



PHASE II:

**DASNR'S AGBIOSCIENCE ACTIVITIES  
DELIVER POSITIVE ECONOMIC  
BENEFITS FOR OKLAHOMA**

PREPARED FOR:

Oklahoma State University's Division of  
Agricultural Sciences and Natural Resources

PREPARED BY:

Battelle  
Technology Partnership Practice

August 2007

Battelle Memorial Institute (Battelle) does not endorse or recommend particular companies, products, services, or technologies, nor does it endorse or recommend financial investments and/or the purchase or sale of securities. Battelle makes no warranty or guarantee, express or implied, including without limitation, warranties of fitness for a particular purpose or merchantability, for any report, service, data, or other information provided herein.

Copyright 2007 Battelle Memorial Institute. Use, duplication, or distribution of this document or any part thereof is prohibited without the written permission of Battelle Memorial Institute. Unauthorized use may violate the copyright laws and result in civil and/or criminal penalties.

**PHASE II:  
DASNR'S AGBIOSCIENCE ACTIVITIES  
DELIVER POSITIVE ECONOMIC BENEFITS  
FOR OKLAHOMA**

**Prepared for:**

**Oklahoma State University's Division of  
Agricultural Sciences and Natural Resources**

**Prepared by:**

**Technology Partnership Practice**

**Battelle Memorial Institute**



**August 2007**

## Abbreviations

R&D	research and development
agbioscience	agricultural bioscience
AHC	American Horse Council
ARS	Agricultural Research Service
BEA	Bureau of Economic Analysis
BLS	U.S. Bureau of Labor Statistics
bu/ac	bushel per acre
CASNR	College of Agricultural Sciences and Natural Resources
CNEP	Community Nutrition Education Programs
cwt	hundredweight
DASNR	Division of Agricultural Sciences and Natural Resources
DOT	Department of Transportation (Oklahoma)
FAO	Food and Agriculture Organization of the United Nations
FAPC	Robert M. Kerr Food and Agricultural Products Center
FFA	formerly known as Future Farmers of America
FTE	full-time equivalent
FQHC	Federally Qualified Health Center
FY	fiscal year
GPS	global positioning system
IRR	internal rate of return
KSU	Kansas State University
NASS	National Agricultural Statistics Service
NASULGC	National Association of State Universities and Land-Grant Colleges
NVDI	normalized difference vegetation index
OAES	Oklahoma Agricultural Experiment Station
OCES	Oklahoma Cooperative Extension Service
Oklahoma A&M	Oklahoma Agricultural and Mechanical College
OQBN	Oklahoma Quality Beef Network
OSU	Oklahoma State University
QCEW	Quarterly Census of Employment and Wages
SAT	Scholastic Assessment Test
TPP	Technology Partnership Practice
USDA	U.S. Department of Agriculture

## **Executive Summary**

The agricultural bioscience (agbioscience) sector is a knowledge-based industry cluster that is constantly reinvented as researchers discover new technologies that impact food and fiber production and consumption, and educators disseminate these technologies through classroom instruction and extension programs for clientele. Furthermore, advances in the agbioscience sector have shifted agriculture's focus beyond food and fiber production toward goals of discovering alternative energy sources, improving public health and social well-being, and sustaining the environment. Agriculture is playing a new and different role in delivering nutritional, pharmaceutical, and bio-based products; in providing sound stewardship of resources; and in supporting rural communities. These technological breakthroughs take shape in new and innovative products used in everyday life.

For Oklahoma's agbioscience sector to remain competitive, the state's producers must be equipped with the knowledge, skills, tools, and inputs required to generate quality products at competitive prices. It may come as a surprise that agriculture, perhaps more than any other industry, requires specialized local industry research and development (R&D) to remain competitive. Unlike producers of the typical manufactured product, agricultural producers must work within an environment that contains great year-to-year variability, uncertainties, and risks. Case in point, January through June 2007 was the wettest period on record in Oklahoma; this followed an extremely dry period (October 2005 through September 2006), the second driest on record.

To help meet the needs of this ever-evolving agbioscience sector, Oklahoma State University (OSU) was established in 1890 under the auspices of the Oklahoma Agricultural and Mechanical College. Over its almost 120-year history, the University has made substantial and diverse contributions to Oklahoma and the nation. Central to the founding mission of OSU as a land-grant university, agricultural sciences have always formed the core of OSU's education, research, and extension activities.

