

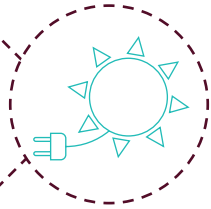


AGENCY 229 MATTERS

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PARTNERS IN PROGRESS

From the Appalachian Mountains to the Chesapeake Bay, Virginia Tech's work touches every corner of the state. Guided by a mission to improve Virginians' standard of living, and supported by Agency 229, university researchers and Virginia Cooperative Extension specialists and agents deliver life-changing research and leading-edge solutions to citizens' doorsteps.

As the university directs its resources to residents within the borders of the commonwealth, this work also extends beyond boundaries, providing food, health, energy, water, economic, and environmental remedies to global challenges and offering hope to humans across the planet.

Experts are finding ways to deliver clean water, advance renewable sources of energy, and provide citizens with access to nutritious foods. They are also pioneering medical advancements that could resolve chronic and infectious diseases. This work continues as we develop new ways to educate and empower individuals, businesses, and communities.

This report provides a glimpse into the challenges and opportunities ahead and underscores the value and impact of Agency 229 on Virginia's future tomorrow – and for years to come.

We invite you to learn more inside these pages and to read stories of our impact on every Virginia county at www.Agency229.cals.vt.edu.

INNOVATIVE RESEARCH

- The Virginia Agricultural Experiment Station includes faculty members in three colleges: the College of Agriculture and Life Sciences, the College of Natural Resources and Environment, and the Virginia-Maryland College of Veterinary Medicine.
- 11 Agricultural Research and Extension Centers are located across the state.

EXPANSIVE EDUCATION

- Virginia Cooperative Extension leads the engagement mission of Virginia Tech and Virginia State University, the commonwealth's land-grant universities.
- Extension is building strong local relationships, forging collaborative partnerships, and providing practical education to help individuals, businesses, and communities thrive.

A LOCAL PRESENCE

- 107 Extension offices are located across Virginia in every county and 12 cities.
- Extension is a cooperative effort among local, state, and federal governments in partnership with tens of thousands of citizens.

A person is riding a brown horse through a green field, herding a group of cattle. In the background, there is a city with a large building and a parking lot, all under a hazy sky with a rising sun. The scene is captured in a wide-angle shot, emphasizing the rural setting in the foreground and the urban environment in the distance.

FOOD AND NUTRITION

912,790

Virginians do not know where their next meal will come from, which is why Extension agents and researchers are addressing food insecurity in communities across the commonwealth.



ENHANCING YIELDS, IMPROVING QUALITY, AND HELPING VIRGINIA PRODUCERS MARKET GLOBALLY



Each day, Virginia Tech experts partner with producers across the state to enhance the quality of their soils, improve their yields, and strengthen their animals. The partnership doesn't end there. These experts also help secure markets and profits for these valuable products.

The success of each and every producer in the commonwealth helps ensure that citizens from each corner of the state may share in the bounty. Virginia Cooperative Extension also works through farmers markets and other venues to provide low-income residents with access to fresh, nutritious foods.

The research and Extension know-how required to support robust food production and distribution are critical – not only to residents of the commonwealth, but to the 2 billion new residents who will join our ranks across the globe.

In 30 years, 9.7 billion people will populate the planet - each requiring safe, nutritious food and clean water. Through the Virginia Agricultural Experiment Station and Virginia Cooperative Extension, Virginia Tech is helping our local producers feed the world.

In Blacksburg, a series of new facilities are under construction, where colleagues from the College of Agriculture and Life Sciences and the Virginia-Maryland College

of Veterinary Medicine may continue collaborating to advance the knowledge and practices used to raise cattle, chickens, sheep, and pigs.

The university is educating a new generation of professionals who will discover even better and more-efficient ways to feed citizens of the commonwealth and the world. For example, one of the programs is leveraging U.S. Department of Agriculture funds to teach students how to translate what they learn in the lab into practical information that producers can use to enhance quality, yield, and profitability.

The need for more food also creates tremendous opportunity for Virginia producers who contribute to the growing export market, valued at more than \$3 billion. Among Virginia's top exports are poultry, wheat, pork, tobacco, soybeans, and wine – commodities for which Virginia Tech provides crucial research and outreach services.

