers and the efficiency of food industry equipment cleaning and other practices. Based on the information received through the program, participating food companies changed their cleaning, labeling, and manufacturing practices. Regulatory agencies used the information to help make regulatory decisions on foods that were out of compliance and posed a threat to the health of food-allergic consumers.

Impact: Held in 2002, IANR training was provided to 114 food industry representatives and two regulatory agency representatives. While it is difficult to quantify cost savings from possible recalls, participants contacted the IANR program leaders noting that the information from this program saved an estimated \$500,000 in potential recall costs and unknown amounts of potential lawsuit payouts from consumer reactions. Subsequent to completion of the program, 19 attending companies continued to work with IANR for further information and follow-up on allergen control strategies. It should also be noted that IANR's internationally regarded allergen research program has had successes resulting in intellectual property generated at the university, most notably in allergen testing products.

Foodborne illnesses, in general, have a significant negative economic impact on society.

U.S. Food and Drug Administration research indicates that seven of the most common foodborne pathogens cause between 3.3 million and 12.3 million illnesses each year in the United States and result in up to 3,900 deaths. If foodborne pathogens caused illness in Nebraska at a rate proportionate to its share of the U.S. population (0.59 percent), between 19,470 and 72,570 foodborne illnesses would harm Nebraskans each year and about 23 would die. In a 1995 study, USDA researchers estimated the negative monetary losses of the seven leading pathogens at between \$6.5 billion and \$13.3 billion annually, or between \$19.5 million and \$38.4 million annually in Nebraska. It is clear, from these estimates, that the work of IANR in promoting a safer food supply holds significant value for the state in terms of offsetting negative costs and human suffering.

Example: Beef Quality Assurance

Background: Bolstering consumer confidence in the quality of beef is a high priority. Materials and education/training programs on Beef Quality Assurance (BQA) have been developed to quell fears regarding the safety of beef products. Nebraska-developed BQA materials have been viewed as the gold standard in educational materials and now are used by 15 other states. The training focuses on production and management techniques that help avoid quality defects and safety issues with beef and boost consumer confidence in beef and beef products.

Impact: IANR reports that, since 1998, demand for BQA-certified beef has increased threefold. In 2000 meat packers contracted for 52,000 head of BQA-certified Nebraska corn-fed beef and agreed to pay a premium of \$16 per head for these certified cattle (an impact of

\$832,000). Premium quality, certified beef programs have now spread further, and positive economic impacts for Nebraska producers have no doubt increased further.

Sustaining Nebraska’s Communities: IANR’s Community and Social Service Impacts

While it is recognized that the American economy is firmly rooted in free enterprise, this competitive system, by its very nature, produces extremes of success and failure. Just as the 19th and 20th centuries saw a powerhouse industrial nation emerge from an agrarian societal base, so too is the 21st century bringing dramatic change as the economy shifts to an information- or knowledge-based, technologically driven platform. As the economy adjusts, some communities prosper immediately; but, many others face great challenges in altering their economic base and structure to fit into the New Economy.

Developing a foothold in the New Economy requires a strong innovation-led strategy, most notably rooted in science- and technology-led R&D activity. The following approaches have been identified as important to the development of such strategy in national and international case studies:²⁰

- **Investing in human capital.** Innovation and the accompanying rapid structural change require a dynamic, well-educated, and skillful populace. The Kenan Institute²¹ notes that “the leading technology regions are investing heavily in programs to enable the workforce to learn and re-learn the competencies and skills required in that dynamic economic world.”
- **Harnessing information technology.** A region must have a “well-developed, well-utilized information network to be competitive in a knowledge economy.”²² Leading technology regions are cementing their leadership position by investing substantially to develop information networks linking schools, governments, private companies, and other organizations—allowing citizens to access expanding information to provide a competitive advantage.
- **Developing an entrepreneurial culture.** It is hard to define an entrepreneurial culture, but it is a distinct necessity to have such an environment for building an innovation- and technology-led economy. Berglund and Clarke note that “in an entrepreneurial culture, people view starting a company as routine rather than an unusual occurrence, entrepreneurs are celebrated, individuals know many others who have started their own company, and people view company failure as a possible outcome of doing business rather than a cause for social disgrace.”²³ This impact report adds to that statement, noting that a true entrepreneurial culture is one in which a considerable number of serial entrepreneurs have successfully created multiple start-ups, are visible in the community, and are actively mentoring the next generation.

²⁰ Kenan Institute of Private Enterprise, University of North Carolina at Chapel Hill. *Best Practices in Science and Technology-Based Economic Development Policy: US and Global*. North Carolina Board of Science and Technology, September 1999.

²¹ Ibid.

²² Ibid.

²³ Berglund, D., and M. Clarke. *Using Research and Development to Grow State Economies*. National Governors’ Association, NGA Center for Best Practices, 2000.

- **Promoting quality of life/quality of place.** Betsy Donald²⁴ points out that “quality of life is an individualized concept, whereas quality of place suggests a consensus in a place regarding how quality of life strategies should be prioritized in terms of an overall development plan.” A city’s quality of place is the sum of those cultural, social, recreational, and other assets that serve the needs of the whole population. While a somewhat intangible concept, the qualities of a place can translate into an image and reputation that are of great importance in talent attraction and associated economic growth.

These changing economic and sociological conditions impact not only agricultural producers and processors, but all aspects of rural and urban life in Nebraska. Global economic forces have shaken traditional production and manufacturing sectors; shifted the economic foundations of communities; and, as a result, challenged the way of life of the typical American family (to the extent that a “typical” family exists in such a diverse and heterogeneous nation). An innovation-driven or “knowledge” economy is leaving behind those who have low educational and skill levels. Many families once supported by one income are requiring two incomes to sustain a similar quality of life. With these challenges have come increases in associated societal problems such as crime, substance abuse, broken families, and other issues related to family and physical health.

These are the challenges of modern economic development, and IANR plays an extremely important role in helping Nebraska’s communities understand and adjust to the positive and negative ramifications of these forces for their economic, community, and social development. IANR provides active research, educational activities, and extension programs, and in many areas other than pure agriculture, agribusiness, and agbioscience. From small rural communities to Nebraska’s largest cities, IANR is active in the research-based development and applied delivery of assistance. IANR’s social and community development work can be separated into the following six categories.

Spurring Economic Development—Business Creation, Retention, and Expansion

Business development is a key component of successful economic development. By expanding the employment base and developing high-productivity, high-wage positions, communities in Nebraska can build long-term economic prosperity and sustainability. IANR actively participates in providing training and tools for local Nebraska business development initiatives.

By adopting a formal approach to business retention and expansion, communities reap multiple benefits. First, the analytical phase builds an in-depth understanding of community economic and general business conditions—understanding that forms a platform for work to sustain the positive initiatives and generate improvements in areas of need. Likewise, the research phase also builds relationships between the economic development community and business and workforce leaders, strengthening local bonds and providing a trusted basis for dialogue. Work to improve local business conditions not only serves existing enterprises, but also improves the marketability of the community to external firms and entrepreneurs. Business development programming is thus a critically important component in a comprehensive and integrated economic development delivery system.

²⁴ Donald, B. “Competitiveness and Quality of Life in City Regions: Compatible Concepts?” Paper presented at the Canadian Association of Geographers Annual Meeting, Montreal, Quebec, June 2001.

While business recruitment often receive the most attention in economic development, it is extremely important for communities to realize the primary importance of developing new business opportunities and retaining and expanding existing enterprise. Research study findings vary in the percent of new employment generated in communities by existing firms; but, in almost every study, the percent has exceeded 50 percent and often run as high as 70 to 90 percent. Despite the importance of business retention and expansion, economic development groups and communities have often approached them haphazardly. IANR has provided training, planning, and strategic assistance designed to increase the professionalism of recruitment and expansion initiatives in the state, including working in communities to prepare for the Heartland Expressway, a federally designated corridor that will intersect Interstate 80 at Kimball and link to other routes from Canada to Mexico in the next decade.

IANR also focuses its efforts to ensure that research-generated knowledge is diffused into the economy through new business development and entrepreneurial endeavors. Activities range from the NebraskaEDGE Program supporting rural entrepreneurial training to specific programs focused on emerging areas of opportunity within food production. It is often difficult for entrepreneurs to find accurate sources of the information necessary to successfully launch a successful business. Because entrepreneurs do not know the steps to take, many of their ideas never make it to the marketplace. Ensuring a new product is introduced, survives, and prospers in a highly competitive marketplace requires informed decisions, careful planning, and precise execution.

Example: The NebraskaEDGE Program

Background: The NebraskaEDGE—Enhancing, Developing, and Growing Entrepreneurs—program provides community-based entrepreneurial education for individuals interested in starting or managing a small business. The course is 12 sessions delivered over 12 to 15 weeks, (40 to 44 hours). Participants develop a comprehensive business and management plan during the course to act as the roadmap for future growth. Comprehensive educational courses are provided to increase management skills that lead to new, expanding, and profitable businesses; increased personal wealth; improved community business networks; and an expanded community economic base. Since 1993, EDGE has provided community-based business training for more than 2,000 people.

Impacts: In spring 2004, participants of NebraskaEDGE were surveyed. The survey results indicated the following:

- 71 percent of the existing or new businesses have increased their business volume, and 55 percent increased the types of products sold or services rendered to customers.
- 33 percent increased the number of employees, 34 percent increased hours of operation, and 16 percent increased number of locations.
- 42 percent of the participants had a business idea when they enrolled in EDGE. Of these, 43 percent have since opened that business or anticipate it in the near future.
- 26 percent used their business plan completed during the EDGE program to apply for financing. Of those, 93 percent obtained a loan. The average loan amount was just over \$151,000, with amounts ranging from \$4,800 to \$1.2 million.

- The average gross annual sales for 2003 was just over \$486,000 among respondents who answered this question. 54 percent said that was an increase from 2002.
- 73 percent of the businesses that reported increased gross annual sales from 2002 to 2003 attributed this change to their participation in the EDGE program. Specifically, 40 percent said participation influenced sales a great deal, 25 percent attributed half the sale increase to the program, and 35 percent said the course influence their sales a little.
- 45 percent believe their business provides them with a higher standard of living since they took the EDGE course.
- 98 percent said the EDGE program should continue to provide business and management educational programs to Nebraska’s small business owners.

Overall, the program has proven to be a very effective way to influence the economy of rural Nebraska by supporting entrepreneurial development and growth, which in turn increases the number of jobs in the state and the wealth of the citizens of Nebraska.

Example: The Food Entrepreneur Assistance Program

Background: The Food Entrepreneur Assistance Program, provided through the Food Processing Center, helps increase and expand the food industry in Nebraska by providing comprehensive assistance to individuals wishing to develop a food manufacturing business. The Food Entrepreneur Assistance Program offers one source for step-by-step assistance through all phases of establishing a food business—from developing a product formulation and process to introducing the product to consumers.

This comprehensive program begins with a 1-day seminar, *From Recipe to Reality*, in which participants gain a basic understanding of the issues and decisions crucial to starting a food business, including the following:

- Market research and selection
- Product and process development
- Food regulatory issues and agencies
- Packaging and labeling
- Pricing and cost analysis
- Product introduction and sales
- Promotional material package
- Food safety and sanitation
- Business structure.

After the seminar, participants may choose to enter the second phase, *From Product to Profit*. In this phase, the Food Processing Center’s food scientists and business consultants offer confidential, individualized assistance.

Impact: Since its inception in 1989, the Food Entrepreneur Assistance Program has helped hundreds of entrepreneurs realize their goal of starting a food business. More importantly,

approximately 70 percent of the businesses that used this program remain in business today. From 2001 to 2005

- A total of 771 individuals attended a *From Recipe to Reality* seminar;
- These 771 attendees represented 499 potential companies;
- Of these 499 potential companies, 59 (12 percent) continued to the second phase, *From Product to Profit*; and
- A total of 32 companies completed the second phase and became existing small companies.

Promoting Innovation-Driven Economic Development

In the New Economy, globalization, competitive market pressures, technological advances, the preeminent importance of innovation and talent, and other forces are restructuring economic development. Against this background, it is imperative that Nebraska's local governments and institutions be structured to respond to the new economic challenges and opportunities.

Technology and the forces of the New Economy are changing the rules upon which industries, and thus regional and local economies, have been built. Such change means that the practice of economic development must also change to reflect the new order. The question, of course, is how the practice of economic development should change to engender positive economic performance in the New Economy.

IANR has focused significant resources on providing educational assistance in an array of information technology programming to support local governments, businesses, and institutions in the rural areas of the State of Nebraska, thereby fostering the advancement of New Economy practices throughout the state. Programming has included the following:

- Access e-Government, an online guide that explains the content, services, technology, politics, and issues specific to e-government. It trains local governments to plan information-rich Web sites to transact governmental business as well as communicate with its citizens.
- Doing Business Online, a program that teaches business owners to use the Internet for business expansion by developing Web sites to expand markets, promote business, and conduct business online.
- Farming with Computer Technology, a four-tiered training project that teaches farmers and agribusiness people to use computers, software programs, and the Internet to increase the productivity of their farm management practices.
- Electronic Retailing, a program that provides small retail business owners the tools to expand markets through the use of the Internet by utilizing Web pages, conducting business online, and buying and selling products online.
- Technologies Across Nebraska, a program that creates awareness and provides education to help local communities, policy leaders, and citizens as they make decisions regarding their future use of technology as a tool to sustain the viability of their communities.
- Master Navigator, a program that introduces Nebraska citizens to computer applications, software programs, and the Internet.

Example: Impact of Nebraska e-Commerce Education

Background: The way we buy and sell consumer goods has changed. Technology advancements foster a constantly evolving business world and provide new tools for doing business. Today’s technology allows businesses to conduct business worldwide with a few clicks on a computer screen. An online Web presence puts a business in the global marketplace, no matter what their physical location might be.

In this environment, small businesses are at risk of falling behind. Many small businesses need specialized training to capitalize on the new technology. To meet this need, IANR has established Electronic Retailing—Selling on the Internet workshops. Participants in the workshops are business owners who have a desire to learn more about incorporating e-commerce into their business practices and business plans. Presentation topics include the following: What the eCustomer Wants, Building the eStore, Web Site Design, and Keys to Marketing.

Impact: As a result of these workshops, just over one-third of the businesses that participated currently have a Web site. Most of the others plan to create one soon. Participants were asked how they would adapt e-tailing to their businesses:

- 54 percent plan to determine how to facilitate e-business in their current operations.
- 45 percent plan to include e-mail as a marketing tool.
- 38 percent plan to submit domain names to search engines.
- 34 percent plan to contract with Web designer to build store.
- 34 percent plan to change marketing strategy to incorporate keywords.
- 16 percent plan to learn Web design software program to build and maintain store.
- 14 percent plan to use a template to build a Web site.
- Only 3 percent said they won’t create a Web store.

By developing the e-commerce education for Nebraska retailers, IANR is helping to ensure that these local Nebraska businesses are able to reach new markets, remain competitive, and benefit from the expanded opportunities.

Developing the Social Well-Being of At-Risk Individuals and Families

A core element of extension activities envisioned in the original Smith-Lever Act was the “*development of practical applications of research knowledge and giving of instruction and practical demonstrations of existing or improved practices or technologies in ... home economics ... and subjects relating thereto.*” Extension was conceived not only as a technological and educational institution for agricultural practitioners, but also as a provider of resources that would strengthen American family life and communities. Today, that original vision of extension as a supporter of families is very much alive.

As America moves forward in the 21st century toward a knowledge- and skills-based New Economy, it is recognizing the preeminent importance of human capital. Social challenges, threats to the family, and urban and rural poverty continue to prevent many Americans from reaching their full potential. For Nebraska to thrive in the New Economy, its residents must have

the well-grounded social network, work ethic, and support services that form a stable life platform upon which personal progress may be built. Single mothers struggling to make ends meet, educational dropouts, youth at risk, and those drawn into crime and self-destructive behavior represent losses of valuable opportunities and human assets. Indeed, in many instances, these groups become costs to society. When set against this background, the work of IANR is perhaps more relevant and needed than ever before.

It is well recognized that the family dynamic within this country has changed significantly over the past several decades, and furthermore, it is anticipated to continue to change over the decades to come. For instance, more blended families than families of first marriages will exist in the future. Already today, more than 59 percent of children will live in a step relationship before they are 18 years old. Yet, the society provides no guidelines for the transition into a blended family.

Given the importance of the family in developing Nebraska's children and thereby the inherent strength of Nebraska's communities, IANR has focused on programming aimed at building stronger families. The Building Strong Families program aims to develop accessible resources to conduct research-based youth and family programming in communities across the state. This research, based on the Family Strengths Perspective, identifies those qualities that strengthen family well-being, including appreciation and affection, positive communication, spiritual well-being, commitment, enjoyable time together, and the ability to manage stress and crisis effectively.²⁵

The Building Strong Families program is designed as a grass-roots effort to meet local-level needs. The goals of the program, and their related activities, are as follows:

- Goal 1: Teach families to strengthen and improve relationship skills in family and community. Programming includes
 - Building Nebraska Families, which provides education for the hard-to-employ rural clients of Nebraska's Health and Human Services System welfare to work program;
 - Parents Forever, which is training offered for divorcing parents who have minor children, as well as Kids Talk about Divorce, which is aimed at the children of divorce; and
 - Real Colors Matrix Program, which teaches positive communication skills.
- Goal 2: Help communities identify family needs and design and implement plans to meet those needs. Programming includes
 - Poverty simulations, which illustrate the plight of poverty to high school students and serve as a motivational tool regarding education and money management;
 - Guardianship training, a program that provides education on the role of guardians/conservators; and
 - Early childhood education, providing training to child care professionals, educators, and parents on appropriate interactions to meet children's needs at different ages.
- Goal 3: Teach families to access, use, and manage resources wisely. Programming includes
 - Preventing Credit Card Blues at 22, a high school program that teaches seniors how to better manage their credit record;

²⁵ Stineet, N., and DeFrain, J. *Secrets of Strong Families*. Boston: Little Brown. 1985.

- Youth Financial Management Programs, through activities such as Money Camps, Money Simulations, and other financial classes; and
- Adult Financial Management Programs, through training in areas such as credit, investments, budgeting, financial planning, and will/estate planning
- Medicare education—Part D, prescription drug card program.

Therefore, IANR operates a range of programs aimed at supporting and improving life across the full range of Nebraska's rural and urban communities.

Example: Building Nebraska Families

Background: Building Nebraska Families (BNF) provides education for the hard-to-employ rural clients of Nebraska's Health and Human Services System welfare-to-work program. By learning necessary family management and life skills, families are better able to manage family resources and maintain their family while securing and sustaining employment and can more effectively use a community network. BNF has a total of 10 educators supported by this program and serves families in 56 rural Nebraska counties. Nebraska Health and Human Services has renewed the BNF contract effective until September 30, 2007, for a total of \$2.2 million.

Impact: In FY 2004, 51 BNF graduates entered the program with a mean average monthly income of \$483.43 and graduated from the program with a mean average monthly income of \$1,202.27. This increase of more than \$700 a month can be directly attributed to the participants indicating upon graduation that they feel more positive about their life and, as a result,

- Are setting goals and paying bills on time and in full;
- Are keeping a record of how they spend their money;
- Have a plan of how they will spend or save their money each payday;
- Use exercise to work off stress; and
- Feel less stressed.

Example: Preventing the Credit Card Blues at 22

Background: Preventing the Credit Card Blues at 22 program is a classroom-based educational initiative directed at high school seniors. Instructors use small-group work surrounding seven real-life scenarios to help students discover key concepts about choosing and managing credit cards responsibly. The content also includes information about protecting personal identity including the precautions to take when using either debit or credit cards.

The program was initially created as a result of a need expressed through focus group interviews conducted by IANR throughout southeast Nebraska in 2001. The focus groups identified credit card use as an item of great concern to local residents. Those polled felt that high school or college would be the best time to reach audiences with information about responsible credit card use.

Impact: IANR's desire to reach youth with information about credit is supported by studies conducted by a national lender, Nellie Mae, which surveyed student applicants in 2000 and

found that 78 percent of those applying for loans already had at least one credit card. The average number of cards held by these students was three, and the average amount of credit card debt was \$2,748. Approximately 13 percent of card holders were found to owe between \$3,700 and \$7,000 and 9 percent owed more than \$7,000.

UN Extension's Preventing the Credit Card Blues at 22 was piloted with nearly 450 students in spring 2002. In November 2002, it was launched statewide. Eleven educators taught the program to 1,337 high school seniors across Nebraska during FY 2003. The following year, 22 educators reached an additional 2,388 high school students.