Upon Oklahoma's statehood in 1907, agriculture became the leading engine driving economic growth and prosperity across the state. Today, much the same is true, with agriculture and ag-related industry of crucial importance to Oklahoma's economic sustainability. The modern Oklahoma economy is firmly rooted in advanced agriculture and agribusiness activities. Analysis by Battelle<sup>1</sup> indicates that agriculture, agribusiness, and agricultural support activities provide more than 17 percent of state employment (jobs for more than 343,000 Oklahomans). Oklahoma is a key hub for U.S. agricultural production, ranking sixth among all states in agricultural employment and generating a direct agricultural output of \$4.7 billion.

OSU fulfills its land-grant mission through the programmatic activities of the Division of Agricultural Sciences and Natural Resources (DASNR), which is composed of three components: the College of Agricultural Sciences and Natural Resources (CASNR), the Oklahoma Agricultural Experiment Station (OAES), and the Oklahoma Cooperative Extension Service (OCES). Through the activities of these three mutually dependent components, DASNR has helped to build, sustain, and improve Oklahoma's agriculture and ag-related industries from the state's beginning. Yet, as much as DASNR has helped drive Oklahoma's economic growth and prosperity in the past, it is likely to be even more important in the state's increasingly technology- and innovation-driven economy. As knowledge, intellectual capacity, and

---

<sup>1</sup> *Phase I: Quantitative Analysis of DASNR's Agbioscience Activities*. Battelle Technology Partnership Practice. Prepared for Oklahoma State University's Division of Agricultural Sciences and Natural Resources, March 2007. The Economic Analysis section of the Phase I report has been incorporated as Appendix A in this Phase II report.

*Phase II Report*

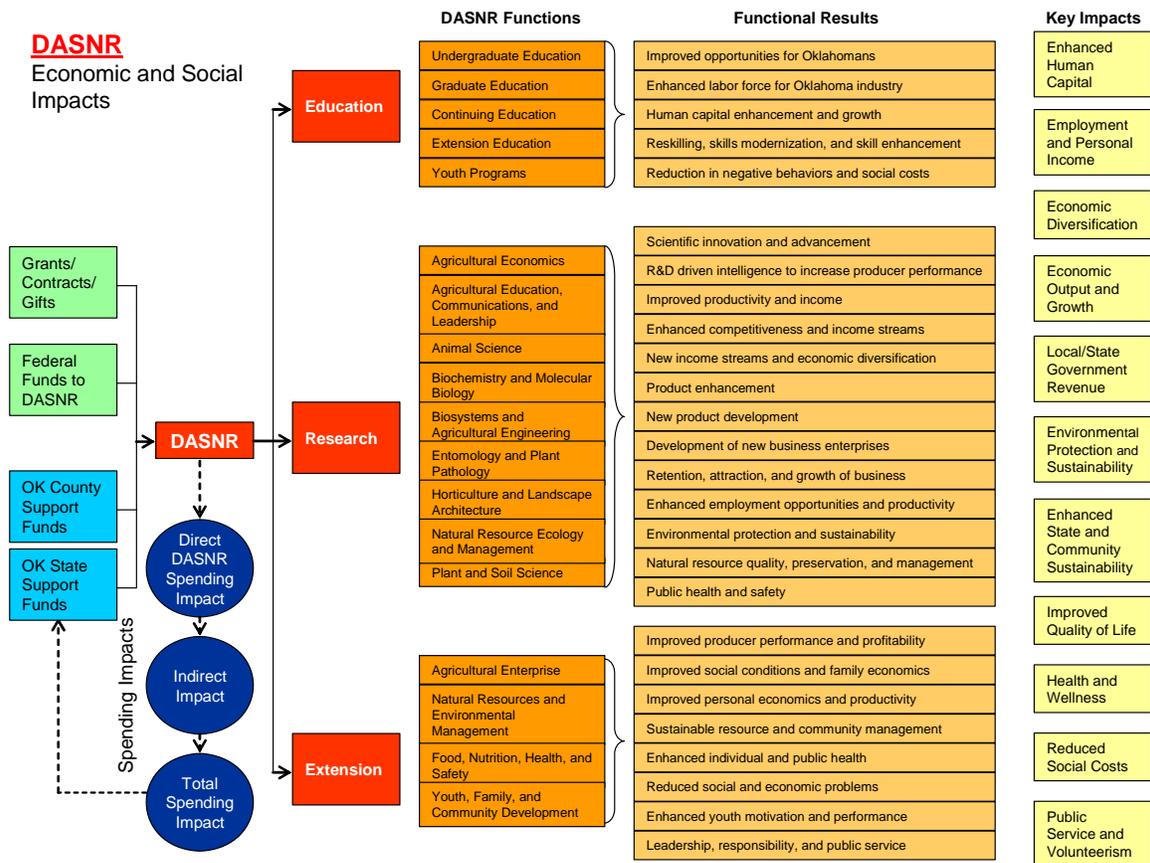
innovation become the foremost drivers of modern western economies, the importance of academic R&D centers, advanced higher education institutions, and knowledge and practice diffusion organizations as engines for economic growth becomes very clear. Innovation, the transfer of knowledge, and enhancement of productivity (activities at the core of DASNR’s mission) are keys to the long-term sustainability of state economies.