**Two billion is a lot of
people to help feed.
But we are ready.**

At left: Researchers at the Virginia Tech campus are working on ways to raise cattle, sheep, pigs, and chickens to feed families across the state and the globe.

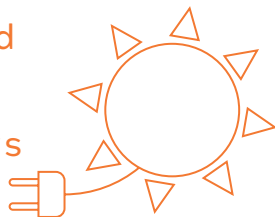
EMBLAZONING A BOLD AND BRIGHT FUTURE FOR VIRGINIA

The conversion of effluent to energy may be a flush away as a result of Virginia Tech renewable energy research. Scientific innovation, coupled with alchemical ingenuity, promises to transform food and water waste into precious energy to fuel our cars and power our homes, a process that could save U.S. taxpayers millions of dollars each year.

These advances mean that water treatment facilities could become the power plants of the future, and energy extracted from last night's leftovers could source a growing demand for clean, renewable energy. Virginia Tech researchers are working to make this a reality by converting not only sewage, but food and plant waste into energy.

The U.S. Energy Information Administration estimates that world energy consumption will accelerate by 48 percent between 2012 and 2040. Concerns about energy security, greenhouse gas emissions, and fluctuating world oil prices are driving the investigation of viable alternatives, such as hydropower, geothermal, wind, and solar. Virginia Tech is committed to helping the U.S. develop clean, affordable, renewable forms of energy and to making these advancements accessible to the global market.

Across campus – and around the state – Virginia Tech researchers are finding ways to keep the lights on.



Other Virginia Tech researchers and Extension specialists are exploring a new kind of “power plant” by growing crops such as miscanthus, a tall grass that is thriving in the university’s test fields. The grass, which conserves soil and reduces runoff, also holds potential as a renewable form of biomass, or organic fuel.

Extension agents are harnessing the sun’s power in new and creative ways. Portable solar pumps that generate water for cattle – and can be moved from field to field – are helping Virginia farmers ensure clean, fresh water for herds without contaminating creeks and streams.

At right, from left: In the Shenandoah Valley, Extension Specialist John Ignash and Extension Agent Matt Booher work with Alston Horn of the Chesapeake Bay Foundation to install solar-powered water stations that help protect the watershed. Photo by Kenny Fletcher, Chesapeake Bay Foundation.

ENERGY



Extension provided energy audits for 66 agricultural operations in Southside and Southwest Virginia, a region that saw \$66 million in annual farm energy-related expenses. The audits identified potential energy savings of **\$850,734** annually.



442,260: Total employment impact of Virginia's agriculture and forestry industries

8.7%: Total state employment related to the agriculture and forestry industries

\$91 billion: Total impact of agricultural and forestry industries

POSITIONING VIRGINIA AS AN ECONOMIC POWERHOUSE

\$91 billion. For context, this figure is the gross domestic product of many small countries. But it also represents the impact of Virginia's agricultural and forestry industries on the state's economy each year.

What is behind these two top-performing industries and economic powerhouses? Agency 229 and the institutions through which it is administered. Virginia Tech researchers, Extension agents, and specialists are educating the next generation of producers and forestry managers, researching innovative technologies, and identifying new domestic and international markets for Virginia products.

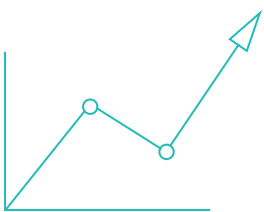
"Virginia Tech has played a vital role in this remarkable growth," said Virginia Secretary of Agriculture and Forestry Basil I. Gooden. "The university's land-grant mission, coupled with its research and Extension contributions, impacts every facet of agriculture in the state. We would not be looking at this kind of figure without Virginia Tech's expertise and innovation."

Wine, soybeans, lumber, tobacco, wheat, poultry, and pork are among the state's top exports and are commodities for which Virginia Tech provides crucial research and Extension services. One in nine Virginia farm jobs contributes to these international exports.

To further boost the agricultural and forestry industries, we are investing in infrastructure around Virginia Tech's Blacksburg campus.

The university also fuels the state's economic prosperity in other ways. A new campus brewhouse serves as a nexus for collaboration among educators, growers, and industry leaders and supports the commonwealth's \$8 billion-per-year beer industry. To

ECONOMY



support this growing industry, Extension specialists are teaching producers how to grow hops.

