# Economic Impacts of The University of Tennessee's AgResearch and Education Centers (AREC)



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The University of Tennessee's AgResearch and Education Centers (AREC) support agricultural and forestry-based research conducted by the University. This research is aimed at benefiting the state's diversified agriculture and natural resource based industries. The ARECs provide facilities and other resources that enable scientists and students to test research ideas and hypotheses under real-life production conditions. The research conducted on the ARECs addresses real problems or questions posed by farmers, agribusinesses, agricultural professionals, and the public. The potential economic impacts from the AREC's may arise from: 1) expenditures on research and educational activities at the AREC's; 2) research findings leading to new or improved technologies or management practices that may enhance profitability of farming or management of forest-based resources; and 3) educational events that transfer research knowledge to industry participants who may then adopt new technologies or practices to potentially improve firm profitability. The purpose of this analysis is to measure the economic impacts on the economies of the counties and surrounding counties from AREC expenditures described in item 1). Please note that this is only one set of potential economic impacts. It is beyond the scope of this analysis to measure the economic impacts resulting from items 2) and 3) across each of the ARECs. We provide an example analysis of item 2) for a state level increase in soybean yield resulting from AREC variety testing and the economic impacts associated with this increase in yield.

For 2018, the University of Tennessee spent approximately \$12.5 million in direct economic activity for agricultural research at nine ARECs located across the state. The ARECs are located throughout the state (Figure 1). Three are in the east, four in the central, and three in west Tennessee. Descriptions of the research conducted at the nine centers are discussed in Table 1. The estimated economic impacts are measured in nine Zones of Economic Influence (ZEI). A ZEI is a county in which the



AREC is located and the surrounding counties that directly and indirectly benefit from a particular AREC's expenditures. The AREC's direct expenditures are modeled using IMPLAN, an input-output model to examine the economic linkages between over 500 industries in the state's economy. Direct and the total estimated economic impacts (with multiplier effects<sup>1</sup>) are examined for total industry output (economic activity measure), employment, and value-added.<sup>11</sup> Wages paid to UT employees are examined and presented separately from the AREC's direct expenditures on goods and services.

Research Center/	Zones of Economic	
<b>County Location</b>	Influence	Description of Research Conducted
Forest Resources	Anderson, Blount,	The University of Tennessee Forest Resource
AgResearch and	Coffee, Knox, Loudon,	AgResearch and Education Center is an over 11,400
Education Center	Morgan, Union	acre field research laboratory, which is regionally
(Anderson County)		recognized leader in developing new technologies
		applicable to modern forestry and wildlife resources
		management and environmental stewardship.
Plateau Research &	Bledsoe, Cumberland,	The center is about equal distance from Nashville,
Education Center	Fentress, Morgan,	Knoxville, and Chattanooga and is the site of
(Cumberland County)	Overton, Putnam,	research in beef, fruits and vegetables, field crops,
	Rhea, Roane, Van	and swine. The center is most noted for its studies
	Buren, White	in beef, squash, muskmelons, watermelons,
		pumpkins, greens, cabbage, green beans, apples,
		blueberries, and tomatoes.
Research & Education	Cocke, Greene,	Known for its research on burley tobacco
Center at Greenville	Hamblen, Hawkins,	production and beef cow/calf production. Areas of
(Greene County)	Unicoi, Washington	research at the center include all aspects of burley
		tobacco production with emphasis on breeding and
		production economics, variety testing, pest
		management, and breeding of field crops important
		to the agriculture of Upper East Tennessee; and
		animal research in the areas of genetics, silage
		feeding, and grazing studies.
West Tennessee	Carroll, Chester,	Known for its research on ornamentals, turf grasses,
AgResearch &	Crocket, Gibson,	agronomic and horticultural crops, the West
Education Center	Hardeman, Haywood,	Tennessee Experiment Station, established in 1907,
(Madison County)	Henderson, Madison	is the oldest research center in the University of
		Tennessee system.
East Tennessee	Anderson, Blount,	The center serves as a field laboratory providing
AgResearch &	Knox, Loudon, Union	experimental plots, lands, livestock, orchards,
Education Center (Knox		equipment, and other types of support for research
County)		programs. Research areas of emphasis included not
		turfgrass management; soybean, corn, and wheat
		breeding; switchgrass production and processing;
		organic vegetable crops; season extension with high
		tunnels; plant diseases; weed management and
		control; reproductive management in beef and dairy
		cattle; row crop and forage variety testing;
		amphibian diseases; bacterial pathogenesis;
		antibiotic resistance; and more.