The role that DASNR has played and will continue to play in building and sustaining success for Oklahoma in the 21st Century economy is the subject of this economic impact report.

## DASNR PATHWAYS FOR GENERATING ECONOMIC AND SOCIAL IMPACTS

DASNR achieves impacts for the State of Oklahoma via three functional paths: education, research, and extension (Figure ES-1). These three pathways achieve a broad range of functional results and economic impacts of benefit to Oklahoma.

**Figure ES-1: Structure of DASNR in Delivering Economic and Social Benefits for Oklahoma**



Through the activities and functions of DASNR, Oklahoma benefits in terms of the following:

- **Enhanced Human Capital**—Produced through the education of students and the education and outreach services provided by cooperative extension.

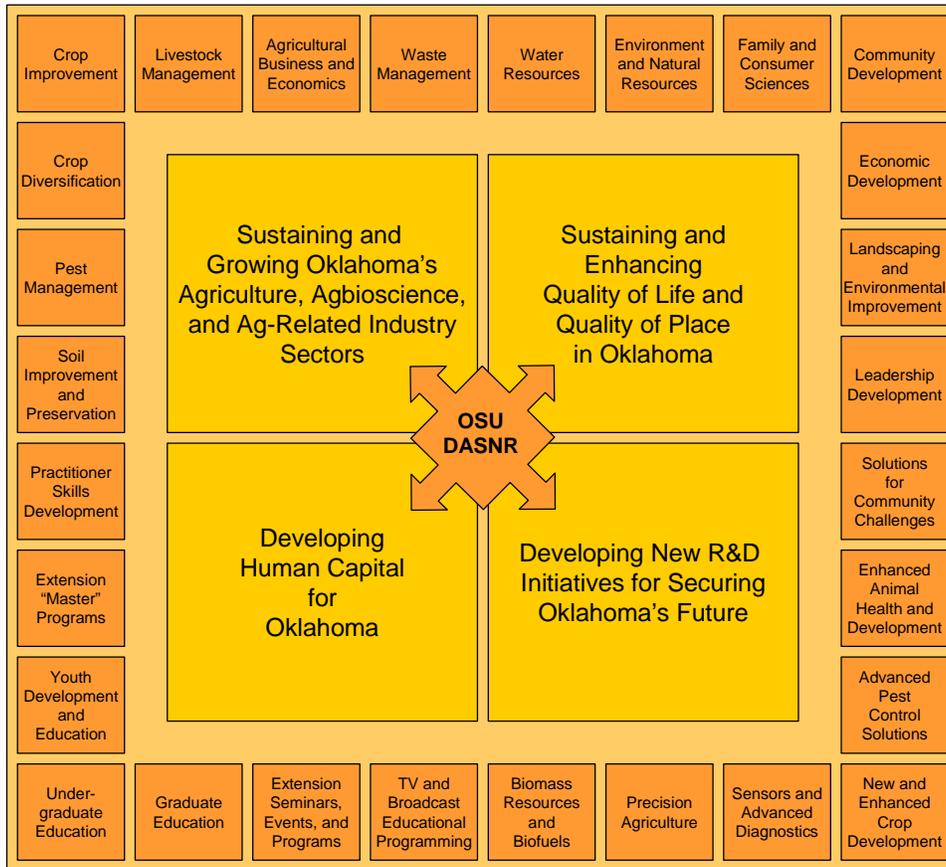
- **Employment and Personal Income**—Generated in agriculture and ag-related industry via DASNR’s impacts on business development, profitability, and growth and in general economic development through multiple DASNR/Extension activities.
- **Economic Diversification**—Achieved through the application of DASNR’s new R&D discoveries, innovations, and practice recommendations.
- **Economic Output and Economic Growth**—Sustained through new innovations, practice recommendations, and scientific and extension activities in support of multiple sectors of the Oklahoma economy.
- **Local and State Government Revenue**—Generated through the enhanced economic activity supported in the state by DASNR research, extension, and education.
- **Environmental Protection and Environmental Sustainability**—Supported through DASNR research, education and extension services in support of preservation, enhanced stewardship, and management of Oklahoma’s natural resources.
- **Enhanced State and Community Sustainability**—Supported by DASNR’s work in maintaining business profitability, developing diversified economic sectors, producing new and enhanced products, and managing Oklahoma’s natural and community resources.
- **Improved Quality of Life**—Supported on multiple fronts by DASNR work in community development, economic development, human capital development, and programs targeting sustainability and environmental preservation and protection.
- **Health and Wellness**—Sustained through DASNR activities in a broad range of functional areas, such as family and consumer sciences, environmental science, education and training, and food safety.
- **Reduced Social Costs**—Supported by DASNR’s work in the prevention of self-destructive behavior, development of alternative paths for at-risk populations, reduction in negative environmental impacts requiring remediation, etc.
- **Public Service and Volunteerism**—Promoted through DASNR’s work with youth, 4-H, community development, and leadership development activities.