Therefore, within the first 3 years of the program, with a conservative estimate of modifying the behavior of only 10 percent of the student body reached through the program, Nebraska youth have the potential to decrease their average debt by more than \$1.15 million in comparison with their national peers. Also, since this number continues to grow with each class that participates in the program, this economic benefit will continue to increase annually as more children are taught these important credit concepts.

Helping to Ensure the Health and Wellness of Nebraskans

Increasing time pressures, dual-worker families, and societal changes have placed significant stresses on the health and wellness of Nebraskans. Fast-food and ready-prepared meals have gained considerable popularity with most consumers; with this shift in diet have come a range of nutritional problems and an epidemic of obesity. Fried food and fat consumption have increased, while consumption of fresh fruits and vegetables has declined. Costs of these problems are borne by society in the form of increased health and insurance costs and an increased tax burden to support government-sponsored care of lower-income groups and seniors. IANR tackles these threats and provides solutions at the individual and family level—working to improve personal nutrition and lifestyle choices with a range of consumers from prenatal children and mothers to Nebraska's senior citizens.

Example: FNP and EFNEP

Background: IANR administers two federal programs, the Family Nutrition Program (FNP) and the Expanded Food and Nutrition Education Program (EFNEP). Both assist Nebraska citizens in acquiring the knowledge, skills, attitudes, and changed behavior necessary for nutritionally sound diets and in contributing to their personal development and the improvement of the total family diet and nutritional well-being. As a result of this educational intervention, participants adopt new behaviors that improve the nutritional quality of their diets, reduce the incidence of chronic disease, increase safe food-handling practices, and stretch their food dollars.

Both the EFNEP and FNP teach basic nutrition, food safety, meal management, thrifty shopping, and food resource management information to a variety of Nebraska citizens across the state. The programs are successful because of close partnerships with local agencies/organizations whose outreach includes food stamp program participants and other low-income audiences.

Impact: National studies²⁶ have found that these activities successfully deliver an educational program that leads to sustainable behavior change. EFNEP impact data from 1997 showed that 89 percent of adults improved nutrition practices, 84 percent improved food resource management practices, and 67 percent improved food safety practices. The benefits are far reaching, not only improving the nutrient intake of a vulnerable population, but also building the basic life skills of those moving into the workforce. In addition, improvements in early childhood nutrition will allow children to achieve their full cognitive-development potential. Results of a cost-benefit analysis showed that, for every \$1 spent on EFNEP, a potential health care savings of \$2 to \$17 may result from the prevention or delayed onset of nutrition-related chronic diseases and conditions among participants.²⁷ Thus, this proven program clearly works for the benefit of families and the state.

In addition, IANR has also explored behavioral risk data at both the state and national levels that indicate the need for more educational programs related to diet and physical activity choices for Nebraska citizens. To help meet that need, IANR developed an integrated and interactive curriculum titled ABCs for Good Health. Through a partnership with Every Woman Matters, a health outreach program administered by Nebraska Health and Human Services targeting 40- to 64-year-old women who are uninsured or underinsured, the ABCs for Good Health Program is being delivered as a lifestyle intervention to these Nebraska women.

Finally, Nebraska communities are constantly facing new challenges concerning the health and wellness of its citizens, and IANR is constantly working to develop programming to help protect and educate Nebraskans from these ever-changing risks. Two recent examples are provided below.

Example: Medicare-approved Prescription Drug Card Educational Program

Background: The 2003 Medicare Reform Act created dramatic changes in Medicare, including the first-ever prescription drug benefit. Changes prompted questions, confusion, and concerns for Medicare recipients and their families. They needed information about the Medicare-approved Prescription Drug Discount Card Program. This program was designed as a temporary response that provided transitional prescription cost assistance before the first-ever prescription benefit program in January 2006.

To help people make more informed decisions about the temporary program, IANR in fall 2004 was one of five state universities nationwide to launch a pilot program to educate and enroll eligible Nebraskans. The Nebraska campaign was titled, “The Greatest Gift You Can Give a Senior Citizen This Year is a Prescription Drug Card.” Extension worked with the Senior Health Insurance Information Program to promote involvement of Medicare beneficiaries in the transitional drug card program. The campaign was publicized by more than 350 news releases, columns, and public service announcements, as well as television and radio spots, interviews, and public presentations. Throughout the state, handouts and flyers promoting the campaign were distributed in extension and medical offices, grocery

²⁶ Multiple EFNEP cost-benefit analysis examples are provided in the EFNEP section of the CSREES Web site at <http://www.csrees.usda.gov/nea/food/efnep/impacts.html>.

²⁷ *Applying Cost Benefit Analysis to Nutrition Education Programs: Focus on the Virginia Expanded Food and Nutrition Education Program*. Virginia Cooperative Extension, Virginia Polytechnic Institute and State University, and Virginia State University. March 1999.

stores, medical facilities, senior centers, and senior housing units. Youth and adult volunteers distributed Medicare worksheets and enrollment forms and helped with one-on-one enrollment sessions.

Impact: Evaluations completed by 26 of the more than 40 extension staff who participated in this quick-response effort, as well as information collected about the program, show that it helped hundreds of Nebraskans understand and enroll in the drug card program from November 2004 to September 2005. For example,

- At least 530 Medicare recipients enrolled for Medicare-approved drug cards as a result of this effort.
- Nebraska Medicare recipients realized a potential savings of at least \$820,320 as a result of this educational campaign.
- More than 430 Medicare recipients received individual assistance with the enrollment process.
- More than 200 civic groups and organizations were contacted about the Medicare-approved Prescription Drug Discount Card Program.
- About 840 people requested worksheets and used them to enroll themselves or others, including more than 450 adult children or caregivers.
- At least 28 on-site sessions helped Medicare recipients complete worksheets and submit information.

Example: Eliminating Methamphetamine—One of Nebraska’s Greatest Challenges

Background: Methamphetamine production and use have reached epidemic levels in some parts of the United States. Rural areas of Nebraska and elsewhere are especially vulnerable because supplies for making the drug can be found easily. If this epidemic goes unchecked, it can tear apart families and communities and overwhelm legal, medical, and social resources. Citizens need to become more aware of this problem’s magnitude and how it impacts families, public health, safety, environment, rural economic development, and their own well-being.

IANR developed a program to increase individual and community awareness of methamphetamine (meth) use and production and its relationship to public health, safety, environment, rural economic development, and families. The program aimed at teaching simple strategies that individuals and communities could implement to fight this problem. This educational effort has continued to grow and is reaching all ages, races, genders, and economic statuses.

Impact: IANR teamed with 3rd District Representative Tom Osborne to promote community awareness of the drug’s dangers. Efforts include community presentations and written materials. In 2005, more than 4,000 Nebraskans learned about meth from Extension Educators who provided this knowledge through in-person meetings, and these Extension Educators also disseminated nearly 29,000 written educational pieces to interested citizens. The Nebraska State Patrol marijuana hotline has been changed to the drug hotline to be more inclusive and will be listed on all new maps and brochures. The state patrol handout, “Do

You Suspect Illegal Drug Activity in Your Neighborhood?,” was distributed. Many participants shared the flyer with family members, friends, community officials, and others.

Six months after a program was presented in Indianola, the county sheriff reported a significant decrease in meth activity. The meth lab that had been a big concern had moved out of the community, and the major meth distributor had been federally indicted. He attributed the drop to neighborhood “meth walks” (similar to a neighborhood watch where citizens walk assigned neighborhoods and report suspicious activities), increased citizen reporting, and increased community cohesiveness.

Preparing Youth for the 21st Century through Nebraska 4-H

4-H seeks to instill integrity, service, leadership, a sense of duty, and personal growth in the youth it serves. In these efforts 4-H builds a basis for positive personal and societal economic impacts. Specific life skills development activities are built into 4-H projects, activities, and events with the goal of helping youth become contributing, productive, self-directed members of society. 4-H projects are designed to be in-depth learning experiences for 4-H members. Animal science, communications and expressive arts, entrepreneurship, conservations, food and nutrition, science and technology, and leadership and citizenship are just a few examples of 4-H project areas.

Within Nebraska, 111,524 children and youth were enrolled in 4-H programs in 2005.²⁸ This enrollment number is representative of the average enrollment per year over the past decade. Overall, 30 percent of total youth in the State of Nebraska between the ages of 5 and 19 participated in 4-H programs in 2005.²⁹ Nebraska’s 4-Hers come from both rural and urban settings, with the specific statistics noted in Table 4.

IANR’s efforts influence youth from all ethnic, racial, and socioeconomic backgrounds who live in rural, suburban, and urban communities.

Table 4: Nebraska’s 4-H Enrollment, 2005

Place of Residence	Nebraska Enrollment
Farms	21,406
Towns with Populations Under 10,000 and Rural Nonfarms	30,839
Towns and Cities with Populations of 10,000 to 50,000	28,926
Suburbs and Cities with Populations over 50,000	764
Central Cities with Populations over 50,000	29,589
Total	111,524

Source: Nebraska 2005 4-H Enrollment Report (ES237 Report).

In Nebraska, 9,245 4-H enrollees are from minority populations and 9,960 youth are from Hispanic or Latino populations, together accounting for 17.2 percent of total Nebraska 4-H

²⁸ Program participants number 163,793, which includes duplication that results from children participating in multiple program offerings.

²⁹ Total state population of children aged 5 to 19 as of July 1, 2004. Source: Nebraska Department of Natural Resources, SC-EST2004-02-31.

membership. Nebraska 4-H is gender inclusive, with 52 percent of 4-Hers being female and 48 percent male.

How effective is 4-H at reaching youth and having a positive influence in their lives? This question was examined in a national survey research project of 4-H participants conducted in 2000 by a research team at Kansas State University, with oversight by a National Impact Project Steering Group.³⁰ The research team found the following eight “critical elements” of 4-H impact on youth:

1. The opportunity to value and practice service for others
2. An opportunity for self-determination
3. A positive relationship with a caring adult
4. A physically and emotionally safe environment
5. An inclusive environment
6. Engagement in learning
7. Opportunity for mastery
8. An opportunity to see oneself as an active participant in the future.

The findings of the survey speak to the positive impact that 4-H programs have on American youth and the high levels of satisfaction with those programs among participating youth. Table 5 highlights responses of survey participants to key questions on the national survey.

Table 5: Percentage of Affirmative Responses to Positive Statements About 4-H on National Survey

Statement Regarding 4-H	Percentage of Respondents Who “Agree” or “Strongly Agree”
“All kinds of kids are welcome in 4-H”	97
“4-H helps me accept the differences of others”	90
“I feel good during 4-H activities”	94
“In 4-H I feel that it is safe to try new things”	94
“Adults in 4-H help me to work with others as a team”	91
“Adults in 4-H make me feel good about myself”	90

Source: *Prepared and Engaged Youth Serving American Communities: National 4-H Impact Assessment Project*, <http://www.national4-hheadquarters.gov/about/impact/impact1.pdf>.

³⁰ *Prepared and Engaged Youth Serving American Communities: National 4-H Impact Assessment Project*, <http://www.national4-hheadquarters.gov/about/impact/impact1.pdf>.

The 4-H youth survey respondents report that, to them, the top benefits of participation in 4-H are best described as follows:

- Knowledge and skill
- Self/well-being
- Friends
- Self responsibility
- Activity
- Relationships
- Engagement
- Community service
- Leadership.

These national results are similar to those obtained in a 2000 study in Nebraska, which indicated that more than 90 percent of 4-H respondents cited the benefits of 4-H as being “responsibility,” “self-confidence,” “a greater respect for others and leadership,” and “relationship building skills.” It is fair to conclude that the education and values instilled by 4-H in the majority of participating youth are those that are important to individual development and to providing valued and productive members of Nebraska society and Nebraska’s economy.

Impact of Education Attainment

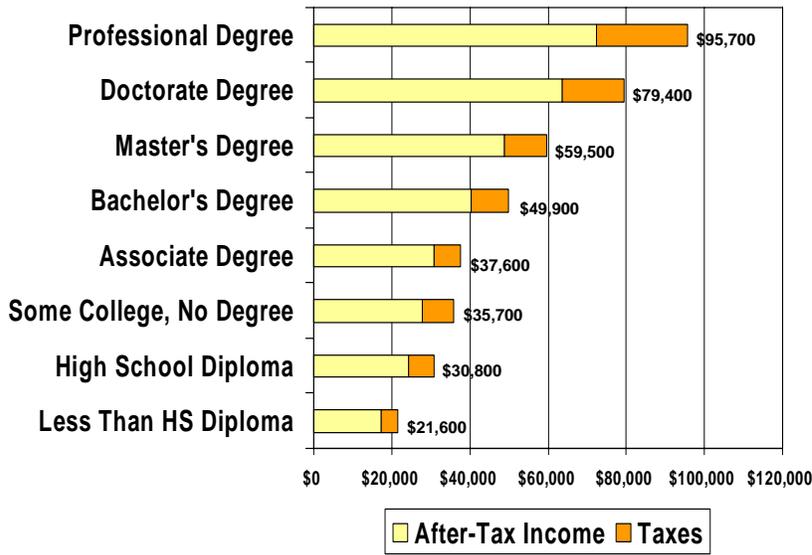
By working to keep youth between the ages of 5 and 19 feeling positive about themselves and their abilities and instilling a desire to learn and improve, 4-H can lead to greater personal and societal economic success. U.S. Census Bureau data illustrate the increasing personal returns from educational attainment, with greater levels of education being rewarded with higher median earnings (and benefiting society through higher taxation receipts). Data for 2003 are shown in Figures 3 and 4.

4-H has taught me responsibility and dedication. The people I have met in 4-H have and continue to inspire me to do my best and to continue growing. I've learned that I want to devote my life to learning, meeting new people, and helping others. 4-H has made me more aware of who I am, and I am able to say I am proud of the person I am, a great deal due to 4-H.

Learned about goals/goals setting, leadership, citizenship, life skills. It has made me an all-around better person who is responsible, optimistic, and artistic. 4-H allows people from all different backgrounds to shine.

Two written statements by respondents to
The National 4-H Impact Survey

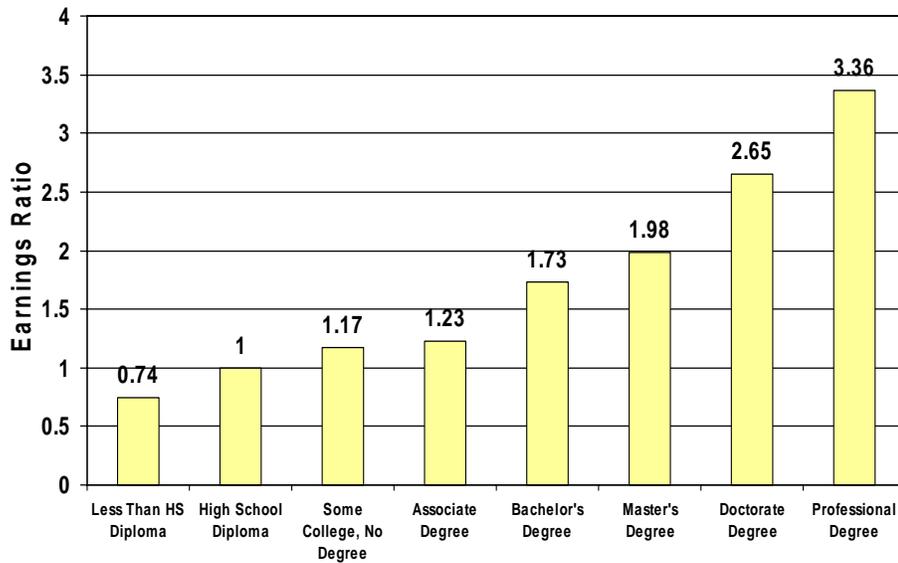
Figure 3: Impact of Increasing Levels of Education on Income



Source: Baum, S., and K. Payea. "Education Pays 2004: The Benefits of Higher Education for Individuals and Society." *College Board, Trends in Higher Education Series*. <http://www.collegeboard.com>.

Figure 3 illustrates the increasing returns to individuals and government arising from increasing levels of education. As the national and state economies increasingly depend on knowledge and innovation as economic drivers, those initiatives that enhance interest in education and promote increased educational attainment will be of heightened importance. Figure 4 emphasizes the high earnings return of education, displaying the ratio of lifetime earnings to be expected by education level attained beyond the baseline of a high school diploma.

Figure 4: Advanced Education Earnings Ratio



Source: Baum, S., and K. Payea. "Education Pays 2004: The Benefits of Higher Education for Individuals and Society." *College Board, Trends in Higher Education Series*. <http://www.collegeboard.com>.

While specific research has not yet confirmed that 4-H has a positive impact on decisions to pursue higher education, the findings of the 4-H national survey in regards to 4-H building more self-confident youth, however, match other research findings that point to faith in personal abilities as a good indicator of college success. Tufts University is currently enrolling participants in a longitudinal study to measure the effects of positive youth development via 4-H.

Therefore, it is reasonable to assume that at least a portion of the youth between the ages of 5 and 19 that 4-H positively influences each year are developing the personal abilities that would lead them to pursue advanced education opportunities. If only 5 percent of the 111,524 Nebraska 4-Hers were encouraged by their 4-H educational experience to achieve a bachelor’s degree, rather than ending their formal education after receiving their high school diploma, this would equate to 5,576 bachelor’s degrees each year. At a median earnings differential of an additional \$19,100 per year for the degree over and above a diploma, this equates to increased annual earnings for this group of \$106.5 million. If 5 percent gained an associate’s degree beyond a high school diploma, this would generate additional personal income of \$37.9 million annually.

The 4-H experience also may keep students from dropping out of high school. Again, if 5 percent of Nebraska 4-Hers stayed and received their high school diploma, rather than dropping out of high school, their annual personal earnings gain would be \$51.3 million. Table 6 summarizes the potential personal-income impacts of Nebraska 4-H positive effects on education decisions using varying percentages of 4-Hers potentially influenced to pursue a higher level of education.

Table 6: Annual Personal-Income Impacts of 4-H Influence on Education by Various Percentages of Nebraska 4-Hers

Higher Level of Education Attained	1% of NE 4-Hers	5% of NE 4-Hers	10% of NE 4-Hers	25% of NE 4-Hers
High School Diploma vs. Less than High School Diploma	\$10,259,840	\$51,301,040	\$102,602,080	\$256,505,200
Some College (no degree) vs. High School Diploma	\$5,464,480	\$27,323,380	\$54,646,760	\$136,616,900
Associate’s Degree vs. High School Diploma	\$7,583,360	\$37,918,160	\$75,836,320	\$189,590,800
Bachelor’s Degree vs. High School Diploma	\$21,300,320	\$106,505,420	\$213,010,840	\$532,527,100
Master’s Degree vs. High School Diploma	\$32,006,240	\$160,036,940	\$320,073,880	\$800,184,700

Source: Baum, S. and K. Payea. “Education Pays 2004: The Benefits of Higher Education for Individuals and Society.” *College Board, Trends in Higher Education Series*. <http://www.collegeboard.com>, with Battelle calculations.

As noted above, 4-H programs are specifically designed to help build character and self-esteem in youth. The national 4-H survey findings point strongly toward 4-H achieving this goal among the national sample of 4-Her respondents. Why does character and self-esteem matter? Research points to multiple positive outcomes attributable to self-esteem, including (1) higher levels of school achievement and reduced dropout rates, (2) reduced levels of crime and violence, (3) reduced teen pregnancy rates, (4) reduced drug and alcohol use, and (5) reduced levels of suicide and self-harm.

In terms of school achievement, considerable evidence exists indicating that self-esteem and a positive image of self are correlated with academic achievement. Covington³¹ found that, as self-esteem increases, so do test scores; while Walz and Bleuer³² found that self-esteem promotion programs in school reduce absenteeism and dropout rates. Wylie³³ found that self-esteem and a positive self-concept are predictors of achievement from primary grades to undergraduate education. Evidence linking low self-esteem to crime and delinquent behavior is even stronger. Steffenhagen and Burns³⁴ concluded from their studies that low self-esteem is the psychodynamic mechanism underlying all deviant behavior; while Kelley³⁵ found that, as programs were implemented to raise the level of self-esteem, the incidence of delinquent behavior in schools declined. Toch³⁶ and Davis³⁷ concluded separately that the most common factor promoting violence was “self-image compensating” that involved aggression in defense of self-image. They found that many who commit violence do so to compensate for their feelings of insecurity and low self-esteem. Other socially harmful and self-destructive behaviors such as teen pregnancy,³⁸ drug and alcohol abuse,³⁹ and suicide⁴⁰ have likewise been correlated with low self-esteem.