Oenology and viticulture research and outreach efforts on campus and at Agricultural Research and Extension Centers around the state have also helped put Virginia wine on the map, creating a market for a burgeoning industry valued at \$1.37 billion per year.

State-of-the-art methods of raising poultry and crops are changing the face of agriculture in the commonwealth. Drones are just one example of a new technology that is providing Virginia farmers with everything from detailed soil and field analysis to daily monitoring and health assessments of crops and animals. The nimble aerial units are capable of

covering large areas and may be equipped to plant fields and spray crops – tasks they are able to complete up to five times faster than traditional machines.

Such technologies, along with Virginia Tech's drive to help position the state as a global leader, are poised to revolutionize the agricultural industry and to ensure that this \$91 billion figure continues to rise.

Above: Researchers at Agricultural Research and Extension Centers around the state are investigating how cutting-edge technology tools such as drones can be used by producers to streamline their operations.

AGENCY 229 IMPACTS BY COUNTY

PAGE COUNTY

Extension uses several programs to educate students about sound money management and financial planning. Reality Store, Kids Marketplace, and Real Money, Real World simulations provide hands-on learning that correlates to Standards of Learning. **Two Reality Store simulations were taught in Page County to 240 students last year.** This program was assisted by 50 community volunteers, with the help of faculty and staff. **Across the state, 73 agents conducted 114 Reality Store programs to 11,330 children in 2016.** Of the students surveyed, **94 percent reported increased awareness of how to make smart financial decisions.**

MONTGOMERY COUNTY

Researchers discovered a genetic indicator that showed **high levels of human sewage in Stroubles Creek.** They found that the **movement of contaminants in watersheds is complex and that pollutants do not all move in the same manner.** Factors such as land-use and seasonal trends impact how contaminants move through the water system. While considerable work has been conducted at Stroubles Creek, **this research indicates the need to address contaminant transport at the larger watershed scale.** This work enhances our ability to identify when, where, and why there is a high risk of fecal contamination in surface waters.

WISE COUNTY

To enhance teachers' knowledge of forestry issues, Extension developed a 30-hour professional development field-tour program called **Trees to Products.** The program was designed to provide teachers with factual information about Virginia's hardwood forests and to link forestry concepts to Standards of Learning. **The 2016 program reached 13 educators who annually instruct approximately 1,000 students.** Educators from Wise and other Virginia counties are now able to use this information in their classrooms. This program has been conducted 11 times since 2006, and has reached 119 educators who annually instruct approximately 13,150 students.

CHARLOTTE COUNTY

Several years ago, Virginia's roughly 5,000 beekeepers lost nearly half of their colonies – a troubling die-off for one of the nation's largest apple producers. **Pollinator and butterfly habitat is on the decline in Virginia and nationally.** Extension enlisted **18 Charlotte County Central Middle School students to design and implement a butterfly garden on the front lawn of the school.** The students learned about soil and water quality and the importance of pollinators and butterflies to the environment, while the garden serves as an educational resource for visitors.

ARLINGTON COUNTY

When low-income renters in Arlington were faced with exorbitant electric bills, they reached out to Extension to address the culprit – poor energy efficiency. **Extension helped train a corps of Energy Masters volunteers** who performed energy- and water-saving retrofits in 655 Arlington and Alexandria apartments. **Their work saved 8,598,774 gallons of water and \$126,944 in utility costs during the first five years of the program**, earning it multiple prestigious awards.

HAMPTON

Each year in the U.S., there are approximately 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths linked to foodborne illness. Last year, the Virginia Seafood AREC provided 18 food-safety trainings and workshops (nine in Spanish) to 292 clients from 64 food-processing companies in Virginia, and nationwide. Afterwards, participants, including safety inspectors, used this knowledge to prevent contamination of the foods they process or serve to the public.

SUFFOLK

Researchers at the Tidewater AREC determined that uneven rainfall and summer heat can limit peanut yield and production value up to \$15 million. **Researchers are developing peanut varieties with improved drought tolerance. A new variety yielded 26 percent more than Sullivan, the most popular peanut in the region.** The team's preliminary research was recently awarded two National Institute for Food and Agriculture awards that will further support in-depth drought research for Virginia peanuts over the next several years.

See how Agency 229 has made an impact in every county in Virginia at www.Agency229.cals.vt.edu.