The impacts of DASNR’s roles can be classified into four macro categories:

- Sustaining and growing Oklahoma’s agriculture, agbioscience, and ag-related industry sectors
- Developing human capital for Oklahoma
- Sustaining and enhancing quality of life and quality of place in Oklahoma
- Developing new R&D initiatives for securing Oklahoma’s future.

Figure ES-2 illustrates these four macro categories and the many core DASNR activities that are associated with them.

Figure ES-2: DASNR Macro Impact Classifications and Associated Core Activities



These four areas effectively capture all of the functional impacts encompassed in Figure ES-1 and provide the basis for the structure of this impact report. The following subsections examine examples of the economic impacts in these four macro categories as a result of the education, research, and extension activities of DASNR.

### Impact Category: Sustaining and Growing Oklahoma's Agriculture, Agbioscience, and Ag-Related Industry Sectors

For a modern state like Oklahoma, competing in the global agricultural economy requires constant innovation, practice improvement, new technology introduction, skills enhancement, and global intelligence—exactly the competitive factors that DASNR works to enhance, develop, and support.

Economic data indicate that over the past two decades Oklahoma has managed to accomplish significant increases in agricultural output. Between 1974 and 2002, Census of Agriculture data<sup>2</sup> indicate that, while total land in farms in the state remained fairly constant at approximately 33 million acres, the market value of agricultural products sold increased from \$1.6 billion in 1974 to \$4.5 billion in 2002 (when adjusting for price inflation since 1974, production value would be expected to be only \$4 billion in 2002). By 2005, this has climbed further to \$4.7 billion.

<sup>2</sup> "Table 1. Historical Highlights: 2002 and Earlier Census Years." 2002 Census of Agriculture—State Data (Oklahoma). U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS).

Helping to sustain productivity increases and other positive gains in primary agriculture, however, is only one aspect of DASNR's services which support a far larger vertically integrated ag-production, ag-processing, food-processing, and products' distribution chain. While primary agricultural production in Oklahoma employed 88,337 farm proprietors in 2002,<sup>3</sup> the total agbioscience chain (including agricultural service workers; workers involved in agricultural inputs; agricultural processing and marketing; and "peripheral" activities in agricultural wholesale, retail, and other indirect agribusiness) employed 323,636 persons (17.1 percent of state employment). Sustaining the international and domestic competitiveness of such a large part of the Oklahoma employment and production base is thus critically important to the economic and societal health of the state.

OSU was founded, as a land-grant university, on the principle that research, education, and extension services to agriculture and related sectors are of critical importance to state development. Given the size and importance of the agbioscience economy in Oklahoma, the same holds true today. Indeed, the growth of the 21st century "Bioeconomy," already highly important, will further increase the relevance and importance of DASNR functions.

In conducting interviews with DASNR administrators, faculty, research leaders, and extension professionals, it was clear that an extremely broad variety of functional DASNR activities could be highlighted as case studies in sustaining and growing agbioscience and ag-related industry in Oklahoma. Selecting individual program areas for in-depth analysis was not an easy process given the breadth of programs to choose from.