By encouraging self-esteem through custom-designed projects and positive experiences, 4-H helps to increase the volume of productive citizenry in Nebraska and reduce the negative factors associated with low self-value.

Skills Development for Youth

Three types of learning experiences are emphasized in Nebraska’s 4-H youth development programs and activities: hands-on (e.g., making, producing, and practicing); organized activities (e.g., demonstrations, workshops, field trips, and camps); and leadership/citizenship (e.g., conducting, planning, assisting, informing, and organizing). Each of these areas imparts specific skills to the youth who participate in them. 4-H in Nebraska operates a range of project-oriented programs designed to build youth skills. Some of these include the following:

³¹ Covington, M. “Self-Esteem and Failure in School.” *The Social Importance of Self-Esteem*. Berkeley, CA: U.C. Press, 1989.

³² Walz, G., and J. Bleuer. *Student Self-Esteem: A Vital Element of School Success*. ERIC Counseling and Personnel Services, Inc., Greensboro, NC, 1992.

³³ Wylie, R.C. *The Self-Concept*. Lincoln, NE: University of Nebraska Press, 1974.

³⁴ Steffenhagen, R.A., and J. Burns. *The Social Dynamics of Self-Esteem*. New York, NY: Praeger, 1987.

³⁵ Kelley, T.M. “Changes in Self-Esteem Among Pre-Delinquent Youths in Voluntary Counseling Relationships.” *Juvenile and Family Court Journal* Vol. 29, May 1978.

³⁶ Toch, H. *Violent Men*. Chicago: Aldine, 1969

³⁷ Davis, E. “Youth Violence: An Action Research Project.” *Journal of Multicultural Social Work* Vol. 1 No. 3, 1991.

³⁸ Beane, J., and R. Lipka. *Self-Concept, Self-Esteem, and the Curriculum*. New York: Teachers College Press, 1984.

³⁹ Skager, R. *Prevention of Drug and Alcohol Abuse*. California Attorney General’s Office, Sacramento, CA, 1987.

⁴⁰ Bhatti, B., D. Derezotes, S. Kim, and H. Specht. “The association between child maltreatment and self-esteem.” *The social importance of self-esteem*, A. M. Mecca, N. J. Smelser, and J. Vasconcellos (Eds.). Berkeley, CA: University of California Press, 1989, pp. 24-71.

- Robotics
- Aerospace
- Computers
- Embryology
- GPS/GIS Programs
- Entrepreneurship
- Healthy Lifestyles
- Crop Production Horticulture
- Unicameral Youth Conference
- Sportsmanship Programs
- Theater Arts
- Veterinary Science
- Photography
- Money FUNdamentals
- Career Exploration Camps

Linked to 4-H programs in skills development are programs specifically directed at helping youth develop the skills to be future practitioners in specific careers. 4-H historic roots in agriculture and agribusiness are reflected in multiple initiatives aimed at producing a well-skilled, productive pipeline of leaders for farming, horticulture, aquaculture, agricultural processing, environmental preservation, and other important areas of focus.

Impact of Mitigating Negative Youth Behavior

Americans for the Arts defines “youth at risk” as youth who are exposed to factors that may increase their tendency to engage in problem or delinquent behaviors. This definition covers self-destructive behavior, as well as criminal and antisocial behavior with related costs to society. The research outlined above on the impact of 4-H shows convincing evidence that participation in 4-H programs engenders positive self-esteem, personal responsibility, and an engagement with and responsibility toward community. Participants from at-risk backgrounds who achieve such positive outcomes through 4-H are, of course, less likely to succumb to external peer pressures and the low self-esteem issues that so often lead to antisocial and self-destructive behavior.

What are the economic returns of preventing youth crime and misdemeanors? Statistics are not readily available that show the impact of youth-related crime in the nation or individual states. However, the costs of various crimes (both juvenile and adult) have been estimated in a major national study by Kathryn McCollister at the University of Miami.⁴¹ Taking both tangible and intangible costs into account, the total per-offense costs in 2004 dollars were found to be significant, as indicated in Table 7.

⁴¹ McCollister, K. *The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation*. University of Miami, 2004. <http://www.tresearch.org/resources/AHSRPresentations/McCollister.ppt#12>.

Table 7: Tangible and Intangible Costs of Crime per Offense in 2004 Dollars

Type of Crime	Tangible per-Offense Costs	Intangible per-Offense Costs	Total per-Offense Cost*
Murder**	\$1,139,922	\$7,352,983	\$8,492,905
Rape/Sexual Assault	\$25,954	\$174,228	\$200,037
Aggravated Assault	\$18,599	\$101,336	\$111,801
Robbery	\$20,890	\$27,755	\$46,484
Motor Vehicle Theft	\$8,166	\$178	\$8,328
Household Burglary	\$3,663	\$342	\$3,974
Larceny/Theft	\$1,333	\$12	\$1,344

Source: McCollister, K. *The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation*. University of Miami, 2004. <http://www.tresearch.org/resources/AHSRPresentations/McCollister.ppt#12>.

* Total per-offense costs were calculated as the sum of tangible costs (excluding uncorrected risk-of-homicide costs) and intangible costs.

** Costs taken into account as tangible include Victim Costs (medical expenses, cash losses, property/theft damage, lost wages), Mental Health Costs (cost estimates of post-victimization counseling), Criminal Justice System Costs (police protection, legal and judicial, corrections), and Crime Career Costs (productivity losses incurred by perpetrator). Intangible costs take into account jury awards data for pain and suffering and adjusted value-of-life in the case of homicide.

Deriving a formal estimate of the costs saved by 4-H programs in reducing youth antisocial behavior is problematic. However, considering some basic Nebraska crime statistics suggests the type of benefits that may be realized. Table 8 shows selected reported crime statistics for Nebraska.⁴²

Table 8: Types and Numbers of Crimes in Nebraska, 1999

Type of Crime	Number of Crimes in Nebraska
Homicide	60
Rape	414
Aggravated Assault	5,429
Robbery	1,264
Motor Vehicle Theft	5,440
Burglary	10,158
Larceny/Theft	45,679

Source: Federal Bureau of Investigation. *Uniform Crime Reports: Crime in the United States 1999*, Table 5, Index of Crime by State. <http://www.fbi.gov/ucr/99cius.htm>.

⁴² Federal Bureau of Investigation. *Uniform Crime Reports: Crime in the United States 1999*, Table 5, Index of Crime by State. <http://www.fbi.gov/ucr/99cius.htm>.

For this discussion, youth of an age to commit such crimes are defined as between 15 and 19 years old. In Nebraska (2000 census), there were 134,909 such persons, accounting for 7.9 percent of the total Nebraska population aged 15 or older (1,341,836 persons). If crimes are allocated proportionately, youth crime metrics as noted in Table 9 would result.

Table 9: Estimated Costs of Crimes in Nebraska Committed by Youth 15 to 19 Years Old

Type of Crime	Number of Crimes in Nebraska (1999)	Estimated Number of Crimes Committed by Youth (at 7.9%)	Total Cost per Crime	Total Cost to Nebraska for Listed Crimes of Youths (Estimated)
Homicide	60	5	\$8,492,905	\$42,464,525
Rape	414	33	\$200,037	\$6,601,221
Aggravated Assault	5,429	429	\$111,801	\$47,962,629
Robbery	1,264	100	\$46,484	\$4,648,400
Motor Vehicle Theft	5,440	430	\$8,328	\$3,581,040
Burglary	10,158	802	\$3,974	\$3,187,148
Larceny/Theft	45,679	3,609	\$1,344	\$4,850,496

Source: Federal Bureau of Investigation, *Uniform Crime Reports: Crime in the United States 1999*, Table 5, Index of Crime by State. <http://www.fbi.gov/ucr/99cius.htm>. With Battelle calculations.

Approximately 30 percent of youth in Nebraska are in 4-H programs, so the potential for IANR's 4-H efforts to positively impact crime statistics and associated costs is likely to be considerable. For example, based on current enrollment, if only a conservative 5 percent of these 4-H members would have committed crimes such as those noted above (had they not been positively influenced by their 4-H experience), the estimated Nebraska crime cost saving is \$1.7 million. Thus, for every 1 percent of 4-H youth who are dissuaded from the above behavior by their positive 4-H experience, Nebraska could save approximately \$340,000 in criminal costs.

SUMMARY

This chapter has analyzed the contributions being made by IANR in *maintaining the health of the economic and social fabric of the state*. Consideration was given to the many IANR programs, activities, and partnerships with producers and community stakeholders that work to maintain the economic viability of Nebraska's agriculture, associated processing, and value-added industries and sustain quality of life within the State of Nebraska.

The next chapter will provide a detailed assessment of the impact of IANR on *expanding Nebraska's economy, diversifying the Nebraska economic base, and building community and individual wealth*. The analysis focuses on critically important activities such as the development of Nebraska's skilled workforce that enables the introduction of improved crop varieties, new alternative crops, and new value-added products and processes, including work in areas such as biofuels, biobased materials and products, and advanced food and nutraceutical products.

The Impact of IANR on Increasing Nebraska's Economic Diversity and Wealth

The previous chapter highlights IANR's many efforts to sustain the economic and social base of Nebraska. This chapter considers the activities undertaken by IANR to expand the Nebraska economy, increase the diversity of the state's economic base, and build wealth in the state.

IANR— EXPANDING NEBRASKA'S ECONOMY, DIVERSIFYING THE NEBRASKA ECONOMIC BASE, AND BUILDING COMMUNITY AND INDIVIDUAL WEALTH

Social and Individual Returns from Education

While much of the previous chapter focused on the benefits of IANR research and the transfer of these research discoveries into the field by means of extension activities, the importance of IANR's other mission, its teaching mission, must not be understated. CASNR provides the knowledge-based workforce that is driving and will continue to drive the growth of the agbioscience industry and, subsequently, the economic prosperity of the State of Nebraska. In the 2006–2007 academic calendar year, CASNR enrolled 1,303 students in its undergraduate program, 72 percent of whom were in-state residents, and an additional 660 graduate students in both its master's and doctoral programs.⁴³ These highly trained graduates are providing the knowledge base for Nebraska's agbioscience economy of the future.

The production of skilled human capital is determinative to the success of modern Western economies; and IANR, through CASNR's education of the next generation, is critically important to the state's economic viability. The root causes of economic progress, higher wages and higher standards of living, can be found in high levels of workforce productivity—gained in part by technological innovations, but also through the skills and ingenuity of the workforce. Only through increasing levels of productivity can standards of living grow. The nations, states, communities, and individual firms that have the highest-skilled workforce, other factors held constant, will be the most productive, produce the best products or services at the lowest costs, earn the highest profits, and dominate markets. Lester Thurow echoes this point when he notes that “productivity

In 2003, the typical full-time year-round worker in the United States with a 4-year college degree earned \$49,900, 62 percent more than the \$30,800 earned by the typical full-time year-round worker with only a high school diploma.

Those with master's degrees earned almost twice as much, and those with professional degrees earned over three times as much per year as high school graduates.

The typical college graduate working full-time year-round paid over 100 percent more in federal income taxes and about 82 percent more in total federal, state, and local taxes than the typical high school graduate.

Those who earned professional degrees paid over \$18,000 a year more in total taxes than high school graduates.

The College Board. *“Education Pays: The Benefits of Higher Education for Individuals and Society”*. 2004.

⁴³ UNL Admission's Web site.

or output per hour of work is the central factor determining the ability of any society to generate a world-class standard of living; it is not possible to divide what is not produced.⁴⁴

A skilled, highly educated populace leads to high productivity and economic gains, pointing to the “social return on investment” that occurs through education. The State of Nebraska, by investing in higher education at UNL, receives a significant return on that investment—namely, a stronger and more productive economy driven by skilled human capital. Public benefits of attending college include increased tax revenues, greater workplace productivity, increased consumption, increased workforce flexibility, and decreased reliance on government financial support.⁴⁵

Of course, the impact of a knowledge-based workforce for Nebraska can occur only if the CASNR-educated student stays in Nebraska post-graduation. In this regard, CASNR performs strongly, with 78 percent of graduates remaining within the State of Nebraska upon completion of their degrees.⁴⁶

An alternative to measuring societal return on education is to use “growth accounting,” whereby calculations estimate the portion of national economic gain attributable to higher education and associated activities. An analysis of higher education growth accounting studies led the American Council on Education to conclude that “overall, education may contribute as much as 50 percent or more of the growth in the economy, and higher education may contribute almost half of this.”⁴⁷

Other Benefits of Higher Education

College graduates also enjoy benefits beyond increased income. A 1998 report published by the Institute for Higher Education Policy reviews the individual benefits that college graduates enjoy, including higher levels of saving, increased personal/professional mobility, improved quality of life for their offspring, better consumer decision making, and more hobbies and leisure activities. According to a report published by the Carnegie Foundation, non-monetary individual benefits of higher education include the tendency for postsecondary students to become more open-minded, more cultured, more rational, more consistent and less authoritarian, and these benefits are also passed along to succeeding generations. Additionally, college attendance has been shown to “decrease prejudice, enhance knowledge of world affairs and enhance social status” while increasing economic and job security for those who earn bachelor’s degrees.

Research has also consistently shown a positive correlation between completion of higher education and good health, not only for oneself, but also for one’s children. In fact, “parental schooling levels (after controlling for differences in earnings) are positively correlated with the health status of their children” and “increased schooling (and higher relative income) are correlated with lower mortality rates for given age brackets”.

Porter, K.

“The Value of a College Degree,” *ERIC Digest*, 2002. Online at <http://www.ericdigests.org/2003-3/value.htm>

⁴⁴ Thurow, L. *Head to Head: The Coming Economic Battle Among Japan, Europe and America*. New York: Morrow and Company, 1992.

⁴⁵ Institute for Higher Education Policy. *Reaping the Benefits: Defining the Public and Private Value of Going to College*. The New Millennium Project on Higher Education Costs, Pricing, and Productivity. Washington, DC, 1998.

⁴⁶ “Annual Report of UNL Graduates 2004-2005.” Prepared by UNL Career Services.

⁴⁷ Leslie, L., and P. Brinkman. *The Economic Value of Higher Education*. American Council on Education Series on Higher Education. Oryx Press, 1994.

The “private rate of return to education” is what analysts call the percentage increase in annual earnings associated with each additional year of schooling. Though the earnings differential between college and high school graduates varies over time, college graduates, on average, earn more than high school graduates. Census Bureau data show that, over a working life, high school graduates earn an average of \$1.2 million; associate’s degree holders earn about \$1.6 million; and bachelor’s degree holders earn about \$2.1 million.⁴⁸ The previously cited American Council on Education report found an average of 11.8 to 13.4 percent private rate of return for a bachelor’s degree (across multiple independent studies). The additional return for a master’s degree is about 7.2 percent, while for a Ph.D., it is 6 percent.

When compared with the cost of gaining a degree and the earnings lost while pursuing a degree, statistics show that the individual rate of return on investment in higher education is sufficiently high to warrant the cost. Rates of return do, of course, vary by the subject studied, with the highest returns most likely to occur in pragmatic disciplines oriented toward advanced, high-skill careers. Thus, in a 21st century increasingly driven by bioscience and other technological disciplines, degrees associated with IANR would likely generate private and social rates of return toward the high end of traditionally accepted scales.

Quality of education attained should also be taken into account in terms of examining educational return on investment. Researchers have noted increasing returns to high-quality education (defined as taking place within a more highly ranked institution). In fast-paced, modern science and technology fields, gaining one’s education in a major research university, with leading-edge research, scientific laboratories, and state-of-the-art equipment, may also provide rate of return advantages. UNL, as one of only 16 Association of American Universities/land-grant universities in the nation, is among the premier research institutions focused on the agbiosciences and associated research. By gaining their advanced education in this environment, IANR-affiliated students have access to faculty at the forefront of research, the latest in scientific equipment, a large diversity of students from varied backgrounds, and work experience within faculty laboratories. The University leverages its significant research-funded equipment to provide access for educational purposes. At a research university such as UNL, students can be participants in the knowledge creation process, not just passive recipients of transferred learning.

Continuing Education and Lifelong Learning Access

Much has been written about the rise of “knowledge” as the driver of the U.S. economy. This rise is an accepted fact; but, there is much misunderstanding about who possesses this “knowledge.” Some have interpreted this to mean that a 4-year-college–degreed elite is the route to economic success; but, the fact is that skills and knowledge are increasingly required across the total workforce. The creative elite may be a critically important driver of invention and new products and services, but it encompasses only a small proportion of the U.S. labor force. The

⁴⁸ Day, J.C., and E.C. Newburger. “The Big Payoff: Educational Attainment and Synthetic Estimates of Work-Life Earnings.” (Current Population Reports, Special Studies, P23-210). Washington, DC: Commerce Department, Economics and Statistics Administration, Census Bureau. Available online at <http://www.census.gov/prod/2002pubs/p23-210.pdf>.

rest of the workforce must produce the output of creativity in volume and do so at a higher level of productivity than can be achieved elsewhere. Gray and Herr⁴⁹ note as follows:

If the route to success is inventing new products, the education of the smartest 25 percent of the labor force is critical. If the route to success is being the cheapest and best producer of products, new or old, the education of the bottom 50 percent of the population moves to center stage. This part of the population must staff those new processes. If the bottom 50 percent cannot learn what must be learned, new high-tech processes cannot be employed. If the education of the bottom half moves to center stage, so too must workforce education, which we have defined as education and training below the baccalaureate level.

Thurow⁵⁰ echoes these sentiments in one of his recent works, when he notes the following:

A knowledge economy requires two interlocking but very different skills sets. Knowledge creation requires highly educated creative skills at the very top of the skill distribution. Knowledge deployment requires high-quality skills and education in the middle and bottom of the skills distribution.

It is critically important for all involved in government, education, and economic development to grasp the implication for Nebraska. It is that, in a 21st century economy driven by high productivity and increasingly skilled processes, an unskilled workforce is no resource at all. It is only a “potential” resource, and that potential can be realized only through workforce education and continuous skills development.

It also must be noted that technology and productive processes are being improved or supplanted at a rapid pace. In such a fast-paced, change-oriented working environment, a workforce has to be equipped with the personal learning skills and adaptability traits required to keep pace. Life-long learning is not just a catch phrase; it is becoming a necessity. Most workers cannot expect that their job will continue to be done as they currently do it, or even that it will exist, a decade from now.

It is readily apparent that IANR, with resources in every county and access to the wide-ranging technical and educational resources of the University, is very well positioned to deliver continuing education and workforce skills development services. Staying ahead in the productivity race requires the adoption of the latest in technologies and personnel equipped with the education and skills to use it. IANR plays an important role with programs as diverse as graduate education in agriculture technology to basic computer literacy for Nebraskan citizens. The following example illustrates this point.

Example: Graduate Education through Distance Education

Kerry John was admitted June 2004 to the Distance M.S. in Entomology Program. She is an Extension Assistant in Kimball, Banner, and Cheyenne counties. Ms. John wants to be able to develop curriculum for 4-Hers and youth that will provide them with basic knowledge of insects and their importance to the agricultural industry. Her course work, which has included Program Evaluation, Insects as Educational Tools, Presentation Methods, Scientific

⁴⁹ Gray, K. C., and E. L. Herr. *Workforce Education*. Massachusetts: Allyn and Bacon, 1998.

⁵⁰ Thurow, L. C. *Building Wealth: The New Rules for Individuals, Companies, and Nations in a Knowledge-Based Economy*. New York: HarperCollins Publishers, 1999.

Illustration, Insect ID & Natural History, and Medical Entomology, clearly is providing her with the tools she needs to accomplish her goals. Ms. John is halfway through the M.S. program and says that the Distance Program has made pursuing an advanced degree possible for her.

Identification of Emerging Trends and Needs (Economic Intelligence)

IANR research teams do not only focus on current and near-term issues facing Nebraska, they also undertake projects that identify emerging trends likely to impact agriculture and the agriculture-related Nebraska economy long term. IANR works in areas such as the following:

- Long-term impacts of pollution, population pressures, agricultural practices, etc., on the Nebraska environment.
- Long-term sustainability and impacts related to scarce water resources in the state, including aquifer depletion/replenishment, groundwater flow, and demand growth projections.
- Agricultural markets and associated economics research pertaining to global commodity and agricultural market forces and their potential impacts on Nebraska agriculture, food products, and value-added ag-related products.
- Emerging opportunities stemming from new technologies and scientific fields, including plant and animal genetics and transgenics; biofuels and biobased materials; biotechnology and opportunities in biopharming, functional foods, and nutraceuticals; and specialty chemical compounds and materials produced through plant and animal pathways.