PROTECTING VIRGINIA'S HUMANS, ANIMALS, AND PLANTS AND OFFERING INNOVATIONS FOR A HEALTHIER FUTURE



Unlocking the mysteries that surround infectious disease to identify health solutions is a cornerstone of Virginia Tech's research agenda.

Zika, malaria, and tick-borne illnesses are among the many infectious diseases that our researchers are working to resolve. A new faculty-cluster hiring approach is bringing specialists in disease modeling, epidemic mapping, genetics, and novel insecticides together to halt the spread of these lethal viruses. These specialists hail from different parts of the university, including the College of Natural Resources and Environment, the Virginia-Maryland College of Veterinary Medicine, and the College of Agriculture and Life Sciences, and will work collaboratively and across disciplines to fight infectious diseases.

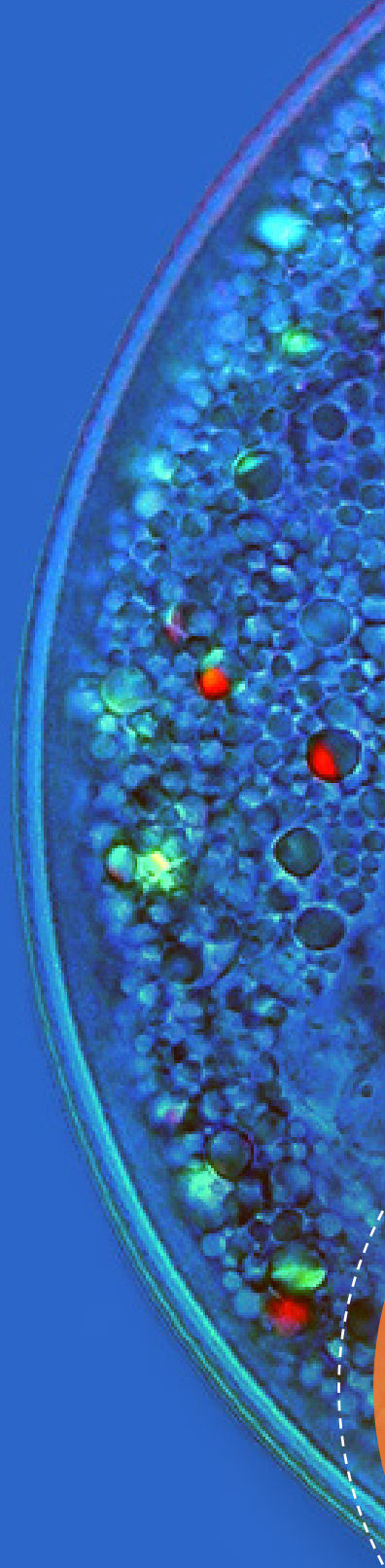
This integrative systems approach promises to deliver new innovations in the treatment of disease.

From scientific laboratories to farmers' fields, experts are working to support healthy bee populations and targeting predatory insects responsible for destroying valuable produce. In response to acres of sweet corn, grapes, and apples lost each year to stinkbugs, entomologists are exploiting the bugs' most distinctive characteristic, their smell, to eradicate them. These scientists are also working to combat other bugs that snatch profits from producers, including the kudzu bug and the corn earworm moth.

The controlled release of beneficial *Laricobius osakensis*, a beetle with the power and appetite to eradicate an invasive insect that has wreaked havoc on entire forests of Eastern hemlock, holds great promise. In conjunction with breeding programs and efforts to preserve valuable genetic material, researchers are using safe and innovative approaches to ensure the health of ecologically and commercially valuable species.

In Roanoke, a partnership between a new research center and local hospitals is helping people with diabetes, obesity, and other conditions to alleviate their symptoms through behavioral modification. Such steps will not only help people make healthier food decisions, but will also drive down the cost of health care.

As Virginia Tech researchers continue to examine health and disease at both the micro and the macro levels and to seek solutions from experts across disciplines, the university is advancing new and novel approaches with the goal of eliminating infectious disease and enhancing human, animal, and plant health.



At right: Scientists in the College of Agriculture and Life Sciences are examining how to keep nematodes from spreading diseases in plants.