Ultimately, the following three program areas were selected as representative of both the breadth and depth of DASNR's work in this category:

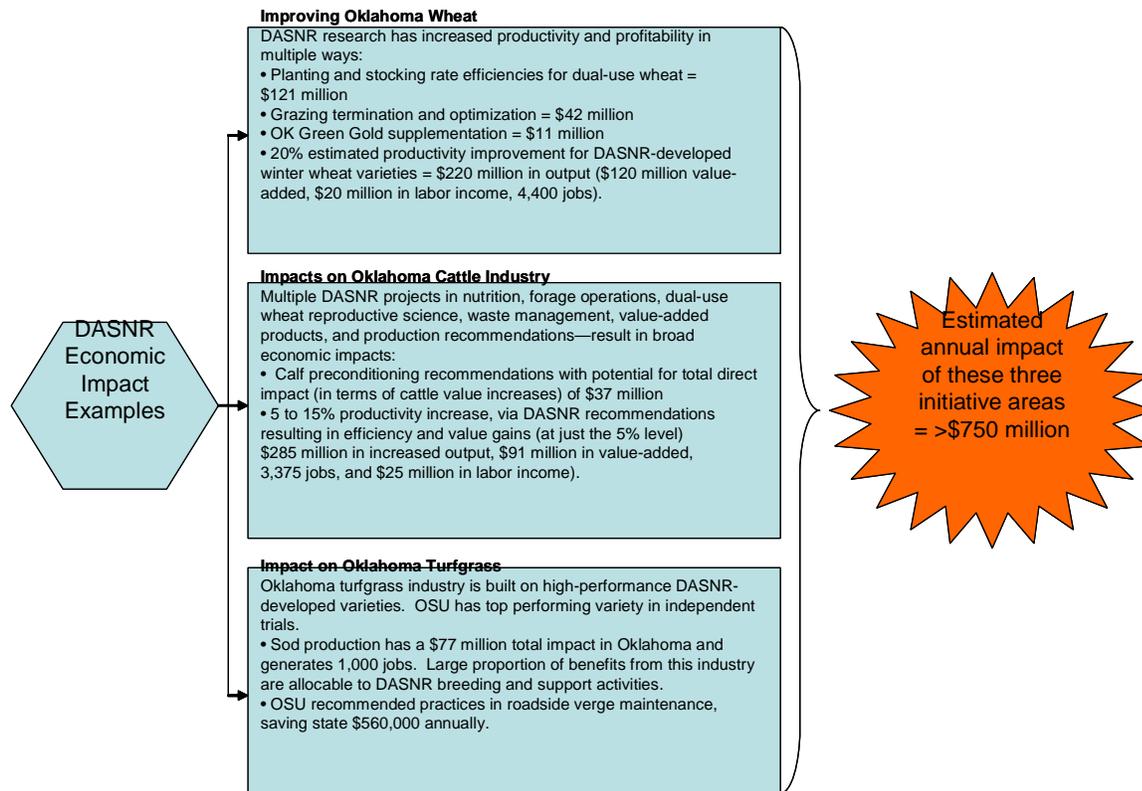
- Wheat—Leading crop in terms of acres harvested in the state
- Beef Livestock—Number one area of Oklahoma agriculture in terms of dollar output
- Turfgrass—Representative of DASNR's work in nontraditional crops.

Figure ES-3 shows examples of DASNR research, education, and extension activities related to sustaining and growing Oklahoma's agriculture, agbioscience, and ag-related industry sectors leading to readily observable impacts.

---

<sup>3</sup> *Phase I. Battelle Technology Partnership Practice.*

Figure ES-3: Examples of DASNR Agbioscience Economic Impact Case Studies



### Impact Category: Developing Human Capital for Oklahoma

Modern U.S. agriculture and agriculture-related industries must compete in a globally competitive economy. For Oklahoma to maintain its competitive edge in these industries, it must have a well-educated and trained workforce that is able to implement the latest productivity-enhancing technologies and techniques.

As one of the nation’s land-grant universities, OSU was established specifically to develop knowledge and diffuse that knowledge through education and training in order to build a more aware and productive population. Education and training for agriculture and agriculture-related industry were at the very heart of the land grant university mission—a mission that DASNR continues to sustain and advance today. OSU is the major Oklahoma hub supporting human capital development in agriculture, agriculture-related industry, and beyond.