As further evidence of IANR's commitment to cutting-edge economic intelligence, CASNR has revised 18 of its 22 undergraduate majors in the past 5 years. In addition, it has approved three new majors since 2005. The revisions and new majors reflect changes in science and industrial needs and CASNR's willingness to respond to the ever-changing demands of the marketplace. Moreover, as an intensive agricultural research institution, IANR views emerging issues and opportunities long term and assembles multidisciplinary teams to work on those future issues most likely to strongly impact the Nebraska economy.

New Crops and Agricultural Products (Diversification)

IANR creates new knowledge and applies that knowledge through education and development of new and enhanced crops and products for the agricultural sector in Nebraska. Programs range from developing enhanced strains of existing crops (with enhanced disease resistance, increased yield and quality characteristics, for example) to introducing completely new crops, livestock, and value-added products. Currently, Nebraska farmers are increasing their income through a range of IANR initiatives, including the following:

IANR generates entirely new products and technologies helping to expand and diversify Nebraska's economic base.

- Introducing new crops for production on Nebraska farms, providing opportunities for increasing value-added production and crop rotation options.
- Developing new value-added beef cuts, significantly increasing the per-head value of Nebraska beef cattle.

- Developing nutraceuticals and functional foods/functional food ingredients through advanced R&D and associated genetics and nutrition research.

Example: New Crops for Western Nebraska

Background: Chicory, a plant grown extensively in Europe, is a source of inulin, fructose, salad greens, and flavorings for a variety of international markets. Dried chicory is also used in the beverage industry (primarily as a flavoring in coffee) and as an ingredient in pet foods. Researchers at the IANR Panhandle Research and Extension Center have been examining chicory production in western Nebraska over the past decade. Studies ranging from plant physiology, planting and harvesting practices, and machinery requirements for production have been conducted. As a result of this research, IANR researchers have demonstrated that chicory can be successfully grown in western Nebraska.

Impact: Because of the research efforts undertaken by IANR, a new company, U.S. Chicory, was formed in Scottsbluff to process chicory grown in the region. The \$2 million drying factory was constructed to receive, wash, slice, and dry the chicory roots for sale to Nestle USA for use in pet foods. Chicory sold for approximately \$55 per ton in 2003, with root yields estimated to average 19 tons per acre. U.S. Chicory is expected to use 5,000 acres of chicory roots, providing more than \$5 million in economic impact to the regional economy in new crop production, in addition to the economic impact generated by the employment of approximately 30 individuals at the new plant. Furthermore, as a result of perceived market opportunities, a second plant, Chicory USA, is under development as an expansion activity for the region.

Example: Value-Added Meat Cuts

Background: Humans have been rearing cattle for beef consumption for thousands of years, so one might think that there is little new to learn about processing beef carcasses to achieve maximum quality and value. This is not true. IANR has been at the forefront of National Cattlemen’s Beef Association (NCBA) efforts to identify increased value cuts of meat from the underutilized chuck and round, which had been declining in value. Muscle profiling research conducted by IANR identified 39 muscles and optimized cuts that would increase the value of the beef. In total, the project evaluated 5,600 muscle samples and identified some undervalued muscles being used for roasts and ground beef (neither high-value uses) that were redesigned as cuts producing the branded “flat iron” steak.

Impact: “2005 Beef State Facts” released by the Nebraska Cattlemen’s Association (NCA) indicates that Nebraska has 1.91 million head of beef cows and that 4.8 million cattle are fed and marketed through the state each year. Meat processing is also a major industry for the state, with 7.66 million head of cattle slaughtered in Nebraska annually. The NCA calculates that beef has an \$11.5 billion impact on the Nebraska economy.

The IANR research that led to the beef value-added cuts, such as flat iron steak, has significantly increased per-head cattle value. Cattle Fax (<http://www.cattle-fax.com>), market research specialists for the cattle industry, has calculated that the cattle producer receives about \$60 to \$70 more per head as a result of the increase in chuck value for these new

cuts.⁵¹ Given the size of the beef industry in Nebraska, the impact of this IANR muscle profiling research is extremely significant. Using an increase of \$60 per slaughter animal, the minimum added value predicted by Cattle Fax, the value added to the 1.91 million head of Nebraska beef equals \$114.6 million. With 7.66 million head of cattle slaughtered in Nebraska annually, the added value totals a potential \$459.6 million (although all this would not be realized within Nebraska because cattle are often shipped into the state for slaughter). Reflecting the impact of IANR's beef work, NCBA has stated that the "flat iron steak is the breakout item in the value cut world." As of mid 2005, about 5,000 stores nationwide were carrying the cuts.

Example: Functional Foods and Nutraceuticals

Background: While still very much a "work in progress," IANR researchers are making considerable strides toward building a nutraceutical-based industry sector in Nebraska. The term "nutraceutical," coined by the Foundation for Innovation in Medicine in 1991, is defined as any substance that may be considered a food or part of a food and provides medical or health benefits, including the prevention and treatment of disease. A nutraceutical may be a naturally nutrient-rich or medicinally active food, such as garlic or soybeans, or it may be a specific component of a food, such as omega-3 fish oil or lycopene from tomatoes.

IANR brings some powerful resources to bear on nutraceutical research. At UNL, IANR's Plant Sciences Initiative and the Center for Biotechnology both coordinate a suite of molecular life sciences resources directly relevant to the identification of plant and animal molecules with nutraceutical potential, and in the genetic manipulation of biological systems to express the desired chemical attributes. The Plant Sciences Initiative brings strengths in plant breeding, incorporating modern technologies for crop improvement and an array of faculty investigating the food safety, environmental impact, and economic implications of agricultural biotechnology. The UNL Center for Biotechnology promotes research on all aspects of molecular life sciences, leading to improvements in agriculture, health care, and the environment. The Center is supported by the Nebraska Research Initiative funds allocated through the Center for Biotechnology and by funds from the National Science Foundation (EPSCoR Infrastructure grant). The Center provides access to core research facilities and various other programs to the UNL research community and local businesses. Currently, there are seven core facilities: Genomics, Structural Biology, Flow Spectrometry, Mass Spectrometry, Plant Transformation, Bioinformatics, and Microscopy. Six of seven core research facilities are located in the state-of-the-art Beadle Center for Genetics and Biomaterials Research on the UNL campus. In addition, UNL's Food Processing Center is conducting research in product characteristics and product functionality. With UN's intellectual expertise in food science, nutritional genomics, and human medical programs, it provides substantial assets for animal-based, and especially plant-based, nutraceutical work.

Impact: IANR researchers have made significant progress toward major nutraceutical discoveries that will add considerable economic value to Nebraska agriculture and form the foundation for building a nutraceutical production economy for the state (helping to move farmers from commodity crops to specialized value-added crops). The first major

⁵¹ <http://www.beefusa.org/NEWSFLATIRONSTEAKGAINSTRACTIONWITHKROGERCUSTOMERS23620.aspx>

breakthrough focuses on enhancing the cholesterol-lowering characteristics of plant sterols. The result is a completely new, patented technology, which has lowered cholesterol in animal models by 70 percent (a result superior to that achieved by the blockbuster statin drugs). Prime sources of the technology are soybeans and beef tallow, both major products in Nebraska. Once commercialized, the production of the cholesterol-lowering compound from soybeans and/or beef tallow would significantly increase the value of these important Nebraska outputs. The compound would have a significant market advantage because it could be used as a food ingredient or as a natural nutritional supplement in capsule form.

IANR research teams are also developing functional extraction technology—technology designed to facilitate chemical separation and extraction of valuable nutraceutical biomaterial from plants and animal products. Initial focus is on the grain sorghum, which may contain antioxidants and many compounds of relevance to heart disease, cancer, and diabetes.

There are still barriers to realizing the full-impact benefits from these discoveries, most notably a lack of (1) pilot facilities to actively process biomaterial and (2) pre-seed/seed funding to support commercialization initiatives. Still, Nebraska has the potential to build a powerful new economic sector upon its fundamental agricultural commodity strengths. With the preponderance of UNL’s work focused on natural (rather than transgenic) compounds, the market could be worldwide for these “natural” nutraceuticals—compounds that would meet little market resistance compared with genetically modified/transgenic-based materials.

Biobased Resource Development and Value-Added Products

Nebraska enjoys a reputation for high levels of productivity in producing and processing food products. This high-productivity agricultural output positions the state well in food and likewise positions the state to assume a leading role in developing and exploiting biorenewable resources for fuel, biobased materials, and other nonfood applications of biomass.

A biorenewable economy differs from one concentrated on biotechnology. Biotechnology can be defined as work on technologies targeting human, animal, and plant health; the biorenewable economy is focused on the commercial application of bioresources to produce energy, industrial commodities, and specialty products. The dependence of modern Western society on fossil fuels and the synthetic products made from them is an increasing problem because of the volatility of pricing for these finite fossil resources and the significant geo-political and environmental challenges associated with them. As such, a concerted national and international push is being made to develop alternatives to fossil fuels and fossil resource chemicals. Opportunities for biorenewables are substantial and can only increase as fossil resources dwindle and prices rise as demand outstrips supply. Examples of opportunities in biorenewables include the following:

IANR is leading the way for Nebraska to be at the forefront of advancements in biofuels and renewable bio-based resources.

- Biofuels (such as ethanol, biodiesel, methane gas)
- Biocomposite materials (such as construction materials, insulation, sound-deadening panels)
- Specialty chemicals (such as plastics/polymers, adhesives, lubricants, catalysts)
- Fibers (for carpeting, textiles, and other applications)

- Environmental remediation and protection systems (such as microbes for toxic waste disposal).

Biorenewables have received attention in Europe where the European Commission sponsored the Interactive European Network for Industrial Crops and Their Applications (IENICA). In its significant analysis of potential markets for biorenewables, IENICA identified five main areas:

1. Oils
2. Fibers
3. Carbohydrates (sugars, starches, glycogen)
4. Specialty products
5. Proteins.

IENICA's research concludes that the first three (oils, fibers, and carbohydrates) will have the greatest potential impact on agriculture because they will require large production land acreage. Independent of fuel production (such as ethanol and biodiesel), IENICA predicts that the following will be main oil market opportunities:

- Biolubricants
- Bio-printing inks
- Biosolvents
- Linoleum
- Surfactants
- Polymers
- Paints and surface coatings.

In terms of fiber applications, the European project predicts the following opportunities:

- Matting-based products (filters, growth media, textiles)
- Biocomposites (such as materials for use in vehicle manufacturing)
- Insulation products
- Wood-based panel substitution with annual constituents (such as straw)
- Paper and pulp manufacturing.

Nonfood carbohydrate markets, especially those for starches, represent approximately 50 percent of the total starch use in the European Community. These nonfood uses are primarily as follows:

- Paper and cardboard manufacturing
- Plastics and detergents
- Fermentation and technical uses
- Specialty areas including water purification, cosmetics, toiletries, pharmaceuticals, paints, and agrochemicals.

In addition, proteins are predicted to have major nonfood applications in packaging and labeling industries, pharmaceutical and chemical production, adhesives, and cosmetics.

Therefore, considerable opportunities exist for the commercial exploitation of biorenewables. Much of the future for these products depends on R&D and the development of processing technologies that will generate price-competitive products.

IANR is working to help cement a leadership position for Nebraska in the field of biorenewables. The IANR, for example, is undertaking leading-edge research in

- Biodiesel—focused on developing biodiesel from both animal fats and vegetable oils;
- Starches for bioplastics—an area in which IANR researchers have developed patents and are pursuing commercialization; and
- Biorenewable fibers—where IANR researchers have made significant advancements in the use of plant fiber for producing textiles.

Example: Biofuels and Industrial Agricultural Products

Background: While biofuels and biobased industrial agricultural products show great promise for growth in the future, they are providing solid economic opportunities today. Nebraska has established a solid foothold in the ethanol production industry (using predominantly corn as the feedstock), and IANR is working on biodiesel, biobased value-added chemicals, and biobased materials.

IANR is engaged in this endeavor through multiple scientific pathways, including working in plant sciences on desirable characteristics in feedstock crops; improving production engineering; developing value-added uses for production by-products and waste materials; and investigating the impacts of ethanol, biofuels, and biomaterials on commodity prices and agricultural economics.

Impact: Nebraska leads the nation in commercial cattle slaughter, producing about 1 billion pounds of tallow annually. This tallow provides a large and inexpensive quantity of raw materials for biodiesel production. To help producers of beef tallow capitalize on this material, the Industrial Agricultural Products Center (IAPC) has developed new uses for it. IAPC is working on producing biodiesel from animal fats and is home to the leading research team in this field. Additional attention is being paid to blended biodiesel production using both animal fats and vegetable oils. Nebraska does not yet have biodiesel operations, but IANR's research indicates that it will in time, given the state's leading position in livestock slaughter and its production of oil crops such as soybeans.

The method most commonly used to convert fats and oils into biodiesel is transesterification, with the conversion products being alcohol esters and glycerol. With a new processing system, the IAPC expects to make smaller manufacturing facilities economically competitive and compatible with rural communities. Small-scale biodiesel processing facilities could provide growth poles around which other value-added products such as lubricants, polymers, solvents, and plastics could be produced. (Eddyville in Iowa has such integrated operations and proves the economics work in terms of developing a small industry cluster that is co-located.)

IANR research shows that ethanol plant production has a positive effect on price in the vicinity of production plants, leading to increased farmer incomes (prices raised about \$0.069 per bushel in the vicinity of ethanol plants). Statewide impacts of \$0.04 per bushel on corn prices are expected, but positive impacts extend further—for example, the distillers grain by-products when fed to cattle can reduce feed costs by \$0.01 to \$0.02 per pound of beef produced. Increased demand for feeder cattle would have further benefits for the cow calf production industry in the state. A 2006 economic impact study estimated that the economic impact of using wet, rather than dry, distillers grains are greater than \$79 million.⁵² IANR has been conducting the vast majority of the research that is conducted in the nation on feeding distillers grains in both beef cow and beef feedlot situations. Its efforts in outreach and research account for over 90 percent of the information on distiller grains available to producers. This work is highly cited and used for decision making by beef producers and nutritionists across the nation.

Currently, Nebraska is at a production cost advantage in ethanol versus competing states (except for Iowa which it is at a production cost parity). Key advantages for Nebraska are its strong corn production and beef livestock production industries, allowing for a very efficient biofuel production operation to be developed whereby livestock and ethanol operations can be located near one another to benefit from by-product synergies. Beef operations produce waste products that can produce methane gas to power the ethanol refining process. In turn, the wet distillers grains can be fed to the proximate cattle (with the feeding of wet grains removing the cost of drying grains for shipment). Other states have far less congruency in their cattle and corn production and thus have less potential to realize the benefits of an integrated operation using methane and wet distillers grains for efficiency gains. The potential for the integrated operation model is being pursued next to the ARDC in Mead, in collaboration with the Mead Cattle Company. At Mead, the development is called the E3 BioFuels Complex (operated by E3 BioFuels, LLC), which incorporates an ethanol plant powered by biogas from the adjacent cattle operation. The ethanol production plant is sized to precisely match the cattle operation and, with the input of 7 million to 10 million bushels of corn, will produce 20 million to 24 million gallons of ethanol each year. By powering the biorefinery with 100 percent biogas, the net energy balance of ethanol is greatly increased versus traditional production methods—again indicating the opportunity for Nebraska to consolidate its natural agricultural advantages to build a significant and efficient industry.

Other biobased opportunities being pursued through IANR include plastics development based on starches (with UNL patents resulting from this research) and biofiber-based textiles (see separate discussion below). Carbohydrates, the fundamental building blocks of plant matter, can also be converted into chemicals, energy, textiles, building materials, paper, and many other industrial products.

Example: Biofiber-based Textiles

Background: As noted above, rising prices for scarce fossil resources have created an urgent incentive for developing renewable biofuels and biobased chemicals. This imperative, however, extends beyond oil and into a key group of products—synthetic textiles and fiber.

⁵² Perrin, R. K. “Economic Impact of Feeding Wet Grain Processor’s Byproducts in Nebraska – 2006 Update.” University of Nebraska Cooperative Extension.

Synthetic fibers, such as nylon, rayon, dacron, and acetate, are major consumers of scarce oil resources in their production. However, natural organic fibers are available as substitutes and more are being developed. IANR researchers are focusing on the use of agricultural by-products to produce alternative natural fibers. Considerable progress has been made in using cellulose-rich material (such as corn stalks and husks, sorghum, and soybean plants) as sources of such fiber. A proprietary process for fiber extraction has been developed by IANR researchers that results in fibers with greater quality and durability versus cotton, the standard natural product.

Impact: The new Nebraska by-product-based biofiber is predicted to cost \$0.57 per pound to produce and carry a retail value of \$1.00 per pound. The research team has calculated that enough agricultural by-product materials are produced each year in Nebraska to produce 1 million pounds of the biofiber. Thus, there is enough feedstock to potentially fuel a \$2 billion value-added business for Nebraska from waste products.

Developing Comparative Advantages within Nebraska's Agbased Industrial Sectors

The agricultural bioscience (agbioscience) sector is a knowledge-based industry cluster driven by innovation in the life sciences. These innovations and technologies are transforming the U.S. economy, spurring innovation and productivity gains. When researchers, scientists, and engineers make new discoveries in plant and animal genetics, healthcare, ecology, or nutrition, the entire industry can change.

Continuous innovation and change characterize this dynamic industry and lead to economic opportunities. Technological breakthroughs and scientific insights are applied to new products, delivering both economic and social benefits around the world. As a result, the consumer witnesses both a stream of new products and the emergence of entirely new industries.

Applying new technologies to traditional industries has likewise changed the economic landscape. As Appendix A illustrates, the agbioscience sector is a vibrant, robust, and extremely important component of Nebraska's economy. It is therefore critically important to the state's economy that this industry segment continues to pursue innovation and employ advanced technologies as a means of developing comparative advantages and helping to ensure economic growth. The ability of IANR to transfer its scientific, technical, and research capabilities to the state's agbioscience industrial base has significant impact on the health and vibrancy of the economy.

Example: Development of Agricultural Value-Added Products

Background: As noted above, the application of new technologies to traditional industries enables Nebraska to maintain a vibrant, robust and healthy agbioscience industrial sector, a major component of the state's overall economy. IANR's Food Processing Center, which was established in 1983, works to advance the value-added food manufacturing industry by partnering on technical and business development from idea through ongoing market support. The Center works with the agbioscience industry of the State of Nebraska by offering technical assistance in areas such as:

- **Product Development**, including concept/prototype development, ingredient functionality and development, line extensions and reformulations, and shelf life extension.

- **Laboratory Testing**, including bromate analysis, starch analysis, printed microarrays, and mycotoxin analysis.
- **Market, Business, and Economic Analysis**, including market research, funding proposal assistance, economic and feasibility analyses, and strategic planning.
- **Pilot Plant Assistance**, which includes services such as extrusion, dehydration, dairy production, modified atmosphere and vacuum packaging, tortilla and chip processing, meat and poultry processing, wet products processing, and bakery processing.

In addition, the Food Processing Center also provides entrepreneurial development assistance, which was discussed in detail earlier.

Impact: Through its array of activities, in addition to the numerous workshops it provides, the Food Processing Center is transferring value-added scientific knowledge to Nebraska agbioscience companies, helping them to maintain a comparative advantage over their ever increasing global competition. Mark Haskins, Founder and President of MBA Poultry, has stated “The Team at the UNL Food Processing Center has been an integral part of MBA Poultry’s success story to say the least. They have been with us in the beginning, aiding us in pioneering the air-chilled process that is unique to not only Nebraska but the United States as well. They have provided us the data to substantiate many of the claims and attributes of our niche product. They have been instrumental in identifying challenges and in turn have designed processes to control and manage these types of issues.”

SUMMARY

The array of programs and activities that IANR provides the citizens, industries, and communities of the State of Nebraska continue to meet today’s needs, just as the University has met the needs of Nebraskans for the past 137 years. However, the opening of the 21st century has brought challenging economic times, times in which some of the underlying fundamentals of economic and community development are shifting rapidly. IANR must stay on the cutting edge of leading issues to ensure its ability to meet these new demands.

The Economic Impact of IANR’s Resource Expenditures on the State of Nebraska

INTRODUCTION

As an operating entity, irrespective of the diverse benefits described in the previous chapters that result from the dissemination of scientific knowledge and functional expertise, IANR generates a significant economic impact for the State of Nebraska via its direct and indirect spending. IANR receives funds from the federal government, extramural sources, industry contracts, and allocations from the State of Nebraska—and it invests these funds in human capital, resources, and infrastructure to benefit the state. In turn, the expenditures of IANR and its faculty and staff within Nebraska generate significant economic impact.