 Table 1. Location and Description of the Research Conducted at University of Tennessee's AgResearch

 and Education Centers

Research Center/	Zones of Economic	
County Location	Influence	Description of Research Conducted
Dairy Research &	Bedford, Giles,	The center is home to the Tennessee Beef Heifer
Education	Lincoln, Marshall,	Development Program. University experts conduct
Center/Lewisburg	Maury	research and demonstrate the best methods for
(Marshall County)		developing replacement heifers – often the most
		costly component of beef cattle production.
Middle Tennessee	Giles, Hickman,	Known for its research in beef and dairy cattle,
AgResearch &	Lawrence, Lewis,	commercial crops, fruit trees, and forage crops.
Education Center at	Marshall, Maury,	More specifically, the center conducts research to
Lewisburg (Maury	Williamson	evaluate varieties of commercial crops,
County)		management systems and weed control systems to
		improve crop production efficiency. Additional
		research is conducted on the production and
		management of fruit and vegetable crops, including
		peaches, apples, grapes, and blueberries.
Research & Education	Carroll, Crockett,	The station is comprised of three locations, the
Center at Milan (Gibson	Dyer, Gibson,	South Tract on Tennessee Highway 104, the North
County)	Madison, Obion,	Tract on US Highway 70A & 79 and the Arsenal Tract
	Weakley	on the arsenal property. With a total 675 acres of
		cropland used for over 100 research projects with
		corn, cotton, soybeans, grain sorghum, wheat and
		cover crops. These studies concern cropping
		systems rotations, tillage systems, row width, plant
		population, varietal evaluation, date of planting,
		fertilizer rates and sources, remote sending,
		precision agriculture, and irrigation of row crops.
		Control of crop pests, including diseases, insects,
		and weeds are also studied. Soil conservation
		studies investigate the rate of erosion for different
		cropping systems, soil productivity and run off. For
		agricultural engineering, the center researches new
		planters and drills, fertilizer placement in no-till,
		directed sprayers and pesticide movement, as well
		as precision farming. More recent studies evaluate
		the establishment and production of bioenergy
		feedstocks for use as a biofuel.

Research Center/	Zones of Economic	
<b>County Location</b>	Influence	Description of Research Conducted
Highland Rim Research	Cheatham, Davidson,	Known for its research in cow-calf management and
& Education Center	Montgomery,	dark-fired and burley tobacco production efficiency.
(Robertson County)	Robertson, Sumner	The center conducts cow-calf research investigating the effects of poor nutritional management on establishment of pregnancy in mature cows. Other areas of beef cattle research include determining effects of endophyte-infected tall fescue on male reproductive function, steer development, grass sustainability, and different variations of creep feeding. The center is also a key location for the development of new soybean breeding lines for the state.
Source: http://taes.tennesse	e.edu/centers/	

### **Annual Expenditures**

For 2018, the ARECs spent \$12.5 million with approximately 59.3 percent of the expenditures allocated to salaries and wages (includes benefits). The East Tennessee, Middle Tennessee, West Tennessee, and Milan ARECs have the largest overall expenditures, accounting for 65.9 percent, followed by the Plateau and Highland Rim ARECs (Figure 2, Table 2).