A detailed microscopic image of a cell, likely a liver cell, showing various organelles. The nucleus is prominent in the center, surrounded by a dense network of cytoplasm containing numerous small, dark, spherical structures. Several organelles are highlighted with bright, glowing colors: red, green, and yellow. The overall background is a deep blue. The title 'HEALTH AND DISEASE' is overlaid in large, white, sans-serif capital letters. Two orange L-shaped brackets are positioned on the left and right sides of the title, framing it. In the bottom left corner, there is a large orange circle containing text about research and outreach projects related to health and disease. The page number '12' is located at the bottom center.

HEALTH AND DISEASE

Why are 20 percent of Extension and Virginia Agricultural Experiment Station research and outreach projects related to health and disease? Because more than 36.5 percent of adults in the U.S. are obese, with an estimated annual medical cost of more than **\$147 billion.**

DELIVERING SCIENCE AND SOLUTIONS TO KEEP OUR WATER CLEAN



As population growth, climate change, urbanization, and other threats pose challenges to our water quality and supply, Virginia Tech researchers – guided by the sobering reality that half of the world’s population will reside in water-stressed areas by 2025 – are studying this precious substance in all of its forms and facets.

Scientists are monitoring the infrastructure used to transfer water to help Virginia farmers irrigate effectively.

These data provide vital information about water losses, empowering communities to address leaks and other inefficiencies in their water-transport systems.

In the future, new models incorporating climate analysis, weather trends, and water-use data will make it possible to forecast drought, flooding, and other hazards, months and even years in advance. This predictive capability will provide farmers and entire industries with a sort of crystal ball, enabling them to plan for their water needs and to prepare for weather-related disasters.

Recovering wastewater and nutrients is also critical. When producers were instructed to limit the amount of nitrogen and phosphorous in the Chesapeake

Bay, a College of Agriculture and Life Sciences scientist engineered an inexpensive water-quality system that removes up to 90 percent of nitrogen, and 45 percent of phosphorus output, safeguarding the bay – and producers’ profits.

Virginia Cooperative Extension agents are also exploring the other side of the equation through the development of safer fertilizers formulated with lower levels of nutrients, such as phosphorus. Novel, automated sensor networks can now identify when irrigation is required, saving growers time, water, and money. And when too much water is the issue, Virginia Tech experts have developed capture systems that collect runoff, allowing growers in the nursery and other industries to recycle this resource.

For consumers, a statewide program offers quick, affordable water testing. Virginia Tech researchers found that approximately 10 percent of Virginia homes served by well water may be contaminated with lead. Identifying whether or not lead and other contaminants are in homeowners’ drinking water is the first step to fixing the problem. This simple water test, available through statewide water-testing clinics, could save countless lives.

At right: Students conduct research near the Virginia Tech campus that will inform how to ensure healthy drinking water for the state — and the world.





WATER

Nearly one quarter of Virginia's residents rely on private supply systems for their household water. Researchers and Extension agents sampled 2,554 private water supplies in 2016 and found that **39%** did not meet EPA standards for total coliform bacteria.

A photograph of three people in a forest. A woman in the foreground, wearing a checkered shirt and glasses, is using an orange measuring tape to measure the circumference of a large tree trunk. A man with sunglasses stands behind her, and a woman with glasses and a white shirt stands to the right. The background is filled with green trees and foliage.

ENVIRONMENT

Virginia has

46,030 farms and more than
8.3 million acres of farmland.

23% of the state's farms have implemented some soil- and water-conservation measures with the help of researchers and Extension agents.

PRESERVING OUR STATE'S NATURAL RESOURCES FOR GENERATIONS TO COME



What does it take to cultivate fertile ground from resource-depleted soil? How will experts develop the next generation of environmental monitoring technology to enhance land- and water-management efforts? How will we teach all citizens to be stewards of our land?

Every day, Virginia Tech researchers and Virginia Cooperative Extension agents answer these questions and extend their knowledge to benefit citizens of the commonwealth and the environment in which they live.

The university's footprint extends across the globe as researchers work to pinpoint the amount of carbon released into the atmosphere. This information could change models used by governments to guide major research and policy decisions.

Data on land-cover in urban municipalities, paired with bold, new thinking about the ways in which these cities are classified, could inform not only resource-management decisions, but also our ability to compare and understand changing land-cover patterns in similar cities across the world.

University experts have found that simple changes to land-cover can reap powerful economic, environmental, psychological, and social benefits.

Urban trees, for example, can lower surrounding temperatures by as much as 20 degrees. When trees cast shade on a building, power bills can decrease by \$10 each month.