This chapter describes the data and methods used to estimate **backward effects**, together with a description of the results and findings of the analysis. Backward effects are the impacts that result from IANR expenditures supporting faculty, extension teams, and associated ancillary staff activities that have salary, wage, and other related impacts on the state economy. These types of impacts, involving expenditures of IANR and its employed populations, are termed “backward linkage impacts” or “spending impacts”—and the structure of these impacts is represented by the blue circles in Figure 2 on page 13.

In calculating the backward effects associated with IANR activities, Battelle used

- Expenditure data provided by IANR to estimate direct impacts of wage, salary, and other spending; and
- An IMPLAN input-output framework to estimate indirect impacts of IANR direct expenditures.

DATA, METHODOLOGY, AND IMPACT MEASURES USED TO ESTIMATE IANR IMPACTS

For Battelle to estimate impacts, IANR provided 2004–2005 academic calendar year (FY 2004) expenditure data, including wage and salary expenditures, benefits, capital projects, and materials and supplies.

Wage and salary expenditure data included full and part-time IANR staff, full- and part-time faculty, and independent contractors hired by IANR. The latter includes partnerships and all 1099 recipients.⁵³ Wage and salary data in each category were adjusted to exclude savings and taxes paid, thereby resulting in the disposable income spent by IANR-funded staff and faculty. It

⁵³ The Internal Revenue Service requires 1099s for any worker who is not an employee who receives in excess of \$600 in payments from the 1099 issuer (the “payer” institution) during a 1-year period.

was assumed that all employee benefits paid from IANR funds were spent outside the state with national service providers; and, therefore, these are excluded from the impact analysis.⁵⁴

All wage and salary expenditures were assumed to take place in Nebraska. For capital projects, 47 percent of capitalized equipment purchases took place in Nebraska (IANR FY 2004). For materials and supplies, it was assumed that 80 percent of IANR expenditures occurred within Nebraska.

Direct Impacts of IANR Activities

Table 10 summarizes IANR funding, employment, and expenditure data for FY 2004. IANR funding was approximately \$163 million in FY 2004. A total of 2,074 full-time equivalents (FTEs) were employed by IANR in FY 2004, including 1,629 full-time and 445 part-time employees. More than 50 percent of IANR expenditures (\$86 million) supported staff wages and salaries. Capital projects, including both renovating existing facilities and constructing new research facilities (\$6.4 million), and the laboratory materials and supplies to operate these facilities (nearly \$50 million) constitute 34 percent of overall annual IANR expenditures.

Table 10: IANR Total Funding, FTE Employment, and Direct Expenditures, FY 2004

IANR Data		Total (\$ millions)
IANR Total Funding		163.1
IANR Direct Expenditures		
Salaries and Wages		86.1
Number of Full-time Employees:	1,629	
Number of Part-time Employees:	445	
Total Number of FTEs:	2,074	
Benefits		21.0
Independent Contractors		0.0
Capital Projects		6.4
Materials and Supplies		49.6
Total Direct Expenditures		163.1

Source: IANR.

Methods Used to Estimate Indirect Impacts

Indirect impacts were estimated based on direct labor expenditure data for specific income categories and procurement data for capital projects and materials and supplies. Expenditure information was associated with the relevant BEA sectors in an IMPLAN input-output model (Minnesota IMPLAN Group, Inc., 2003 data files⁵⁵) specified for the State of Nebraska.

⁵⁴ Expenditures for employee benefits such as health care and retirement program providers were assumed to flow out of the state. While some in-state providers (i.e., ones with in-state headquarters) may be producing an in-state impact, the majority are likely located out of state. There may be local offices through which payments are made (either directly by employees or on their behalf by IANR); however, their headquarters (and therefore the locations of the majority of the subsequent expenditures by these firms) are likely out of state.

⁵⁵ The 2003 Minnesota IMPLAN data files are the latest available.

The IMPLAN input-output model is a PC-based program that constructs input-output models for counties or combinations of counties for any location in the United States. Input-output data show the flow of commodities to industries from producers and institutional consumers for any given region. The data also show consumption activities by workers, owners of capital, and imports from outside the region. The IMPLAN model contains 528 sectors, representing industries in agriculture; mining; construction; manufacturing; wholesale and retail trade; utilities; finance, insurance, and real estate; and consumer and business services. The model also includes information for each sector on employee compensation; proprietary and property income; personal consumption expenditure; federal, state, and local expenditure; inventory and capital formation; and imports and exports.

The model was used to estimate multipliers for each sector where labor and procurement expenditures occur. Multiplying expenditures by the sector multipliers and summing across all sectors influenced by IANR expenditures produce estimates of IANR impacts on the state.

Impact Measures

The impact of IANR activities in Nebraska was measured using four economic and two fiscal variables. The economic variables are

- **Output.** The total value of production (sales) in all industries as a result of expenditures by IANR.
- **Value added.** An overall measure of individual and institutional income produced by IANR activities. Value added includes labor income (employee compensation), income to self-employed persons (proprietor income), rents, royalties and dividends, and indirect business taxes (primarily property taxes).
- **Income.** Employee compensation. In addition to being included in value added, the impact of IANR on labor income was also specified separately in the analysis.
- **Employment.** The total number of jobs created by IANR in all industries. To include both full- and part-time workers, jobs are measured in terms of FTEs.

In addition, the analysis also estimated the tax impacts of IANR activities, including

- **Sales taxes.** Direct sales tax revenues were estimated by multiplying the value of IANR capital project expenditures and materials and supplies expenditures by the current sales tax rate in Nebraska of 5.5 percent. Indirect sales taxes were calculated using the value of the additional indirect output (sales) generated by IANR wage and salary spending and procurement of materials and supplies and capital projects and the Nebraska sales tax rate.
- **State personal income taxes.** State income tax revenues were estimated by multiplying the value of direct and indirect personal income generated by IANR activities by the state tax rates for six separate taxpayer income categories.

THE IMPACT OF IANR ON THE NEBRASKA ECONOMY

IANR expenditure activities in FY 2004 generated 2,070 direct jobs and more than \$70 million in direct income. Direct expenditures on wages and salaries, capital projects, and materials and supplies by IANR produced an additional 1,670 indirect jobs and almost \$47 million in indirect

income in the state. Thus, 3,740 total (direct plus indirect) jobs and \$64 million in total income were generated (Table 11). IANR funding produced more than \$206 million of direct and indirect value added and \$338 million in total output in the state. IANR funding also produced \$12.8 million in sales taxes and \$5.5 million in personal income taxes.

Table 11: Total Impact of IANR on the Economy of Nebraska, FY 2004

	Output (Sales) (\$ millions)	Value Added (\$ millions)	Income (\$ millions)	Employ- ment	State Income Tax Revenues (\$ millions)	Sales Tax Revenues (\$ millions)
Direct Impacts	163.1	116.2	70.6	2,074	3.3	3.1
Indirect Impacts	175.3	89.9	46.7	1,669	2.2	4.2
Aggregate IANR Impact	338.4	206.1	117.3	3,743	5.5	7.3

Note: Data in columns may not equal totals due to independent rounding.

Source: IANR. Minnesota IMPLAN Group, Inc., 2003 Nebraska state data files.

The profiles of direct and indirect economic impacts of IANR are somewhat different. Table 11 shows that the direct value-added, income, and employment impacts of IANR activities are larger than the corresponding indirect impacts, while direct and indirect output impacts are almost identical. This distinction results from the relative importance of IANR labor expenditures compared with labor expenditures in the various sectors affected indirectly by IANR spending.

Specifically, IANR expenditures on wages and salaries constitute more than half of the overall IANR annual budget, with support provided to a relatively large number of higher-income staff positions. In contrast, funding for capital projects and expenditures on materials and supplies play a relatively small role in the annual IANR budget. While the direct effects of IANR reflect the important role of funding for higher-income staff and faculty positions, the indirect effects of wage and salary spending by IANR employees and expenditures on capital projects and on materials and supplies produce are also substantial. This impact is also reflected in the indirect personal income tax revenue.

FUNDING FOR IANR ACTIVITIES

Following a long-standing tradition, IANR's operations are supported by federal, state, and local (primarily county) resources. In FY 2005, total revenues received by IANR totaled \$167.4 million (comprising \$71.6 million in state-appropriated funds; \$41.4 million in federal grants and contracts; \$6.2 million in federal formula funds; \$21.2 million in revolving and auxiliary operations; and \$27 million from local, county, industry, and other sources of support).

For the state's legislative appropriation of \$71.6 million, Nebraska received a sizable return, including \$338.4 million in economic output, an additional \$12.8 million in tax revenues, and \$117.3 million in earned income from the 3,743 Nebraska citizens whose jobs resulted from IANR.

Furthermore, the state’s legislative appropriation leverages a significant number of competitive grants and awards through sponsored projects. In FY 2005, IANR received \$52.7 million in sponsored projects supported by external funds, which represents 47 percent of the grants awarded to UNL (see Table 12).

Table 12: IANR Sponsored Projects FY 2005

	IANR Total Grants Awarded	UNL Total Grants Awarded	% of Total Grants
Total Grants Awarded to other UNL Colleges		\$59,495,447	53%
Total Grants Awarded to IANR			
Extension Grants Awarded	\$11,905,849		11%
Instruction Grants Awarded	42,778		0%
Research Grants Awarded	38,562,745		34%
Vice Chancellor Grants Awarded	2,152,910		2%
Total Grants Awarded to IANR		\$52,664,282	47%
Total Grants Awarded to UNL		\$112,159,729	100%

SUMMARY

As an operating entity, irrespective of the benefits of its transfer of scientific knowledge and functional expertise, IANR generates a significant economic impact for the State of Nebraska. Battelle’s analysis of IANR using input-output analysis techniques shows that, on an annual basis, the Institute’s direct and indirect expenditures generate the following:

- **\$338.4 million in total Nebraska economic output (sales)**, divided almost evenly between direct and indirect economic output
- **3,743 jobs in Nebraska**, comprising 2,074 direct jobs and 1,169 jobs generated in the Nebraska economy by the employment multiplier effect
- **Personal income for Nebraska residents amounting to \$117.3 million annually**, divided between direct income of \$70.6 million and indirect income of \$46.7 million
- **\$12.8 million in annual tax revenues** through Institute-generated taxes.

IANR’s institutional spending impact generates \$338.4 million in economic output and more than 3,700 jobs in Nebraska.

It is important to once again note that these are simply the impacts realized by the annual expenditures of IANR and its associated faculty and staff and by the follow-on multiplier effect of these expenditures. Because IANR diffuses knowledge, training, and skills to Nebraskans, its R&D, programs, and activities also impact the State of Nebraska. These impacts are categorized as forward-linkage impacts that, rather than being related to institutional spending, result from the institutional mission and functions of IANR. The two previous chapters of this report examine this broad and multifaceted array of positive forward-linkage economic and social impacts for Nebraska.

Conclusion

NEW ECONOMY REQUIREMENTS

In the 21st century challenges such as globalization, competitive market pressures, technological advances, and the preeminent importance of innovation and talent are restructuring the economy. Since R&D institutions are primary engines for economic growth, it is imperative that Nebraska have them in place to respond to new economic challenges and opportunities.

Underlying innovation and successful technology implementation, and therefore employment growth, in high-performance regions constitute a strong R&D base—a base rooted in skilled human capital and infrastructure providing technology-intensive companies with access to top-quality research talent, resources, and research facilities. Berglund and Clarke,⁵⁶ in a report for the National Governors Association, note that a successful technology-based economy (or New Economy) requires the following:

- A strong intellectual infrastructure, such as universities and public or private research laboratories that generate new knowledge and discoveries
- Efficient mechanisms through which knowledge is transferred from one person to another or from one company to another
- Excellent physical technology infrastructure
- A highly skilled technical workforce
- Good sources of capital.

Robert Atkinson⁵⁷ of the Progressive Policy Institute points out the fundamental differences in forces and drivers of the old versus New Economy. The following lists illustrate the considerable differences between the old and new ways of operating:

Old Economy Building Blocks	New Economy Building Blocks
<ul style="list-style-type: none"> • Stable • Nationally Based • Hierarchical • Mass Production and Standardization • Capital and Labor • Mechanization • Lower Costs • Go-It-Alone Business Culture • A Skill or Degree • Adversarial Relations 	<ul style="list-style-type: none"> • Dynamic • Global • Networked • Flexible Production and Customization • Innovation and Knowledge • Digitization • Innovation, Quality, and Speed (Productivity) • Alliances and Partnerships • Lifelong Learning • Collaboration

⁵⁶ Berglund, D., and M. Clarke. *Using Research and Development to Grow State Economies*. National Governors Association, NGA Center for Best Practices. 2000.

⁵⁷ Atkinson, R. “Urban Economic Prospects in the New Knowledge Economy.” Paper presented to the CEOs for Cities Conference, Chicago, IL, October 20, 2000.

Clearly, the fundamentals for economic progress in the 21st century have changed significantly. The gripping reality of this new economic order is that some states, regions, and communities win and others lose. It is equally clear that state governments and their institutions must not be passive as their economies change. State policies, development departments, land-grant universities, and many other state-related institutions need to participate in determining the economic success of their state.

THE RELEVANCE OF AGRICULTURAL RESEARCH AND EXTENSION IN THE 21ST CENTURY ECONOMY

Against such a background of rapid and dramatic change, can a system such as agricultural research and extension, established in the late 1800s, be relevant? The surprising answer—that agricultural research institutions and agricultural extension may well be *more* necessary and relevant than ever before—is a testimony to the foresight of those who ensured the creation of IANR in 1973 through the passage by the Nebraska Legislature of LB149, which recognized the importance of agricultural development and scientific advancement to the State of Nebraska’s economy. **Much of what is required for 21st century success (innovation, technology transfer, human capital enhancement, productivity improvement, networking, and quality of environment and place) is directly addressed through the mission and operations of IANR.**

As illustrated throughout this report, IANR is dedicated to fulfilling multiple functions of critical importance to economic and social progress in Nebraska—and these functions directly relate to the needs and challenges of the New Economy:

- IANR is an innovation engine for the state, using science to develop and test new technologies and bioscience innovations to sustain the current agriculture economy and power a new economy based on bioscience discoveries.
- IANR is a pragmatic disseminator of the latest in research and technologies to enhance productivity and expand the economic base of Nebraska. IANR works to ensure that its research discoveries are translated into practical, on-the-ground and in-the-field technologies to enhance productivity in Nebraska.
- IANR, with its history of agricultural production, has a track record in applying technology and enhancing productivity to ensure Nebraska’s performance in the highly competitive, global marketplace.
- IANR is focused on teaching, seeking to significantly enhance human capital, generate new scientists and well-educated practitioners, and promote lifelong learning across the state.
- IANR provides a statewide network—with a presence in every county—linking communities, businesses, and the general population to the intensive R&D and technical resources of UN.
- IANR is flexible, using integrated cross-disciplinary approaches to tackle complex problems in scientific, economic, and social areas.

- IANR works to improve natural resource management practices, enhance the environment, and sustain the quality of place in Nebraska, ensuring the attractiveness of the state for human capital and new ventures.
- IANR focuses its research, teaching, and extension efforts to bolster food safety and a safe food supply.
- IANR works to strengthen the quality of life of individuals and families, thereby contributing to community vitality.
- IANR emphasizes youth development and leadership, helping to provide the next generation of New Economy workers and leaders.

Because of these focus areas, IANR activities compare very favorably with the types of economic building blocks that Atkinson points out as necessary for New Economy success. Table 13 indicates the direct relevancy between the New Economy success factors and IANR’s operations and functions.

Table 13: New Economy Building Blocks and IANR’s Related Activities

New Economy Building Blocks	IANR’s Activity
<ul style="list-style-type: none"> ▪ Dynamic 	IANR is a “change-oriented” organization, responding to dynamic agricultural, business, community, and social challenges on an annual basis. Response to highly dynamic businesses like agriculture (responding constantly to dynamic forces such as weather, pest emergence, global commodities markets, etc.) testifies to IANR’s importance in fast-paced modern economic development.
<ul style="list-style-type: none"> ▪ Global 	Because of the global nature of the agricultural and commodities markets, IANR has considerable experience working with producers and processors on global issues.
<ul style="list-style-type: none"> ▪ Networked 	With operations in every Nebraska county, IANR serves as the gateway to the University, providing links to IANR and the University’s deep pool of talent and expertise. Extension’s programs are delivered in a networked partnership with multiple agencies and nonprofits throughout Nebraska’s counties. Extension is also an integral part of the national network of extension agencies and land-grant institutions.
<ul style="list-style-type: none"> ▪ Flexible Production and Customization 	IANR’s direct work with producers, processors, and manufacturers provides access to this field of expertise. IANR researchers are constantly working on methods to differentiate Nebraska agricultural output and value-added products.
<ul style="list-style-type: none"> ▪ Innovation and Knowledge 	This is a primary mission of IANR. Through IANR, the University is an innovation engine working to produce new knowledge and to diffuse new technologies and working practices into Nebraska’s economy.
<ul style="list-style-type: none"> ▪ Digitization 	IANR has been an early adopter of advanced technologies, using Internet-based distance education and statewide networking from office to office. IANR also leverages new digital technologies to improve traditional focus areas, such as work in sophisticated software systems for informing producer decision making and modeling drought conditions. Increasingly, geographic information systems are being integrated into IANR’s work. In addition, through community development activities, IANR is promoting the adoption of information technologies by Nebraska’s local governments, businesses, and farmers.

Table 13: New Economy Building Blocks and IANR’s Related Activities (continued)

New Economy Building Blocks	IANR Activity
<ul style="list-style-type: none"> ▪ Innovation, Quality, and Speed (Productivity) 	<p>Again, this factor lies at the core of IANR’s mission. IANR develops innovations and new knowledge and then diffuses the latest innovations, technology, and know-how into the Nebraska economy to increase the volume and quality of economic output. Examples of IANR’s work in this area range from new wheat varieties and livestock animal diagnostics to biobased industrial products.</p>
<ul style="list-style-type: none"> ▪ Alliances and Partnerships 	<p>Much of IANR’s work in Nebraska, especially in the social and community development areas, is delivered through partnerships with other organizations. Benefits include avoiding program duplication and extending Nebraska’s skills and talents to strengthen and improve the activities of other organizations. Extension alliances extend across state lines, helping to leverage the expertise of other state extension activities for the benefit of Nebraska. IANR researchers also maintain close working relationships with federal government laboratories and universities in surrounding states, further strengthening knowledge sharing and dissemination.</p>
<ul style="list-style-type: none"> ▪ Lifelong Learning 	<p>As a distributed system, with operations in every county, IANR is well positioned to provide lifelong learning opportunities across the state. Beginning with youth programs, IANR is working to instill the practice of lifelong learning and skills improvement in Nebraska’s population. Extension is also home to a variety of specialized continuing education and skills development programs targeted to specific audiences in industry and community.</p>
<ul style="list-style-type: none"> ▪ Collaboration 	<p>As noted above, IANR is networked both within the state and across the country. Collaboration occurs internally, with UNL scientists in multiple areas forming cross-disciplinary research teams to solve complex problems. Collaborations also occur externally within Nebraska, in other states, and internationally.</p>

This summary clearly indicates that IANR has been, is, and will continue to be a primary engine for economic and social sustainability and growth in the State of Nebraska. Ultimately, IANR is an institution focused on improving and sustaining Nebraska—improving its economy, preserving its environment, and contributing to continuing social sustainability and responsibility. As clearly indicated throughout this report, IANR is positively impacting the State of Nebraska in significant ways through both its diverse array of activities, as well as its close partnerships with producers and community stakeholders—without these partnerships, much of IANR’s accomplishments could not be achieved.

Taken together, it is evident that IANR’s research, teaching, and extension activities are having powerful impacts on Nebraska’s economic growth and on economic and social sustainability in the State of Nebraska. In FY 2005, IANR received an annual appropriation of \$71.6 million from the State of Nebraska. As illustrated throughout this report, the estimated annual impacts of IANR programs far exceed \$750 million in direct economic output and savings benefits for Nebraska, a leverage ratio conservatively estimated to be greater than ten to one. This number does not include the impact of IANR’s direct and indirect expenditures (salaries, benefits, capital improvements, etc.) as highlighted in the preceding section, which represents an

It is the conclusion of this study that the State of Nebraska is receiving an excellent return on its investment in IANR.

additional leverage ratio of approximately five to one. Taken together, the impact of IANR's programs and expenditures represents a leverage of state funding that exceeds fifteen to one. Based on the impact examples examined by Battelle, it is the conclusion of this study that the State of Nebraska is receiving an excellent return on its investment in IANR.