Figure 2. Proportion of Total Expenditures to AgResearch and Education Centers, 2018

Research	County	Total Operating &		Total
Center	Location	Maintenance	Wages	Expenditures
Dairy	Marshall	\$225,286	\$358,372	\$583,658
East Tennessee	Knox	\$2,147,974	\$1,831,175	\$3,979,149
Forest Resource	Anderson	\$102,527	\$569,940	\$672,467
Greenville	Greene	\$177,274	\$650,182	\$827,456
Highland Rim	Robertson	\$213,528	\$737,296	\$950,824
Middle Tennessee	Maury	\$683,446	\$1,006,516	\$1,689,962
Milan	Gibson	\$565,111	\$708,821	\$1,273,932
Plateau	Cumberland	\$371,869	\$872 <i>,</i> 855	\$1,244,724
West Tennessee	Madison	\$618,532	\$702,678	\$1,321,209
	Total	\$5,105,546	\$7,437,834	\$12,543,381

The categorical breakdown of the expenditures for the ARECs is detailed in Table 3. Other than salaries and wages, the largest expenditure category was for supplies, followed by utilities and fuel, maintenance and repair, equipment and capital, insurance, communications, travel, other, professional service membership, contractual special services, media processing, and computer services.

Table 3. Categorical	Breakdown of	Expenditures	for ARECs.
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Category		Expenditure	Percent
Salaries & Benefits		\$7,437,834	59.3
Travel		\$39,277	0.3
Media Processing		\$6,629	0.1
Utilities & Fuel		\$1,456,589	11.6
Communication		\$89,578	0.7
Maintenance, Repair		\$961,941	7.7
Professional Service Membership		\$18,975	0.2
Supplies		\$1,993,549	15.9
Insurance		\$121,923	1.0
Contractual Special Services		\$22,949	0.2
Computer Services		\$7,039	0.1
Equipment & Capital		\$351,057	2.8
Other		\$36,041	0.3
	Total	\$12,543,381	100.0

#### Estimated Economic Impacts of the Annual Expenditures

Expenditures used to purchase inputs and labor (durable/nondurable goods and services) at the ARECs result in additional economic activity. Individuals are employed and then purchase goods and services within the region. Durable and nondurable inputs are ordered and transported to the center for use in the production of agricultural commodities, as well as in support of the ongoing research efforts<sup>III</sup>. The \$4.1<sup>iv</sup> million directly spent on operations and maintenance, excluding wages and salaries, result in an estimated close to \$6.9 million impact in the ZEIs (Table 4). Of this \$6.9 million, the purchase of inputs resulted in an estimated \$1.1 million of additional economic activity within the zone and induced another \$1.6 million. These expenditures result in an additional 17.3 jobs above as a result of direct expenditures by the ARECs. These employment impacts, along with proprietor profits resulting from sales to the experiment station, result in increased value added within the ZEI's of nearly \$4.2 million.

	Total Industry Output		Employment		Total Value Added	
Research Center	Direct	Total	Direct	Total	Direct	Total
	Dolla	nrs	Num	ber	Dolla	irs
Dairy	\$199,218	\$294,355	3.5	4.2	\$122,228	\$172,610
East Tennessee	\$1,600,838	\$2,883,204	15.3	23.2	\$1,042,962	\$1,780,432
Forest Resource	\$95,328	\$163,605	0.6	1.1	\$53 <i>,</i> 562	\$91 <i>,</i> 656
Greenville	\$128,530	\$196,681	1.5	2.0	\$71,463	\$105 <i>,</i> 982
Highland Rim	\$180,869	\$319,398	2.5	3.3	\$129,047	\$214,443
Middle Tennessee	\$638,145	\$1,064,973	8.6	10.9	\$434,046	\$700 <i>,</i> 869
Milan	\$460,570	\$688,543	4.8	6.4	\$270,908	\$392 <i>,</i> 581
Plateau	\$308,929	\$474,076	4.9	6.1	\$182,039	\$269,180
West Tennessee	\$525 <i>,</i> 995	\$779,755	4.8	6.6	\$300,454	\$432 <i>,</i> 094
Total	\$4,138,422	\$6,864,590	46.5	63.8	\$2,606,709	\$4,159,847