DASNR’s human capital development work serves multiple populations within the state, including the following key customers for CASNR’s educational services:

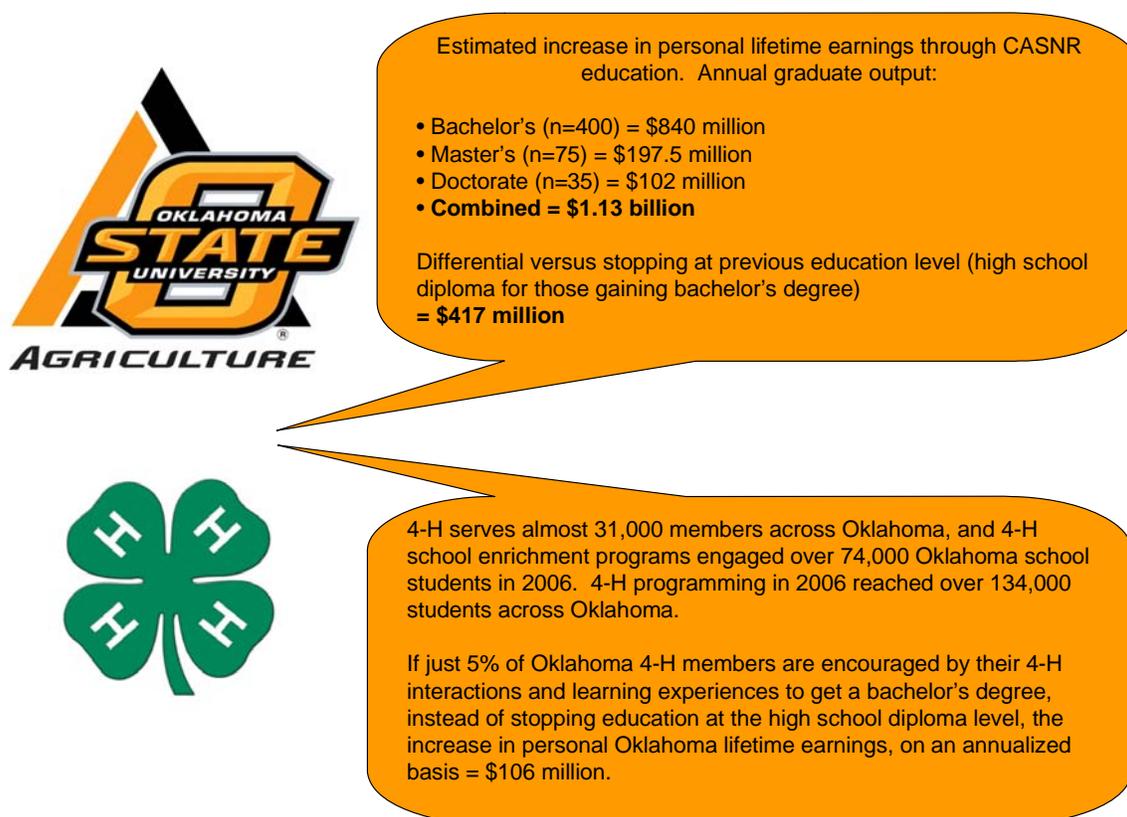
- Undergraduate students
- Graduate students
- Agricultural practitioners through continuing education and training
- Agribusiness and ag-related industries through continuing education and training
- Entrepreneurs through assistance and training services

- Children and youth through 4-H and K-12 teachers and educators within Future Farmers of America through educational support and training
- Communities and families in urban and rural Oklahoma through education and training courses, seminars, events, and materials
- Oklahoma government through training in multiple areas of development, governance, natural resource and public lands management, and other areas.

Extension serves as a formal engine for human capital development through the diffusion of R&D-based knowledge and know-how from the university and through the development of specific training materials, courses, and events for multiple audiences.

Figure ES-4 summarizes examples of DASNR research, education, and extension activities related to developing human capital for Oklahoma leading to readily observable impacts.

**Figure ES-4: Examples of DASNR Human Capital Economic Impact Case Studies**



## **Impact Category: Sustaining and Enhancing Quality of Life and Quality of Place in Oklahoma**

DASNR directly supports Oklahoma's economy through R&D, education, and extension activities designed to sustain and enhance Oklahoma agriculture, agribusiness, and skilled human capital. The work of DASNR in these areas is probably more widely recognized than the equally important work undertaken by the Division in sustaining and improving quality of life and quality of place in the state.