Appendix A: The Importance of Agriculture and the Agriculture-Based Economy to the State of Nebraska

INTRODUCTION

Technology is transforming the U.S. economy, spurring innovation and productivity gains. As a result, the consumer witnesses both a stream of new products and the emergence of entirely new industries. Applying new technologies to traditional industries has likewise changed the economic landscape. This overall shift emphasizes intellectual capital and knowledge, rather than raw materials or physical labor.

The agricultural bioscience (agbioscience) sector is a knowledge-based industry cluster driven by innovation in the life sciences. When researchers, scientists, and engineers make new discoveries in plant and animal genetics, healthcare, ecology, or nutrition, the entire industry can change. Continuous innovation and change characterize this dynamic industry and lead to economic opportunities. Technological breakthroughs and scientific insights are applied to new products, delivering both economic and social benefits around the world. Today, agriculture has a new role, acting not only as a producer of food and other goods, but also as a leader in affecting public health and the environment.

With the convergence of technology, biosciences, and a traditional economic base in agriculture, many regions around the United States are diversifying and enhancing their local economies. To successfully commercialize R&D, a state or locality must promote clustering among these diverse but related activities and leverage its comparative advantages. Agricultural producers might provide their goods as inputs to manufacture bio-engineered fuels or to make botanical and medicinal products or pharmaceuticals. In addition, farmers can adopt biotechnology practices to help breed healthier animals, develop disease-resistant crops, or grow their products in a more energy-efficient manner. A region can reap the benefits of the agbiosciences through better jobs and a stronger economic future.

The IANR at the UNL can apply its Nebraska-specific industry and workforce knowledge to help foster the continued development of the agbioscience sector in the state. As the demand for labor accelerates and the overall U.S. economic conditions resume their longer-term trend toward higher growth, the Institute has an opportunity to guide the economic future of Nebraska by investing in the agbiosciences.

The following economic analysis examines the agbioscience sector in Nebraska in 2004. The report highlights the overall economic status of the sector and key trends over a 4-year period (2001 to 2004) and compares the state sector with the national agbioscience sector as a whole. The analysis identifies key emerging industries within the Nebraska agbiosciences, as well as existing subsector strengths. This information can help guide the Institute to effectively direct its efforts and research investments in the future.

DEFINITION OF THE AGBIOSCIENCES

Characterized by a mix of new and emerging technologies and continuous innovation, as well as more traditional commodity-producing farms and firms, the agbioscience sector is diverse and fluid, which complicates any attempt to define this particular set of industries. Currently, the “biosciences” or “agbioscience” industry is not defined officially by the U.S. government or other entity.

Recognizing the diverse nature of agriculture and the biosciences, Battelle included in its definition industries from two major sectors—agricultural and life sciences. The agricultural sector includes those industries involved in agricultural production, manufacturing, processing, and related services. This component comprises six major subsectors: agricultural machinery and equipment, agricultural processing, agricultural production, agricultural services, food processing, and organic and agricultural chemicals.

The life sciences sector includes firms involved in applying biological research and development technologies for pharmaceutical, botanical, and other biological product manufacturing and in producing laboratory-specific instruments and surgical, dental, and other medical instruments, equipment, and supplies (including veterinary). It comprises three major subsectors—biological research and testing, drugs and pharmaceuticals, and medical instruments and devices.

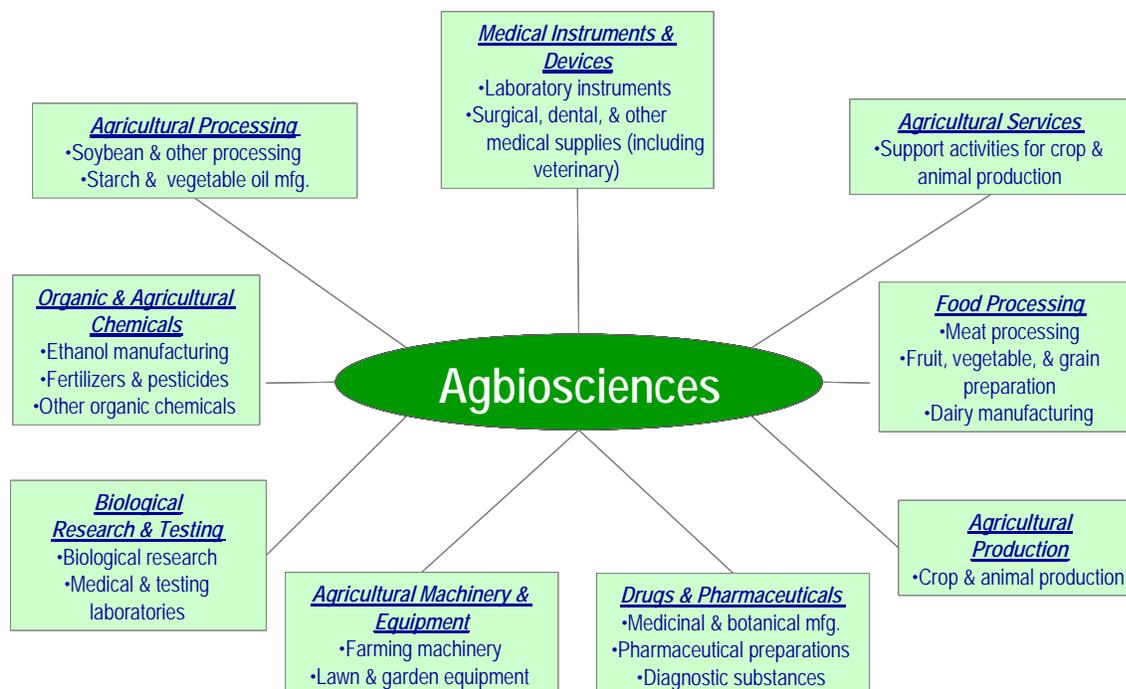
The North American Industry Classification System (NAICS) is the official federal government system for classifying establishments and their activities into appropriate sectors. The NAICS is based on the production processes of firms and categorizing them with other establishments engaged in the same or similar activities. NAICS industries at the most detailed (six-digit) level were selected for this analysis and together make up the major sectors and subsectors. Using this system, Battelle has chosen 78 industries at the six-digit level. These detailed industries were aggregated up to nine major subsectors of the agbioscience industry.⁵⁸

Figure A-1 illustrates the nine agbioscience subsectors. Each subsector is engaged in unique activities, but together they demonstrate the widespread agricultural and bioscience-related activities that characterize Nebraska’s economy.

Given the dynamic nature of the agbiosciences, it is possible that certain economic activities are not captured in this definition according to NAICS codes. Aggregating production activities on a broad scale will inevitably result in some data gaps; however, characterizing this industry according to the most detailed NAICS data available is the best approach to analyze the majority of key agbioscience economic activity in Nebraska and the nation.

⁵⁸ In addition to industries at the six-digit level, some three-, four-, and five-digit NAICS industries were used where necessary. Table B-1 in Appendix B lists NAICS codes and the corresponding agbioscience subsector.

Figure A-1: Agbioscience Industry Subsectors



DATA AND METHODOLOGY

The following economic analysis examines data and corresponding trends in Nebraska and the United States as a whole for the agbioscience sector from 2001 to 2004. For most of the employment analysis, Battelle has selected the Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages (QCEW) data set. The QCEW data (also known as the ES-202 program data) are the most current, detailed, state-level industry employment, establishment, and wage figures available.⁵⁹ Battelle receives an “enhanced” version of these state and county data from a private vendor, the Minnesota IMPLAN Group, Inc.

The QCEW program is a cooperative program involving BLS and the State Employment Security Agencies. The QCEW program produces a comprehensive tabulation of employment and wage information for workers covered by state unemployment insurance laws and federal workers covered by the Unemployment Compensation for Federal Employees program. Publicly available files include data on the number of establishments, monthly employment, and quarterly

⁵⁹ In general, QCEW monthly *employment* data represent the number of covered workers who worked during, or received pay for, the pay period that included the 12th day of the month. Virtually all workers are reported in the state in which their jobs are located. Covered private-industry employment includes most corporate officials, executives, supervisory personnel, professionals, clerical workers, wage earners, piece workers, and part-time workers. It excludes proprietors, the unincorporated self-employed, unpaid family members, and certain farm and domestic workers. An *establishment* is an economic unit such as a farm, mine, factory, or store that produces goods or provides services. It is typically at a single physical location and engaged in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. *Total wages*: Covered employers in most states report total compensation paid during the calendar quarter, regardless of when the services were performed. A few state laws, however, specify that wages be reported for or be based on the period during which services are performed, rather than for the period during which compensation is paid. Under most state laws or regulations, wages include bonuses, stock options, severance pay, the cash value of meals and lodging, tips and other gratuities, and—in some states—employer contributions to certain deferred compensation plans such as 401(k) plans.

wages, by NAICS industry, by county, and by ownership sector, for the entire United States. These data are aggregated to annual levels, to higher industry levels (NAICS industry groups, sectors, and supersectors), and to higher geographic levels (national, state, and metropolitan statistical area).⁶⁰

Since 2001, the QCEW has been producing and publishing data according to the NAICS system. Federal statistical agencies are mandated to publish industry data according to this improved classification system. Compared with the prior classification system—the 1987 Standard Industrial Classification (SIC) system, NAICS better incorporates new and emerging industries. For example, a new industry sector called *Information* brings together units that turn information into a commodity with units that distribute the commodity and units that provide information services. *Information*'s major components are publishing, broadcasting, telecommunications, information services, and data processing. Under the SIC system, these units were spread across the manufacturing, communications, business services, and amusement services groups. Another new sector of interest is *Professional, Scientific, and Technical Services*. This sector is composed of establishments engaged in activities where human capital is the major input.

Employment, establishment, and wage estimates produced by the QCEW program for 2001 to the present are not comparable with SIC-based industry estimates from previous years, preventing the construction of a longer time series for data analysis; however, 4 years of NAICS-based data are available for analysis.

Also recognizing the limitations of certain definitions and available economic data, it is important to note that many workers on small farms are excluded from QCEW data. The program data are collected from unemployment insurance records and do not cover self-employed farmers and some wage and salary farm workers (approximately 8 percent are excluded). A critical component of any Nebraska-specific economic analysis is the small farm and its activities; therefore, other data sources are needed to account for this farm-related activity.

Key economic data on family farms are available from other sources, including farm and farm-related employment estimates from the USDA's Economic Research Service (ERS) and the Bureau of Economic Analysis (BEA). The USDA's National Agricultural Statistics Service (NASS) and the Nebraska Department of Agriculture also publish useful information on the number and size of farms, as well as crop, livestock, and poultry production. Data from these sources are used to supplement the BLS data for the economic analysis. Employment estimates from BLS may differ significantly from other sources due to differences in concepts, definitions, and estimation methodologies.

The following section of the analysis will focus solely on agricultural production within Nebraska; the report will then investigate Nebraska's agbioscience industry.

⁶⁰ Major exclusions from UI coverage, and thus from the QCEW data, include self-employed workers (both farmers and nonagriculture), some wage and salary agricultural workers, unpaid family workers, railroad workers, and some state and local government workers.

NEBRASKA FARMS AND AGRICULTURAL PRODUCTION

Nebraska's economic present and future are critically tied to the production of agricultural commodities. While much of this economic analysis focuses on Nebraska's value-added agbioscience sector, it will first examine the core economic activities of producers to promote understanding of the state economy.

Producer Employment

Nebraska is home to 1.7 million people. The 2000 Census found that 5 percent of these individuals were living on a farm. By contrast, the 1930 Census recorded 42 percent of Nebraska residents living on farms. Though this might imply a shift away from farming, it instead mirrors a national trend during the 20th century toward the use of nonhuman capital for production (i.e., machinery and equipment). Today's farming practices require fewer farmers and other agricultural workers to produce the same or greater yields.

Currently, Nebraska, with 5 percent of residents living on farms, ranks fourth among all states, behind only South Dakota, North Dakota, and Iowa, respectively. The trend in Nebraska's farm population matches that of the overall U.S. farm population during the 20th century. In 1930, 25 percent of Americans were living on farms. After steady declines, this share now stands at 1 percent.

Farm and farm-related employment data from the USDA's ERS provide estimates of farm proprietors in Nebraska from 1981 through 2002. In 2002, ERS estimates that there were 50,754 farm proprietors in the state. At 4.3 percent of total state employment, Nebraska ranks sixth among all states in the number of farm proprietors as a share of total employment. For Nebraska, the number of farm proprietors has steadily declined over time, with the highest available recorded figure at 65,552 in 1983.

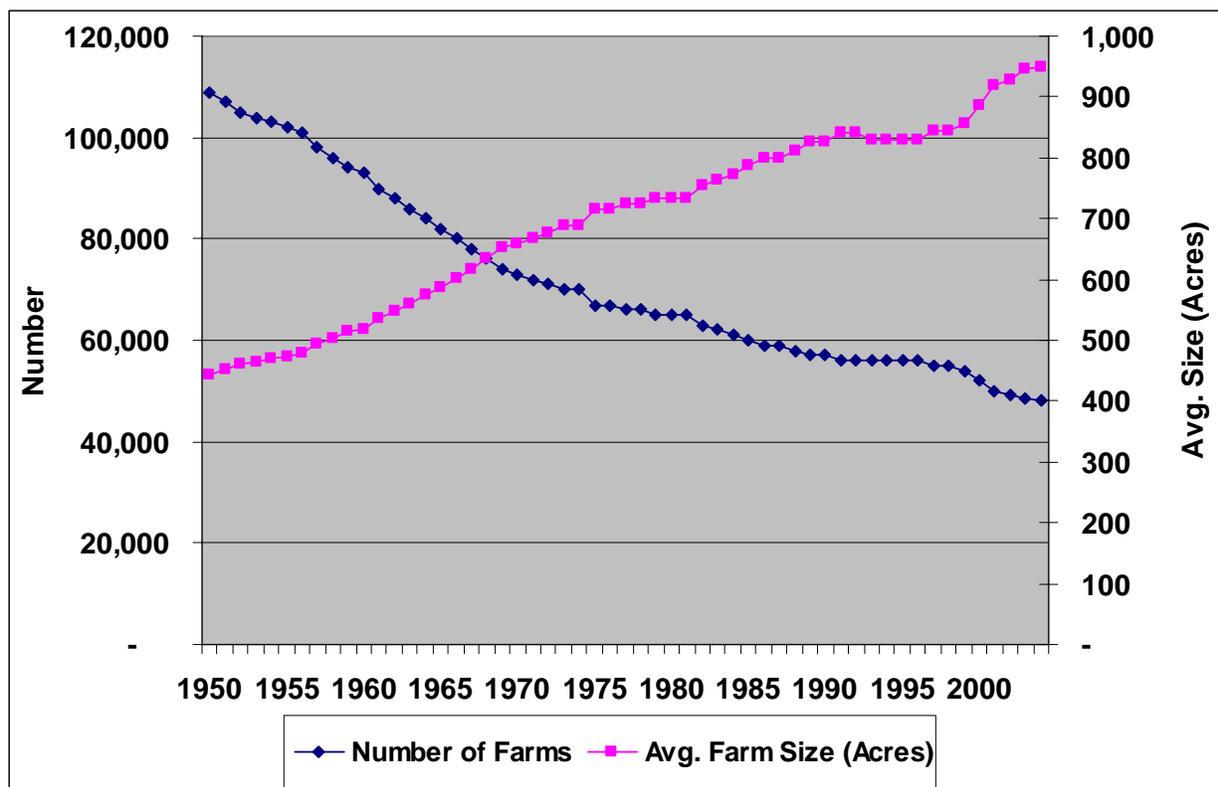
The ERS also calculates a broader measure of "farm-related" employment that includes not only farm proprietors and wage and salary workers, but also agricultural services workers; workers involved in ag inputs, ag processing, and marketing; and ag wholesale, retail, and other indirect agribusiness. When these related activities are included, total farm and farm-related employment reached 239,583, or 20 percent of total state employment, in 2002. This broad employment metric may be overly inclusive, but it indicates the significant impact that agriculture has on the State of Nebraska. Similar to the trend of fewer farmers over time, this overall share of farm and farm-related employment has eroded over the past two decades. In 1981, the same share of total employment stood at 27 percent.

Producer Establishment

According to the USDA's National Agricultural Statistics Service, 48,300 Nebraska farms and ranches covered nearly 46 million acres of land in 2004. This covered approximately 94 percent of Nebraska's total land area. Nebraska ranks fourth largest among all states in farm acreage. The land coverage remained near its peak of more than 48 million acres in the 1950s and 1960s; however, the number of farms has declined for 70 years.

While farms in Nebraska are fewer in number today, they are significantly larger than ever before. The average farm size is now 950 acres. Figure A-2 illustrates the long-term trend toward fewer, but larger, farms in Nebraska.

Figure A-2: Nebraska Farms and Ranches, Number and Average Size in Acres, 1950–2004



Source: USDA National Agricultural Statistics Service.

Commodity Production

Nebraska’s leading crops are corn, soybeans, winter wheat, and sorghum, which make up most of the state’s cropland. Table A-1 presents Nebraska’s largest commodities and their national rank in 2004.

Table A-1: Nebraska Commodity Production, State Rankings and Percentage of U.S. Total Production, 2004

Rank	Commodity	Number	Unit	Percentage of U.S. Total
1	Great northern bean production	827,000	Cwt	87.0
2	Pinto bean production	1,196,000	Cwt	15.3
3	Corn for grain production	1,319,700,000	Bushels	11.2
3	Sorghum for grain production	33,615,000	Bushels	7.4
4	On-farm grain storage capacity	1,020,000,000	Bushels	9.1
4	Off-farm grain storage capacity	698,838,000	Bushels	8.2
6	Soybean production	220,875,000	Bushels	7.0
6	Alfalfa hay production	4,438,000	Tons	5.9
7	All hay production	6,143,000	Tons	3.9
7	Winter wheat production	61,050,000	Bushels	4.1
7	Sugarbeet production	1,050,000	Tons	3.5
8	Cash receipts from crops, 2003	3,753,907,000	Dollars	3.5

Source: Nebraska Agricultural Statistics Service, USDA, Nebraska Agri-Facts Special Edition , April 2005.

More than half of Nebraska farms and ranches (55 percent) sell livestock, poultry, and other products. In 2003, sales of these products accounted for 65 percent of total state agricultural receipts. Cattle, a huge component of these sales, accounted for 56 percent of the state's total receipts. Table A-2 provides Nebraska's current rankings in livestock, poultry, and other products.

Table A-2: Nebraska Livestock and Other Products, State Rankings and Percentage of U.S. Total Production, 2003

Rank	Product	Number	Date	Percentage of U.S. Total
1	Commercial red meat production	6.8 billion lb	2004	15.0
2	Commercial cattle slaughter	6.9 million	2004	21.1
2	Cattle on feed	2.5 million	Jan-05	18.0
3	Cattle and calves	6.4 million	Jan-05	6.6
3	Fed cattle marketed, 1000+ lots	4.5 million	2004	20.1
3	Livestock cash receipts	\$6.9 billion	2003	6.5
4	Beef cows	1.9 million	Jan-05	5.8
5	Calves born	1.8 million	2004	4.8
6	Commercial hog slaughter	7.0 million	2004	6.7
7	Hogs and pigs	2.9 million	Dec-04	4.7
10	Honey production	4.5 million lb	2004	2.5
12	Chickens	14.0 million	Dec-04	3.1
18	Sheep and lambs	97,000	Jan-05	1.6

Source: Nebraska Agricultural Statistics Service, USDA, Nebraska Agri-Facts Special Edition, April 2005.

In addition to specializing in the production of numerous agricultural commodities, Nebraska has become a key producer of ethanol. According to the NASS, Nebraska ranked fourth in the United States in ethanol production capacity at 523 million gallons in 2005. Eleven ethanol plants are operating across the state. More than 20 percent of Nebraska's corn crop goes into producing ethanol and exemplifies the value-added spillover characterizing the convergence of agricultural production and the biosciences.

Ethanol, a plant-derived biofuel, is linked to reductions in harmful air pollutants. According to the Council for Biotechnology Information, ethanol is increasingly being produced from biotech corn varieties, which yield additional eco-benefits.⁶¹ Biotechnology enables more efficient corn production with regard to energy and allows farmers to use environmentally friendly growing techniques.

Nebraska is clearly one of the top state producers of agricultural commodities. The state ranks highly in the production of a variety of goods vital to the U.S. market. Based on this strong production, Nebraska has developed additional specializations in related agbioscience sectors. The following analysis focuses on this overall sector and its component industries.