 Table 4.
 Estimated Economic Impacts of AREC's Expenditures on Total Industry Output, Employment, and Total Value Added in the Zones of Economic Influence, 2018

#### Wages and Salaries

Over \$7.4 million in direct wages and salaries (plus benefits) are spent at the ARECs. These expenditures also impact various sectors of the economy within the regions where the stations are located. For instance, the \$1.8 million spent at the East Tennessee Research Center, has an additional \$1.4 million total impact within its ZEI creating an additional nine jobs beyond those hired directly by the East Tennessee Research Center (Table 5). Statewide, an estimated \$2.8 million is added to the ZEI's in value-added as a result of consumption activities of those employed and paid \$7.4 million in wages and salaries by the ARECs.

	Total Industry Output Employment		Total Value Added			
Research Center	Direct	Total	Direct	Total	Direct	Total
	Doll	ars	Num	ber	Doll	ars
Dairy	\$358,372	\$546,075	4.0	5.3	\$358,372	\$462,019
East Tennessee	\$1,831,175	\$3,227,756	28.0	37.0	\$1,831,175	\$2,646,838
Forest Resource	\$569 <i>,</i> 940	\$991,504	9.0	11.7	\$569,940	\$815,270
Greenville	\$650,182	\$1,071,089	4.0	7.0	\$650,182	\$877,130
Highland Rim	\$737,296	\$1,245,628	12.0	14.9	\$737,296	\$1,055,283
Middle Tennessee	\$1,006,516	\$1,639,396	15.0	18.4	\$1,006,516	\$1,413,050
Milan	\$708,821	\$1,130,183	10.0	13.1	\$708,821	\$943,323
Plateau	\$872 <i>,</i> 855	\$1,359,790	13.0	16.4	\$872,855	\$1,140,302
West Tennessee	\$702,678	\$1,122,950	11.0	14.1	\$702 <i>,</i> 678	\$935 <i>,</i> 860
Total	\$7,437,834	\$12,334,371	106.0	137.9	\$7,437,835	\$10,289,075

## Table 5. Estimated Economic Impacts of ARECs Research Center Wage and Salary Expenditures on Total Industry Output, Employment, and Total Value Added in the Zones of Economic Influence

#### **Total Impact of ARECs Expenditures**

Expenditures of \$11.6 million at the ARECs result in an estimated total impact of \$19.2 million, with \$1.1 million indirect and another close to \$6.5 million induced (Table 6). An estimated \$10.0 million in value-added, or 52.3 percent of the total impact to the Tennessee economy, occurs as a result of expenditures at the ARECs.

	Total Industry Output		Employment		Total Value Added	
Research Center	Direct	Total	Direct	Total	Direct	Total
	Dolla	ars	Num	ber	Dolla	ars
Dairy	\$557 <i>,</i> 590	\$840,430	7.5	9.5	\$480,600	\$634,629
Forest	\$3,432,013	\$6,110,960	43.3	60.2	\$2,874,137	\$4,427,270
Highland Rim	\$665,268	\$1,155,109	9.6	12.8	\$623,502	\$906,926
East Tennessee	\$778,712	\$1,267,770	5.5	9.0	\$721,645	\$983,112
Middle Tennessee	\$918,165	\$1,565,026	14.5	18.2	\$866,343	\$1,269,726
Milan	\$1,644,661	\$2,704,369	23.6	29.3	\$1,440,562	\$2,113,919
Plateau	\$1,169,391	\$1,818,726	14.8	19.5	\$979,729	\$1,335,904
Greenville	\$1,181,784	\$1,833,866	17.9	22.5	\$1,054,894	\$1,409,482
West Tennessee	\$1,228,673	\$1,902,705	15.8	20.7	\$1,003,132	\$1,367,954
Total	\$11,576,257	\$19,198,961	152.5	201.7	\$10,044,544	\$14,448,922