On the state's rural terra firma, experts in the College of Agriculture and Life Sciences are helping producers implement sound conservation practices, such as cover crops, field borders, and grassed waterways, all of which enrich soil and prevent erosion. Once farmers' products are ready for market, Extension is bringing to residents, businesses, and non-profits to create thriving and resilient local food systems that benefit local Virginia communities.

Extension is also expanding the university's reach and harnessing the power of volunteers through the Virginia Master Naturalist program. In 2016, volunteers logged more than 146,000 hours, applying their natural resources training in myriad ways, from community naturalist classes to stream monitoring.

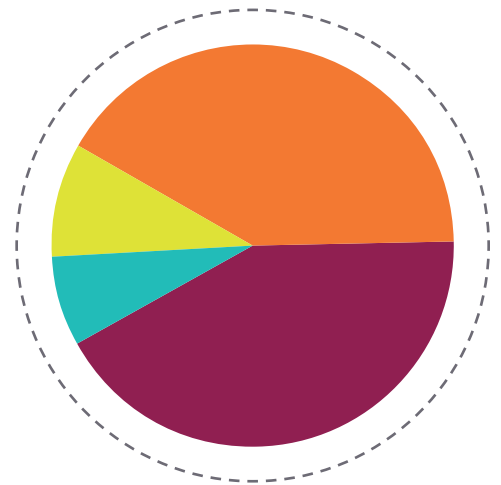
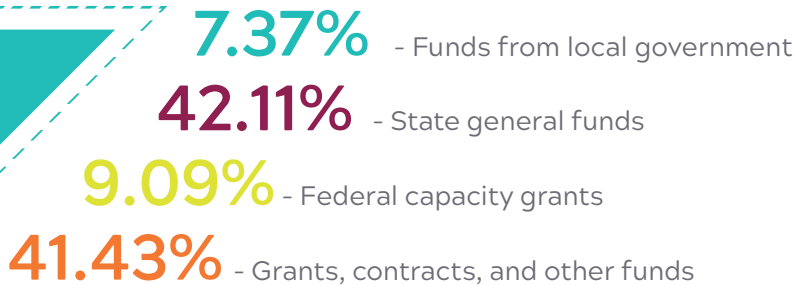
In the College of Natural Resources and Environment, researchers partnered with a Virginia-based business to develop monitoring technology to track contaminant plumes and measure nutrient concentrations. The team is moving this state-of-the-art system toward commercialization, benefiting Virginia's environment and economy.

At left: Jennifer Gagnon (left), a Virginia Cooperative Extension project associate and coordinator of the Virginia Forest Landowner Education Program, works with landowners around the state to manage their forest land.

BY THE NUMBERS

EXTENSION AND RESEARCH FUNDING (FUNDING SOURCES FOR FY2017)

Virginia Cooperative Extension and the Virginia Agricultural Experiment Station received \$168.8 million from federal, state, and local government, as well as from grants, contracts, and other sources.



VALUE OF VOLUNTEERS

In 2016, Virginia Cooperative Extension had 29,845 volunteers who assisted Extension staff in delivering education programs. These volunteers contributed