⁶¹ Council for Biotechnology Information, "Green Ethanol Provides Environmental Advantages," 2004, for more information, see <http://www.whypiotech.com/index.asp?id=5174>.

THE NEBRASKA AGBIOSCIENCE SECTOR

The agbioscience industry employed 59,657 individuals across 1,990 establishments in 2004 in Nebraska (Table A-3). Since 2001, employment in the sector has declined by 3.8 percent, about the same decrease in total U.S. agbioscience employment (-3.7 percent). Nebraska agbioscience establishments, however, have increased nearly 7 percent during this period. Despite the employment decline, a steady increase in the number of establishments signals new business investments and promising entrepreneurial activity.

The decline in agbioscience employment during the 2001 to 2004 period is not surprising, given the national employment declines and overall economic weakness following the relatively short recession in 2001.⁶² It is important to keep in mind the business cycle context of the time period being discussed.

The overall employment trends for both the Nebraska agbioscience sector, and the entire private sector mirror those experienced nationally. Total private sector employment was relatively unchanged for both Nebraska and the United States from 2001 to 2004—both fell by 0.7 percent. Following heavy job losses in 2002, total employment in Nebraska and the United States rebounded and significantly increased from 2003 to 2004.

This recent employment turnaround is encouraging for the Nebraska agbiosciences. While employment has declined for many components of the agbiosciences since 2001, a rebound and continuation of longer-term job growth is ongoing. Since 2002, six of the nine agbioscience subsectors in Nebraska have added jobs.

While earnings for Nebraska's agbioscience workers are lower than for their counterparts across the United States, they are significantly more than the average worker in the Nebraska private sector (\$33,419 vs. \$31,055 in 2004). Higher average wages for agbioscience workers signal a strong demand for their skills and the value they add in providing a service or producing a good. Economic development efforts in Nebraska should aim to add high-paying agbioscience jobs.

Employment statistics were weak during the early 2000s, but average annual wages rose at a healthy pace. Nebraska agbioscience workers earned \$33,419 on average in 2004, up 8.7 percent from 2001. Nationally, earnings in the sector grew a rapid 13.8 percent over the same period to \$41,903.⁶³

⁶² The National Bureau of Economic Research (NBER) Business Cycle Dating Committee is the official arbiter of U.S. Business Cycles. The Committee determined that the business cycle peaked in March 2001, marking the end of an expansion and the beginning of a recession. The peak ended a record-long expansion (10 years). The business cycle trough occurred in November 2001, ending a recession of relatively short duration. For more information, visit <http://www.nber.org/cycles.html/>.

⁶³ Average annual wages per employee for any given industry are computed by dividing total annual wages by annual average employment. Annual pay data only approximate annual earnings because an individual may not be employed by the same employer all year or may work for more than one employer at a time. Average weekly or annual pay is affected by the ratio of full-time to part-time workers, as well as by the numbers of individuals in high-paying and low-paying occupations. When comparing average pay levels among states and industries, data users should take these factors into consideration.

Table A-3: Nebraska and National Agbioscience Industry Comparison, 2001–2004

Metric	Nebraska		United States	
	Agbiosciences	Total Private Sector	Agbiosciences	Total Private Sector
Establishments				
2001	1,868	49,230	171,447	7,724,965
2004	1,990	51,562	168,548	8,093,142
'01-'04 % change	6.6%	4.7%	-1.7%	4.8%
Employment				
2001	62,024	735,492	4,164,714	109,304,802
2004	59,657	730,413	4,009,056	108,490,066
'01-'04 % change	-3.8%	-0.7%	-3.7%	-0.7%
Employees Per Establishment				
2001	33	15	24	14
2004	30	14	24	13
Average Annual Wages				
2001	\$ 30,744	\$ 28,034	\$ 36,806	\$ 36,157
2004	\$ 33,419	\$ 31,055	\$ 41,903	\$ 39,134
'01-'04 % change	8.7%	10.8%	13.8%	8.2%
Location Quotient				
2001	2.21		N/A	
2004	2.21		N/A	
Share of Private Sector Employment (Percent)				
2001	8.4%		3.8%	
2004	8.2%		3.7%	

Source: Battelle calculations based on data from QCEW/ES-202 of the BLS and Minnesota IMPLAN Group, Inc.

Agbioscience employment remains a significant share of the Nebraska private sector. The concentration of workers in this industry has consistently exceeded the national average. In fact, *the industry currently makes up 8.2 percent of the state's private sector employment, more than twice the national share of 3.7 percent.* This greater employment concentration within Nebraska can be quantified by calculating a location quotient (LQ).

An LQ determines a specific industry's employment concentration relative to the nation.⁶⁴ An LQ of 1.0 indicates that an industry has a similar degree of concentration in the region as in the nation. When the region has significantly above-average employment—an LQ greater than 1.20—the area is said to possess a specialization in that industry.

Figure A-3 illustrates the formula for calculating an LQ.

Nebraska has more than twice the employment concentration in the agbiosciences as the United States as a whole. With an LQ of 2.21, the

concentration of employment in agbiosciences in Nebraska is considered to be regionally specialized. The quotient has remained steady at about 2.2 over 2001 to 2004. The change (or lack of change) in an LQ can result from changes in total employment and/or industry employment at either the regional or national level. In this case, the LQ was unchanged and remained high because both total and industry employment experienced similar, modest declines for both the nation and the State of Nebraska.

Nebraska has a clear incentive to develop and nurture the agbioscience sector of the state's economy. The industry is highly concentrated and accounts for 8 percent of total state employment—more than twice the national level. Annual wages for agbioscience workers exceed the average for other Nebraska workers by nearly 8 percent or \$2,364. Job numbers are growing substantially in key subsectors of the agbioscience industry including drugs and pharmaceuticals and organic and agricultural chemicals. In addition, earnings in the highest-paying agbioscience subsector, biological research and testing, have grown at twice the rate of the national subsector. The following section focuses on these major subsectors and the underlying trends driving the overall agbioscience industry.

NEBRASKA'S AGBIOSCIENCE SUBSECTORS

The diverse and dynamic nature of the agbiosciences calls for a closer inspection of its major components. Overall magnitudes and trends can be explained only by examining the subsectors that comprise the agbioscience sector. Component industries and their activities and characteristics often differ greatly from one another. While the overall sector is generally engaged in value-added activities involving living organisms, the approach to research and industrial/commercial applications among the subsectors vary.

In this analysis, Battelle examines the subsectors of the agbioscience industry to identify the unique characteristics that define their progress. Each subsector's strengths and potential emerge

Figure A-3: Calculating a Location Quotient (LQ)

$$LQ_{it} = (E_i / E_t) / (US_i / US_t)$$

Where:

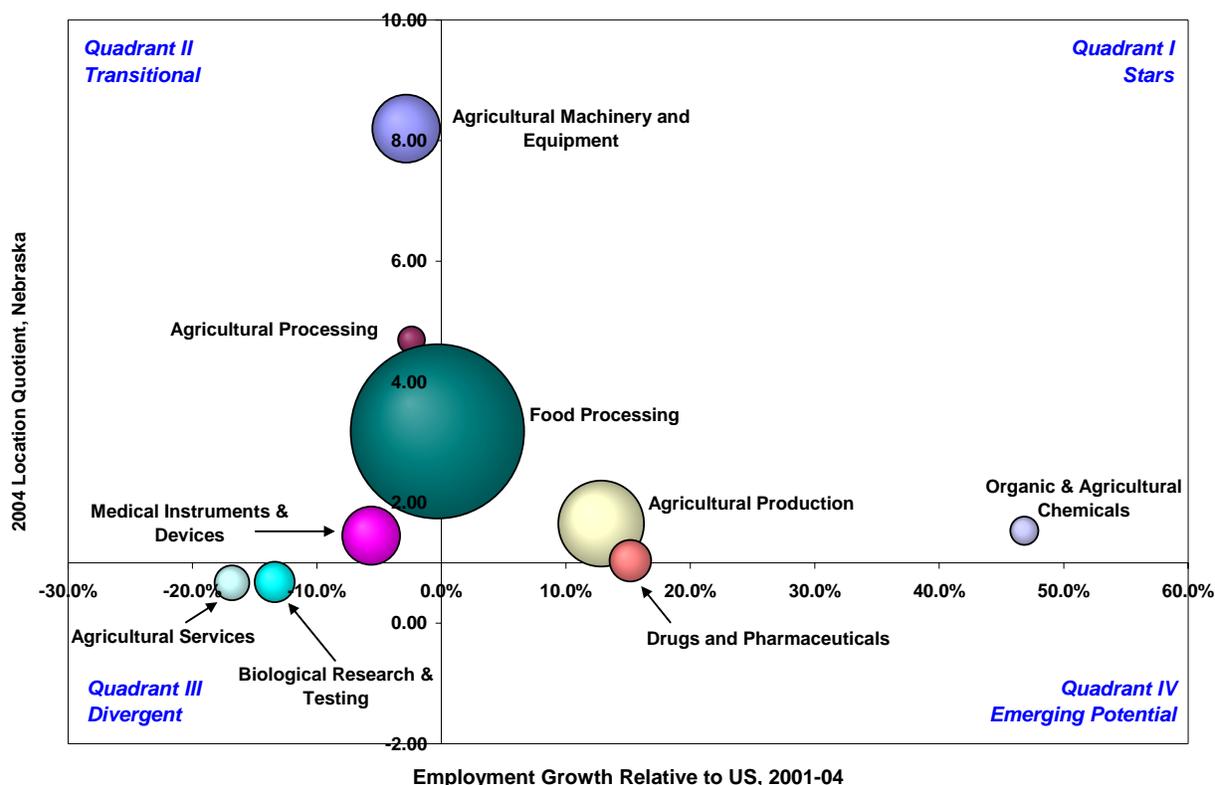
- E_i = Industry *i* regional employment
- E_t = Total regional employment
- US_i = Industry *i* national employment
- US_t = Total national employment

⁶⁴ LQs are a standard measure of the concentration of a particular industry in a region relative to the nation (reference area). The LQ is the share of total regional employment in the particular industry divided by the share of total industry employment in the nation (reference area). An LQ greater than 1.0 for a particular industry indicates that the region is relatively concentrated, whereas an LQ less than 1.0 signifies a relative underrepresentation. An LQ greater than 1.20 denotes employment concentration significantly above the national average. Throughout this report, LQs are used to report regional industry concentrations relative to the United States as a whole. The minimum concentration threshold for declaring a regional specialization is a matter of judgment and varies somewhat in the relevant literature. In this analysis, regional specializations are defined by LQs of 1.20 or greater.

when state and national economies are compared. Each development and growth opportunity identified among the subsectors can benefit the entire agbioscience sector and increase the benefits derived from their convergence.

Figure A-4 illustrates the degree of specialization and employment growth of each major agbioscience industry in Nebraska relative to the United States. The figure plots Nebraska 2004 LQs for each industry against the difference in employment growth in Nebraska versus the United States during 2001 to 2004. The size of a bubble represents the respective industry's employment size.

Figure A-4: Nebraska Agbioscience Subsectors, Their Degrees of Specialization and Employment Growth, 2001–2004



Source: Battelle calculations based on data from QCEW/ES-202 of the BLS.

The majority of subsectors exhibit a strong regional specialization. Among the nine subsectors, six have LQs greater than 1.20. Of those six, two of the industries—organic and agricultural chemicals and agricultural production—experienced employment growth from 2001 to 2004. The drugs and pharmaceuticals subsector is not considered to be specialized in Nebraska, but the industry experienced strong employment growth despite the relatively weak labor market in the state and nation.⁶⁵

The fastest growing subsector, organic and agricultural chemicals has grown into a regionally specialized industry in recent years. The subsector grew by 37 percent from 2001 to 2004 and now employs 927 individuals. While the industry is relatively small, its marked employment

⁶⁵ In Appendix B, Table B-2 details agbioscience subsector data for both Nebraska and the United States.

growth has boosted its LQ from 1.01 to 1.53 over this period, making it a specialized industry within Nebraska. This employment increase is additionally noteworthy given the nearly 10 percent decline in the national industry employment level.

The organic and agricultural chemicals subsector includes firms producing ethyl alcohol (ethanol) and other organic chemicals, an array of fertilizers, and pesticides and other agricultural chemicals. While still modest in employment size, ethyl alcohol manufacturing has strong regional specialization—a LQ of 13.65—and helped drive employment growth in this subsector by increasing its employment base by 53 percent during 2001 to 2004.

As previously mentioned in this analysis, ethanol production is a key component of the Nebraska economy. The state ranks fourth in production capacity, and 20 percent of state corn production goes into manufacturing ethanol. A specialized, growing industry within Nebraska, ethyl alcohol manufacturing also offers average annual wages significantly greater than both private-sector and overall agbioscience wages. In 2004, the average annual wage in ethyl alcohol manufacturing was \$43,224, nearly 40 percent higher than the average annual private-sector wage. Nebraska has successfully positioned itself as a leading producer of ethanol, a more environmentally friendly fuel additive. The state should continue to develop its ethanol industry as a critical component of its overall agbioscience sector.

Abengoa Bioenergy Corporation (formerly High Plains Corporation) in York County is the nation's seventh-largest producer of ethanol, with a production capacity of more than 50 million gallons of fuel alcohol.

Agricultural production in Nebraska is regionally specialized, large, and growing. As discussed in the data overview section of this analysis, BLS data *do not* include the majority of farm proprietors because they are not covered by state unemployment insurance. Undoubtedly, the actual number of Nebraska producers greatly exceeds the total agricultural production employment estimates that follow. In fact, the number of workers in the state farm production sector totaled 63,138 in 2002, according to estimates provided by the USDA's ERS. Within this USDA production employment estimate are 50,754 farm proprietors—80 percent of the total. Most agricultural wage and salary workers, however, are included in the BLS data; and the agricultural production estimates in this analysis are useful in assessing a major component of Nebraska's agbioscience industry.

Both the number of establishments (1,098) and the state employment level (8,495) grew significantly from 2001 to 2004—by 11.4 percent and 3.5 percent, respectively. This growth occurred despite substantial establishment and employment declines at the national level.

It is no secret that Nebraska has a strong specialization in agricultural production, ranking among the top 10 state producers of many crops and livestock production and products. The LQ confirms this; at 1.65 in 2004, the sector is 65 percent more concentrated in Nebraska than at the national level. Even though the available BLS agricultural production employment data used in this analysis significantly underrepresent this critical state sector, Nebraska is still very specialized compared with other regions.

The drugs and pharmaceuticals subsector is emerging as a key component of agbiosciences in Nebraska, after experiencing strong employment growth from 2001 to 2004. This subsector is not yet considered a state specialization (its LQ is 1.04); but its growth, especially during a period of modest national job growth, is significant. The industry employed 2,005 individuals in

2004 in Nebraska, up 17 percent since 2001 compared with only 2.3 percent growth at the national level. The drugs and pharmaceuticals subsector's small share of private sector employment in Nebraska matches that of the United States as a whole (0.3 percent).

Employment increases in drugs and pharmaceuticals have lifted the employment concentration within Nebraska. The LQ in 2001 was 0.90 and stood at 1.04 in 2004. While not regionally specialized, this high-tech industry has risen above national concentration levels and can play a significant role in future agbioscience development in Nebraska.

This subsector includes firms that produce animal healthcare products. One example is the international drug firm Schering-Plough. The company develops medicines and healthcare products for consumers around the world. Their two locations in Nebraska—in Elkhorn and in Omaha—focus on animal health products (vaccines, anti-inflammatories, ointments).

Food processing is the largest industry within the agbiosciences in Nebraska and is regionally specialized. This industry employs 34,888 individuals across 366 establishments. It is by far the largest component of the agbiosciences in Nebraska, accounting for 58 percent of total sector employment. At the state level, it makes up 4.8 percent of private sector employment, more than three times the national concentration (1.5 percent). The LQ, therefore, stood at 3.18 in 2004, nearly unchanged from 2001.

Employment declined in the food processing subsector from 2001 to 2004 by 4.6 percent. This decrease mirrors a similar national employment reduction of 4.3 percent.

Agricultural machinery and equipment has the greatest degree of specialization among the Nebraska agbioscience subsectors. Employment in the subsector in 2004 stood at 5,336 individuals, down 10.8 percent from 2001. National employment in agricultural machinery is down 7.9 percent over the same 3-year period. After 2 years of rather sharp employment declines, employment increased slightly in 2004.

Analyzing the recent employment declines reveals that jobs were lost within this state subsector mainly within the lawn and garden equipment manufacturing component, not within the larger farm machinery component. Employment in the lawn and garden sector declined by 85 percent since 2001 (from 564 to 83), likely reflecting a company or plant closing or moving to another state.

Nebraska remains highly specialized in the subsector. In fact, the machinery and equipment manufacturing industry has the highest LQ of all major subsectors—8.20—representing a level of concentration eight times the national average. With a large and specialized employment base, Nebraska has a unique opportunity to maintain its comparative advantage in producing first-class farm and other machinery and equipment and to position the subsector as a platform on which to build its agbioscience industry.

The Thurston Manufacturing Company in Thurston, Nebraska, manufactures fertilizer equipment, tillers, and other farm machinery and equipment. The company's engineers work to ensure that their equipment will perform well and increase the productivity of farm workers.

Agricultural processing has the second-highest degree of specialization among the agbioscience subsectors. The industry is relatively small, employing 852 individuals state-wide in activities such as wet corn milling and soybean processing. While modest in size, these

activities are highly concentrated in Nebraska when compared with the entire United States. The LQ in 2004 was 4.70, second in magnitude only to agricultural machinery and equipment.

The medical instruments and devices subsector is yet another industry in which Nebraska has a regional specialization. This high-tech manufacturing subsector produces laboratory instruments and furniture; surgical and veterinary instruments, appliances, and supplies; and dental and ophthalmic goods. In 2004, the industry employed 3,894 Nebraskans across 77 establishments. The employment level is down 8.7 percent since 2001, compared with a more modest 3.1 percent decline nationwide.

The production of medical instruments and related supplies and devices is important to Nebraska's agbioscience economy. The state's LQ is a strong 1.45, down slightly from 1.54 in 2001. A key component of this subsector is surgical and medical instrument manufacturing, employing 2,558 workers in 2004. This component industry will be discussed in greater detail in a following section, but it is important to note here this high-tech bioscience employment concentration and to monitor future employment trends.

With job losses and weak labor market conditions in the early 2000s, medical instrument manufacturing is potentially in a transitional period. It remains highly concentrated in Nebraska, but this concentration has eroded because of lost jobs. Job losses in the state have leveled off, though, and it is important now to invest in the future of this advanced manufacturing industry.

Biological research and testing employment experienced job losses from 2001 to 2003, but rebounded well in 2004. After declining by 13 percent from 2001 to 2003, this agbioscience subsector added 135 state jobs in 2004, boosting employment by 8 percent to 1,862. At the national level, employment in this subsector was unique during the full 2001-to-2004 period, steadily increasing each year despite the recession and subsequent labor market weaknesses. Over this period, national research and testing employment rose 7 percent, more than any other major subsector. When an industry exhibits this robust growth in an overall weak economy, it is clear that the sector is a national strength and that capital investments will continue.

Demand for skilled workers in this knowledge industry is strong, as average annual wages in both the state and national sector are very high. State wages for workers in research and testing are \$55,402, the highest of the Nebraska agbiosciences. The average annual national wage is \$65,411, the third highest among the agbioscience component industries. The demand for workers in Nebraska has elevated the average annual wage by a substantial 23.3 percent since 2001. This rate of wage increase is faster than for any other subsector at either the state or national level. While still lower than the national average, wages in Nebraska's research and testing sector are outpacing their counterparts in other states and are catching up.

Employment and wage trends in both the United States and Nebraska in biological research and testing point to increased demand for workers. Activities in this industry are at the heart of the agbiosciences. Investments in biological research yield new technologies and products and are the foundation for economic growth in the agbiosciences. Nebraska is not specialized in this sector; in fact, the state has only about 50 percent of the national employment concentration (LQ is 0.49). Despite this low LQ, the state would be wise to invest in this high-paying, robust industry that drives both national and state job growth.

Transgenomic, Inc., headquartered in Omaha, exemplifies firms within the biological research and testing subsector. The company is involved in biotech research and product development,

including products and systems for deoxyribonucleic acid (DNA) analysis. Transgenomic's WAVE system was developed to allow researchers to identify DNA mutations. Among its customers are the National Institutes of Health and major drug companies such as Merck, Eli Lilly, and Bristol-Myers Squibb.

Agricultural services, a support sector for agricultural production, has experienced a relatively large employment decrease since 2001. Nebraska's agricultural services industry has seen employment decline by 18.6 percent since 2001 to 1,399 individuals. For the United States overall, employment in agricultural services remained relatively flat in the early 2000s, down just 1.8 percent from 2001 to 2004.