For instance, much of the work of OSU Extension focuses on addressing critical issues related to social and community sustainability for the citizens of Oklahoma. In fact, cooperative extension was formed under a mandate to diffuse knowledge and to develop more informed and educated agricultural practitioners and community residents to help improve the overall quality of life and economic sustainability of rural regions across the state.

Today, DASNR through its Extension activities continues to operate under that mandate, providing a broad variety of initiatives and programs across all 77 counties of Oklahoma. The following two examples illustrate the well-rounded nature of the key initiatives housed under DASNR.

### **DASNR Support for the Oklahoma Quality Beef Network:**

Cattle sickness costs the beef industry million of dollars each year, with these losses negatively impacting not only the producer's profitability but also every level of the beef production chain. To facilitate the adoption of best management practices that should result in reduced sickness and associated adverse effects, DASNR, in partnership with industry, created the Oklahoma Quality Beef Network (OQBN) in 2001. The program focuses on adding value to Oklahoma's calf crop and helps ensure that a portion of that added value is captured by the local producer.

Over a 4-year period, approximately 21,000 head of cattle have been certified under the program. OSU researchers have documented that, on average, buyers were willing to pay \$5.01 more per hundredweight for lots of OQBN cattle compared with calves that had no documented management program. The average price premium has been approximately \$32 per head, while the added value of weight gain during the preconditioning period averaged \$56 per head, for a gross increase in revenue of \$88. Documented program costs have averaged \$64 per head, resulting in an average increase in net income of \$24 per head for the producer.

The state's inventory of cattle and calves average 5.3 million annually. At a conservative estimate of only 1 percent of that inventory participating in the OQBN certification process on an annual basis and being sold, the resulting net gain for producers would be approximately \$1.3 million annually.

### **DASNR Support for the Community Nutrition Education Programs (CNEP):**

Research conducted by DASNR indicates that the number of Oklahomans living below the poverty level exceeds the national average. It has also been well documented that prevalent low socio-economic status is associated with poor nutrition habits that contribute to chronic disease, including heart disease, cancer, stroke, and diabetes.

As a result of this unmet nutritional need of the economically disadvantaged in Oklahoma, OSU Extension has leveraged state monies to bring \$3.5 million (fiscal year [FY] 2006) in federal nutrition education program funds to the state through CNEP. These programs assist Oklahoma 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 studies<sup>4</sup> have found that these activities successfully deliver an educational program that leads to sustainable behavior change. National 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 allow children to achieve their full cognitive-development potential.

Results of a cost-benefit analysis show that, for every \$1 spent on programs such as CNEP, 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.<sup>5</sup>

During the FY 2006 program year, CNEP staff worked individually in one-on-one sessions with 5,318 low-income Oklahoma families. If Oklahoma is assumed to be representative of the national average in terms of the cost-benefit effects of this program, then the impact of the \$3.5 million in CNEP funding in FY 2006 resulted in health care savings of more than \$26 million from the prevention of nutrition-related chronic diseases and conditions among Oklahoma's citizenry.

### **Impact Category: Developing New R&D Initiatives for Securing Oklahoma's Future**

Agriculture and related enterprises in Oklahoma are expected to experience a resurgence spurred by the 21st century Bioeconomy in which rapid advancements in genomics and biological and agricultural sciences lead to the development of new, fast-growth economic sectors in biomass products, bioenergy production and advanced foods and fibers and to future innovations in other value-added bio-based products.

As finite fossil fuel and other Oklahoma extractive resources become increasingly scarce over time, the importance of moving toward long-term, sustainable, bio-based resources will become even more necessary and prominent to assure Oklahoma's ongoing success. Agriculture and agriculture-related industries have always been important to Oklahoma—but they may become the lifeblood of renewed growth and economic opportunity in the state. **Because of this, the importance of OSU and DASNR has snapped into focus more clearly at the present time perhaps than at any other time in Oklahoma's history.**

As an organization heavily invested in R&D, DASNR is consistently applying its infrastructure and faculty expertise to innovations and advancements in agricultural and agbioscience technology and practice. At any given time, DASNR is engaged in upwards of 300 individual research projects across its broad range of departments and programs—so the volume of potential influential programs is considerable.