Table 6. Accumulated Annual Impacts within the Zones of Economic Influence of the Tennessee
Agricultural Experiment Station's Expenditures at the ARECs

As stated earlier, the analysis to this point does not include the impacts of the research conducted at the ARECs on technology or management practices. Nor do they include impacts of educational events on improved practices by farmers, forest managers, or other agribusinesses. Therefore, these numbers likely underestimate the overall economic impact of research at the centers. These potential benefits include adoption of output enhancing and/or cost reducing technologies. Minimum tillage farming systems conserve energy and reduce erosion while maintaining output. Other benefits include safer, less costly food supplies. According to Norton and Ortiz (1992) and Lyu, White, and Liu (1984), the estimated annual rates of return range from 20 to 60 percent (as reported in Norton and Ortiz--available at https://dl.sciencesocieties.org/publications /jpa/abstracts/5/2/203). Using estimated annual rate of returns estimated in previous studies, the \$12.5 million in AREC expenditures increases the annual impacts estimated in this study by an estimated \$2.5 to \$7.5 million.

#### Soybean Hypothetical Yield Example of Secondary Economic Impacts of ARECs

As an example, suppose a soybean field trial indicates a new soybean variety increases yields by two bushels on average across the state. If we assume a 50-percent adoption rate by Tennessee soybean producers and a soybean price of \$8.65/bu, the estimated direct and total economic impacts are \$14.1 million and \$25.5 million, respectively.<sup>v</sup> The new soybean variety has value when sold and its production generates economic impacts. The new soybean variety also creates additional economic impacts when adopted by soybean producers. To obtain measure of adoption, findings from previous studies for adoption might be used, or survey analysis of Tennessee soybean producers might be conducted to obtain adoption information.

<sup>&</sup>lt;sup>i</sup> The multipliers effects include the sum of the input supplying industries providing goods and services (*indirect*) and increased spending from households (*induced*) as a result of the direct expenditure.

<sup>&</sup>lt;sup>II</sup> Economic impacts result because the ARECs purchase goods and services from other industries (*Direct impacts*). In turn, those input supplying industries purchase goods and services from other industries (*Indirect impacts*). In addition, household spending increases due to the added economic activity (*Induced impacts*) resulting from the initial AREC's expenditures. Total industry output (measure of economic activity) estimates the economic impact of the expenditure, while total value-added measures changes to employee compensation and proprietor income (labor income), plus indirect business taxes and other property income. Jobs created are expressed as full-time equivalent and are an estimate of the numbers required to meet the change in demand for goods and services. <sup>III</sup> The economic impacts are estimated using 2017 IMPLAN data.

<sup>&</sup>lt;sup>iv</sup> The analysis in this section uses the local purchase percentage (LPP) option available in IMPLAN, which affects the direct impact value applied to the multipliers. Instead of 100-percent direct expenditure value (for example,

\$2.1 million for the East Tennessee AREC), the model is set to reflect the actual expenditure (\$1.6 million for the East Tennessee AREC). If a 100-percent direct annual expenditure value is applied to the multipliers for all the ARECs, the estimated total economic impacts for total industry output is \$8.1 million.

<sup>v</sup> The analysis assumes a state level soybean yield of 47.8 bu/ac, acreage of 1,643,153, production of 78,555,989 bushels (2017 Census of Agriculture), and a soybean price of \$8.65/bu (July 23, 2019 Wall Street Journal commodity cash price). See example calculations below. Analysis assumes that the increase in yield has no impact on prices received and adopting the new variety has no cost to producers.

New Soybean Variety Example for Tennessee (Proprietor's Income)					
Old	New				
47.8	49.8				
1,643,153	1,643,153				
78,555,989	81,829,019				
3,273,030					
50.0					
\$8.65					
\$14,155,856					
\$25,53	35,817				
	ssee (Proprieto Old 47.8 1,643,153 78,555,989 3,273 50 \$8 \$14,15 \$25,53				

#### New Soybean Variety Example for Tennessee (Proprietor's Income)