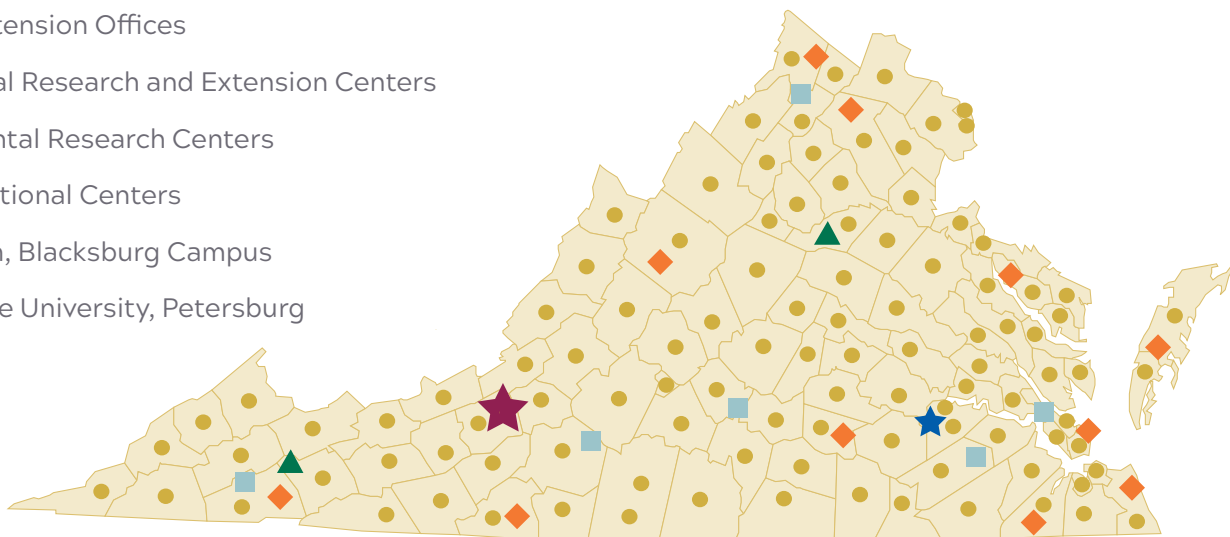
1,181,416

hours of service valued at

\$30,823,143*

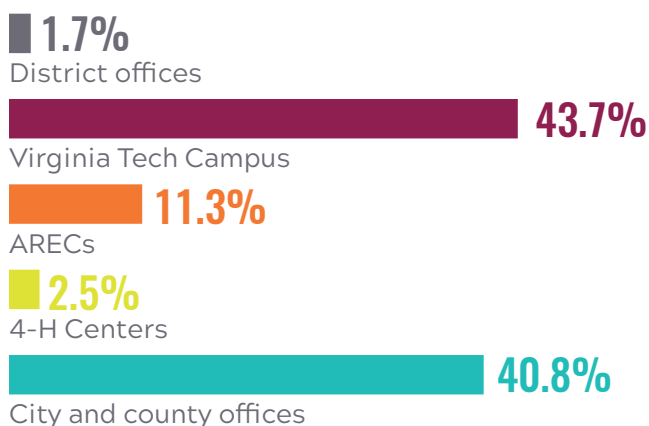
* Based on Independent Sector 2016 Value of Volunteer Hours by State.

- 107 Local Extension Offices
- ◆ 11 Agricultural Research and Extension Centers
- ▲ 2 Departmental Research Centers
- 6 4-H Educational Centers
- ★ Virginia Tech, Blacksburg Campus
- ★ Virginia State University, Petersburg

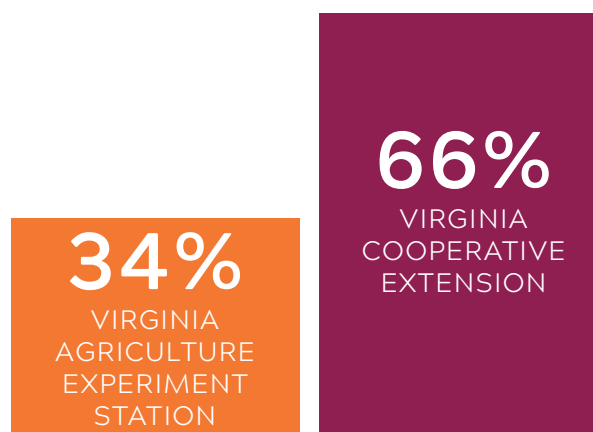


\$1.37*
Additional amount of funding
 Agency 229 generates for every \$1 the state invests.

LOCATION OF RESEARCH AND EXTENSION PERSONNEL



EXTENSION AND RESEARCH EFFORT



767 FTEs

Total number of faculty and staff members for research and Extension

* A 2017 modification to the way in which the university attributes research expenditures is reflected in this report. That modification impacts the total ROI calculation compared with previous reports. Total resources increased \$496,209 from 2016 to 2017.



FOR MORE INFORMATION ABOUT OUR PROGRAMS,
VISIT OUR WEBSITES OR ONE OF OUR LOCAL
EXTENSION OFFICES.

Virginia Cooperative Extension – www.ext.vt.edu

Virginia Cooperative Extension local offices – www.ext.vt.edu/offices

Virginia Agricultural Experiment Station – www.vaes.vt.edu

College of Agriculture and Life Sciences – www.cals.vt.edu

College of Natural Resources and Environment – www.cnre.vt.edu

Virginia-Maryland College of Veterinary Medicine – www.vetmed.vt.edu



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