---

<sup>4</sup> Multiple Expanded Food and Nutrition Education Program (EFNEP) cost-benefit analysis examples are provided in the EFNEP section of the Cooperative State Research, Education, and Extension Service (CSREES) Web site at <http://www.csrees.usda.gov/nea/food/efnep/impacts.html>.

<sup>5</sup> *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.

## *Phase II Report*

Some areas of current R&D at DASNR indicate the institution's commitment to producing a bright future for Oklahoma. Large-scale, high-potential impact initiatives being undertaken at DASNR that show potential benefits for the state include the following:

- Advanced Technology for Precision Agriculture
- DASNR's Biofuel Initiatives
- Robert M. Kerr Food and Agricultural Products Center.

## **THE ECONOMIC IMPACT OF DASNR'S RESOURCE EXPENDITURES ON THE STATE OF OKLAHOMA**

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

- **\$191.1 million in total Oklahoma economic output (sales)**, divided almost evenly between direct and indirect economic output
- **2,228 jobs in Oklahoma**, comprising 1,308 direct jobs and 920 jobs generated in the Oklahoma economy by the employment multiplier effect
- **Personal income for Oklahoma residents amounting to \$72.9 million annually**, divided between direct income of \$44.2 million and indirect income of \$28.7 million
- **\$9.9 million in annual tax revenues** through Division-generated taxes.

*DASNR's institutional spending impact generates \$191.1 million in economic output and 2,228 jobs in Oklahoma.*

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

## **CONCLUSION: DASNR'S AGBIOSCIENCE ACTIVITIES DELIVER POSITIVE ECONOMIC BENEFITS FOR OKLAHOMA**

Battelle finds that OSU's DASNR is a key contributor to the economic health of Oklahoma. Through its comprehensive R&D, education, and extension activities, DASNR comprises a major economic engine for the state.

DASNR's basic and applied R&D drives innovations in Oklahoma that sustain and expand agriculture and agribusiness, while Extension works proactively to assure these innovations are diffused and of maximum benefit to the Oklahoma economy. Case studies, performed by Battelle, to assess the impact of just some of these initiatives find positive benefits for the Oklahoma economy that run into the hundreds of millions for several individual agricultural subsectors.

DASNR is clearly an institution that is positively impacting the profitability and sustainability of Oklahoma's staple crops, vertically integrated livestock industry, and agribusiness sectors while working proactively to develop new products and opportunities that diversify and strengthen Oklahoma's economic base. DASNR is also a strong contributor to human capital and social development in the state. The value provided through CASNR's education programs generate major gains in Oklahomans' lifetime incomes, while Extension education programs targeting youth and other key state populations likewise help Oklahoma's human capital reach its full potential. DASNR initiatives targeting community economic development, sustainable families, and environmental protection round out a comprehensive range of services designed to ensure the long-term economic and social prosperity of the state.

It is important to note that the future of agricultural and rural sustainability in Oklahoma will greatly depend on constructing "value-added" chains of production that vertically integrate agribusiness and agbioscience. The ability to leverage discoveries from agbioscience R&D into an integrated production, processing, and manufacturing agbioscience sector generates significant economic returns for Oklahoma. Furthermore, the ability to leverage Oklahoma's significant production capacity into downstream value-added industry sectors creates jobs in traditional fields such as food processing, agricultural machinery and equipment, and agricultural services, as well as in emerging fields such as alternative fuels. Constructing a robust value-added supply chain that vertically integrates the agbioscience sector will lead to local industry sources providing local jobs with benefits, a critical component of sustaining a rural economy.

Overall, Oklahoma's investment in DASNR clearly provides a very strong return on investment for the state. For an annual state investment of \$61.4 million (2007), DASNR initiatives are generating dividends just in wheat and livestock economic impacts alone totaling more than \$700 million in an average year (as illustrated in Figure ES-3). These impacts show the State's current return, but it must be noted that DASNR may be even more critical to securing Oklahoma's economic future. The 21st Century economy will be characterized by significant bio-based technological advancements in areas such as biofuels, biomass resources, advanced foods and fibers, biopharmaceuticals, and other high-value bioproducts from plant and animal resources. The presence of DASNR as a prominent bioscience and agbiotech R&D engine, educator, and innovation disseminator is, and will be, tremendously valuable. DASNR's position on the frontlines of advanced agricultural and environmental biosciences gives Oklahoma a resource of international stature to draw from and build upon into the future.