Workers in this subsector are engaged in support activities for crop and animal production. Nebraska does not have a regional specialization in this services component—its location quotient is 0.67, down from 0.81 in 2001. Average wages in this sector are by far the lowest among all subsectors for both the state and the nation.

SUBSECTOR ANNUAL WAGE ANALYSIS

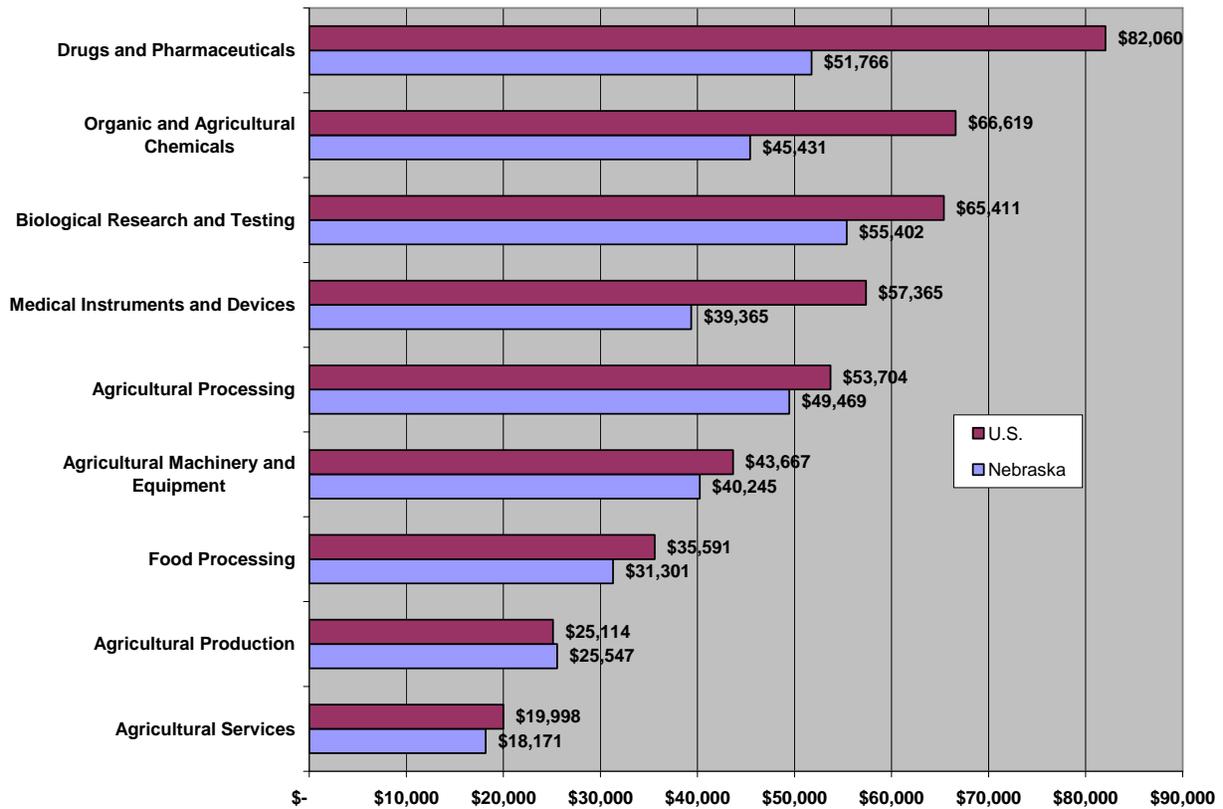
Analyzing wages across the major agbioscience subsectors provides insight into the demand and relative supply of workers in Nebraska. In addition, it highlights those industries with the highest-paying jobs for the state to target in its development efforts. A higher-paying sector implies a greater degree of value added to a good produced or a service provided. In developing its agbioscience economy, Nebraska can look to wage rates as one key signal of the market's allocation of capital.

Despite the relatively low demand for labor in both the national and state economies during 2001 to 2004, wages have risen across all subsectors. For all Nebraska agbioscience workers, average annual wages rose 8.7 percent to \$33,419, compared with a 13.8 percent increase for their counterparts across the United States (\$41,903 in 2004). While slower than the national average, this rate is significant given the prevailing labor market weaknesses.

Total Nebraska private-sector wages outpaced the agbiosciences, rising 10.8 percent since 2001. Despite slightly slower wage growth, ***annual wages for agbioscience workers exceed the average for other Nebraska workers by 8 percent or \$2,364.*** Similarly, agbioscience wages at the national level (\$41,903) are 7 percent higher, on average, than the rest of the private sector. Agbioscience jobs pay very well and raise the standard of living throughout the state and the nation.

Figure A-5 illustrates national and Nebraska average annual wages in agbioscience subsectors for 2004. In all but one major subsector, U.S. average annual wages exceed those for Nebraska.

Figure A-5: Average Annual Wages in the Agbioscience Subsectors, 2004



Source: Battelle calculations based on data from QCEW/ES-202 of the BLS and Minnesota IMPLAN Group, Inc.

Wages in agricultural production are slightly higher in Nebraska than in the United States as a whole. The fact that, on average, Nebraskan agricultural producers are earning more than their national counterparts is encouraging for a well-established industry that is the economic foundation of the state. While higher-paying jobs exist within the agbiosciences, agricultural production workers are earning a competitive wage.

The highest-paying Nebraska agbioscience subsector, biological research and testing, had the fastest wage growth over 2001 to 2004. Average annual wages in this sector grew by 23.3 percent. Organic and agricultural chemicals wage growth was second, increasing by 15.6 percent in 3 years to \$45,431 in 2004. These growth rates outpaced the same industry rates for the nation.

Strong wage and employment growth in these higher-paying Nebraska industries is promising. Organic and agricultural chemicals experienced the greatest employment growth relative to its base in the early 2000s (37.3 percent); and, though biological research and testing saw a net job decline from 2001 to 2004, in this most recent year its employment rose 8 percent. In addition, while wage growth was modest in drugs and pharmaceuticals, its employment rose by 17.5 percent. Upward wage and employment trends among three of the highest-paying industries are very encouraging signs for Nebraska’s agbiosciences. Demand is strong in these high-tech, high value-added agbioscience sectors; and wages are significantly greater than in the overall Nebraska private sector.

DETAILED INDUSTRY STRENGTHS

The diversity of activities within the agbiosciences calls for an examination of the subsectors at the most detailed level. Such an analysis can indicate detailed subsector strengths and identify what is driving trends in each major subsector for the State of Nebraska. Caution should be used, however, when studying magnitudes and trends at the detailed industry level. Minor changes within small industries or among one establishment can be magnified and interpreted as a major shift. To help control for this, the following detailed industry analysis is limited to those with a state employment base of at least 500.

Each major subsector in this economic analysis is composed of more detailed four-, five-, or six-digit NAICS industries. Most are aggregated up from the six-digit classification level. Table A-4 highlights detailed industries that have exhibited significant strength in at least two of three metrics—a “large” employment base (2,000 workers or more), “growing” faster than the industry-wide national employment rate, and/or “regionally specialized” with an LQ greater than 1.20.

Table A-4: Nebraska Detailed Industry Strengths

NAICS Industry Code	Industry	Employment, Rate of Growth, and Regional Specialization
Large, Growing, and Regionally Specialized		
311612	Meat processed from carcasses	Large Employment: 6,314 workers Growth: Employment increased by 5.6 percent since 2001 Regionally Specialized: LQ is 8.42
11211	Beef cattle ranching, farming, and feedlots	Large Employment: 3,448 workers Growth: Employment increased by 2.3 percent since 2001 Regionally Specialized: LQ is 11.61
Large Employment and Regionally Specialized		
333111	Farm machinery and equipment mfg.	Large Employment: 5,142 workers Growth: Employment decreased by 2.6 percent Regionally Specialized: LQ is 13.46
311611	Animal, except poultry, slaughtering	Large Employment: 17,751 workers Growth: Employment declined by 6.3 percent since 2001 Regionally Specialized: LQ is 17.48
339112	Surgical and medical instrument manufacturing	Large Employment: 2,558 workers Growth: Employment declined by 4.4 percent since 2001 Regionally Specialized: LQ is 3.64

Table A-4: Nebraska Detailed Industry Strengths (continued)

NAICS Industry Code	Industry	Employment, Rate of Growth, and Regional Specialization
Growing and Regionally Specialized		
311222	Soybean processing	Employment: 814 workers Growth: Employment increased by 208 percent since 2001 Regionally Specialized: LQ is 10.99
1111–11115	Other oilseed and grain farming	Employment: 612 Growth: Employment increased by 108 percent since 2001 Regionally Specialized: LQ is 4.74
325414	Other biological product manufacturing	Employment: 1,101 workers Growth: Employment increased by 12.8 percent since 2001 Regionally Specialized: LQ is 6.74
311111	Dog and cat food manufacturing	Employment: 793 workers Growth: Employment increased by 4.9 percent since 2001 Regionally Specialized: LQ is 6.67
311230	Breakfast cereal manufacturing	Employment: 815 workers Growth: Employment increased by 1.9 percent since 2001 Regionally Specialized: LQ is 8.50
311613	Rendering and meat byproduct processing	Employment: 705 workers Growth: Employment increased by 19.9 percent since 2001 Regionally Specialized: LQ is 12.56
311999	All other miscellaneous food manufacturing	Employment: 1,154 workers Growth: Employment increased by 5.1 percent since 2001 Regionally Specialized: LQ is 6.31

Source: Battelle calculations based on data from QCEW/ES-202 of the BLS and Minnesota IMPLAN Group, Inc.

Detailed subsector strengths highlight further industry segments to target those of significant size and regional specialization. In the top group, traditional Nebraskan economic strengths emerge—meat processing and beef cattle ranching and farming. These industries remain strong in Nebraska, providing a significant agbioscience employment base that has grown in recent years despite job declines at both the state and national levels.

Much of Table A-4 shows traditional, agricultural production and manufacturing activity; however, surgical and medical instrument manufacturing has a large employment base (2,558 workers in 2004) and a high LQ of 3.64. An example is Kendall-Tyco Healthcare, which has a location in Norfolk, Nebraska, and manufactures a broad range of surgical/medical products including syringes, blood tubes, electrodes, and other nursing care products. This industry within the larger medical instruments and devices subsector is a strong platform from which to advance high-tech agbioscience manufacturing in Nebraska.

SUMMARY

Nebraska continues to be a top state producer of agricultural goods and services. This economic analysis highlights additional and often overlooked strengths in the state's agbioscience economy. Nebraska has a regional specialization in six of the nine major agbioscience subsectors: agricultural machinery and equipment, agricultural processing, food processing, medical instruments and devices, agricultural production, and organic and agricultural chemicals. Recent exciting trends among the high-tech agbioscience subsectors include the following:

- The organic and agricultural chemicals subsector emerged as a regional specialty in 2003 and has shown strong wage and employment growth in recent years. A state specialization in ethanol production is playing an important role.
- The drugs and pharmaceuticals subsector has shown marked employment growth. The industry is not yet a regional specialization, but could be soon if employment growth continues.
- High wage growth in biological research and testing is very encouraging for Nebraska. As the highest-paying agbioscience sector in the state, it has seen its wages rise faster than those in any other subsector. In addition, the number of biological research and testing establishments in Nebraska has grown to 99 (54 percent) since 2001.

Agricultural production continues to be the primary driver of Nebraska's economy. While BLS employment data used in this analysis do not cover the full scope of farm employment, they nevertheless point to a high degree of specialization in a large, important state industry. The broadest measure of Nebraska farm and "farm-related" employment from the USDA (including farm workers and related services, inputs, processing, marketing, and wholesale and retail) puts the sector at 239,583 workers, or about 20 percent of total state employment. Wages for this sector are higher than the national average. Nebraska continues to fulfill its role as a critical producer of agricultural goods and services.

By focusing on its existing strengths and related, emerging agbioscience industries, the economy of the State of Nebraska looks encouraging. The dynamic agbioscience industry thrives in a state like Nebraska where more traditional agricultural production activities and technologies can spill over into new industry strengths such as manufacturing medical devices, producing organic chemicals, developing new pharmaceuticals, and encouraging further biological research and testing.

Appendix B

Table B-1: Detailed NAICS Codes Defining Nebraska Agbioscience Industry

Agricultural Machinery and Equipment	
333111	Farm machinery and equipment manufacturing
333112	Lawn and garden equipment manufacturing
333294	Food product machinery manufacturing
Agricultural Processing	
31122	Starch and vegetable oil manufacturing
311221	Wet corn milling
311222	Soybean processing
311223	Other oilseed processing
311225	Fats and oils refining and blending
Agricultural Production	
111	Crop production
1111	Oilseed and grain farming
11115	Corn farming
1111-11115	Other oilseed and grain farming
1112	Vegetable and melon farming
1113	Fruit and tree nut farming
1114	Greenhouse and nursery production
11141	Food crops grown under cover
11142	Nursery and floriculture production
1119	Other crop farming
111991	Sugar beet farming
11194, 11199 (PT)	Hay farming and all other crop farming
112	Animal production
1121	Cattle ranching and farming
11211	Beef cattle ranching, farming, and feedlots
11212	Dairy cattle and milk production
1122	Hog and pig farming
1123	Poultry and egg production
1125	Animal aquaculture
1129	Other animal production
113*	Forestry and logging
1131	Timber tract operations
1132	Forest nursery and gathering forest products
1133	Logging

Table B-1: Detailed NAICS Codes Defining Nebraska Agbioscience Industry (continued)

Agricultural Services	
115	Agriculture and forestry support activities
1151	Support activities for crop production
1152	Support activities for animal production
1153	Support activities for forestry
Biological Research and Testing	
541380 (PT)	Testing laboratories
541710 (PT)	Physical, engineering and biological research
621511	Medical laboratories
621512	Diagnostic imaging centers
Drugs and Pharmaceuticals	
325411	Medicinal and botanical manufacturing
325412	Pharmaceutical preparation manufacturing
325413	In-vitro diagnostic substance manufacturing
325414	Other biological product manufacturing
Food Processing	
311111	Dog and cat food manufacturing
311119	Other animal food manufacturing
311211	Flour milling
311212	Rice milling
311213	Malt manufacturing
311230	Breakfast cereal manufacturing
311311	Sugarcane mills
311312	Cane sugar refining
311313	Beet sugar manufacturing
311320	Confectionery manufacturing from cacao beans
311330	Confectionery manufacturing from purchased chocolate
311340	Nonchocolate confectionery manufacturing
311411	Frozen fruit and vegetable manufacturing
311412	Frozen specialty food manufacturing
311421	Fruit and vegetable canning
311422	Specialty canning
311423	Dried and dehydrated food manufacturing
311511	Fluid milk manufacturing
311512	Creamery butter manufacturing
311513	Cheese manufacturing
311514	Dry, condensed, and evaporated dairy products
311520	Ice cream and frozen dessert manufacturing
311611	Animal, except poultry, slaughtering
311612	Meat processed from carcasses
311613	Rendering and meat byproduct processing
311615	Poultry processing
311711	Seafood canning
311712	Fresh and frozen seafood processing
311811	Retail bakeries

Table B-1: Detailed NAICS Codes Defining Nebraska Agbioscience Industry (continued)

Food Processing (continued)	
311812	Commercial bakeries
311813	Frozen cakes and other pastries manufacturing
311821	Cookie and cracker manufacturing
311822	Mixes and dough made from purchased flour
311823	Dry pasta manufacturing
311830	Tortilla manufacturing
311911	Roasted nuts and peanut butter manufacturing
311919	Other snack food manufacturing
311920	Coffee and tea manufacturing
311930	Flavoring syrup and concentrate manufacturing
311941	Mayonnaise, dressing, and sauce manufacturing
311942	Spice and extract manufacturing
311991	Perishable prepared food manufacturing
311999	All other miscellaneous food manufacturing
312111	Soft drink manufacturing
312112	Bottled water manufacturing
312113	Ice manufacturing
312120	Breweries
312130	Wineries
312140	Distilleries
Organic and Agricultural Chemicals	
325193	Ethyl alcohol manufacturing
325199	All other basic organic chemical manufacturing
325221	Cellulosic organic fiber manufacturing
325311	Nitrogenous fertilizer manufacturing
325312	Phosphatic fertilizer manufacturing
325314	Fertilizer, mixing only, manufacturing
325320	Pesticide and other ag. chemical manufacturing
Medical Instruments and Devices	
334510	Electromedical apparatus manufacturing
334516	Analytical laboratory instrument manufacturing
334517	Irradiation apparatus manufacturing
339111	Laboratory apparatus and furniture manufacturing
339112	Surgical and medical instrument manufacturing
339113	Surgical appliance and supplies manufacturing
339114	Dental equipment and supplies manufacturing
339115	Ophthalmic goods manufacturing
339116	Dental laboratories

NOTE: Industries labeled "(PT)" include only the portion of the industry engaged in relevant biological or other life science activities.

Table B-2: Nebraska and National Agbioscience Subsector Comparison, 2001 and 2004

NEBRASKA	Agricultural Machinery and Equipment	Agricultural Processing	Agricultural Production	Agricultural Services	Biological Research and Testing	Drugs and Pharmaceuticals	Food Processing	Organic and Agricultural Chemicals	Medical Instruments and Devices
Establishments									
2001	88	6	986	216	64	25	374	34	75
2004	84	5	1098	199	99	23	366	39	77
01-04 Percent change	-4.5%	-16.7%	11.4%	-7.9%	54.2%	-8.0%	-2.0%	14.1%	2.7%
Employment									
2001	5,980	906	8,207	1,719	1,989	1,706	36,575	675	4,266
2004	5,336	852	8,495	1,399	1,862	2,005	34,888	927	3,894
01-04 Percent change	-10.8%	-6.0%	3.5%	-18.6%	-6.4%	17.5%	-4.6%	37.3%	-8.7%
Average Annual Wages									
2001	\$ 37,111	\$ 47,300	\$ 22,706	\$ 16,432	\$ 44,923	\$ 49,439	\$ 29,433	\$ 39,303	\$ 35,331
2004	\$ 40,245	\$ 49,469	\$ 25,547	\$ 18,171	\$ 55,402	\$ 51,766	\$ 31,301	\$ 45,431	\$ 39,365
01-04 Percent change	8.4%	4.6%	12.5%	10.6%	23.3%	4.7%	6.3%	15.6%	11.4%
Location Quotient									
2001	8.47	4.82	1.45	0.81	0.78	0.90	3.19	1.01	1.54
2004	8.20	4.70	1.65	0.67	0.68	1.04	3.18	1.53	1.45
Share of Private Sector Employment (Percent)									
2001	0.8%	0.1%	1.1%	0.2%	0.3%	0.2%	5.0%	0.1%	0.6%
2004	0.7%	0.1%	1.2%	0.2%	0.3%	0.3%	4.8%	0.1%	0.5%
UNITED STATES									
Establishments									
2001	2,355	391	82,038	17,303	16,622	2,519	33,313	1,829	15,077
2004	2,160	398	77,328	17,205	19,956	2,499	32,153	1,792	15,057
01-04 Percent change	-8.3%	1.8%	-5.7%	-0.6%	20.1%	-0.8%	-3.5%	-2.0%	-0.1%
Employment									
2001	104,959	27,923	843,163	316,009	378,275	280,608	1,702,978	99,230	411,569
2004	96,631	26,930	764,559	310,413	404,745	287,181	1,629,909	89,802	398,886
01-04 Percent change	-7.9%	-3.6%	-9.3%	-1.8%	7.0%	2.3%	-4.3%	-9.5%	-3.1%
Average Annual Wages									
2001	\$ 39,268	\$ 47,461	\$ 20,992	\$ 17,573	\$ 59,230	\$ 72,407	\$ 32,800	\$ 60,065	\$ 48,707
2004	\$ 43,667	\$ 53,704	\$ 25,114	\$ 19,998	\$ 65,411	\$ 82,060	\$ 35,591	\$ 66,619	\$ 57,365
01-04 Percent change	11.2%	13.2%	19.6%	13.8%	10.4%	13.3%	8.5%	10.9%	17.8%
Share of Private Sector Employment (Percent)									
2001	0.1%	0.0%	0.8%	0.3%	0.3%	0.3%	1.6%	0.1%	0.4%
2004	0.1%	0.0%	0.7%	0.3%	0.4%	0.3%	1.5%	0.1%	0.4%

Source: Battelle calculations based on data from QCEW/ES-202 of the BLS and Minnesota IMPLAN Group, Inc.