

INSIGHTS

FROM
2017

An Inside Look at Agricultural Research and Cooperative Extension at Virginia State University



Food, Nutrition & Health



Agriculture Profitability & Sustainability



Small Ruminants



Plant Research & Sustainability



IMPROVING LIVES THROUGH PROVEN SOLUTIONS



Virginia Cooperative Extension
Virginia Tech • Virginia State University



**College of
Agriculture**

VSU's Agricultural Research Station and Cooperative Extension program made great strides in 2017 to deliver research-based information into the hands of people who can benefit from this impartial, unbiased knowledge. Here's a peek into some of the ways we did it.

106 # of public events

5,127 # of attendees at public events

BIGGEST event:

USDA FIELD DAY - 482 attendees

Most popular new event:

INDUSTRIAL HEMP FIELD DAY



Total New Likes: **475**

Engaged FB Users: **13,455**

People Reached: **219,127**

Impressions (times seen): **391,332**



Impressions (times seen): **99.6K**

Total Profile Visits: **5,684**

Total Mentions: **97**

New Followers: **127**

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Dr. M. Omar Faison
Interim Executive Director, Center for
Agricultural Research, Engagement and
Outreach

Dr. M. Ray McKinnie
Dean/1890 Extension Administrator

Dr. Wondi Mersie
Associate Dean/Director of Research

Virginia State University
College of Agriculture
One Hayden Drive • P.O. Box 9081
Virginia State University, VA 23806
(804) 524-5961

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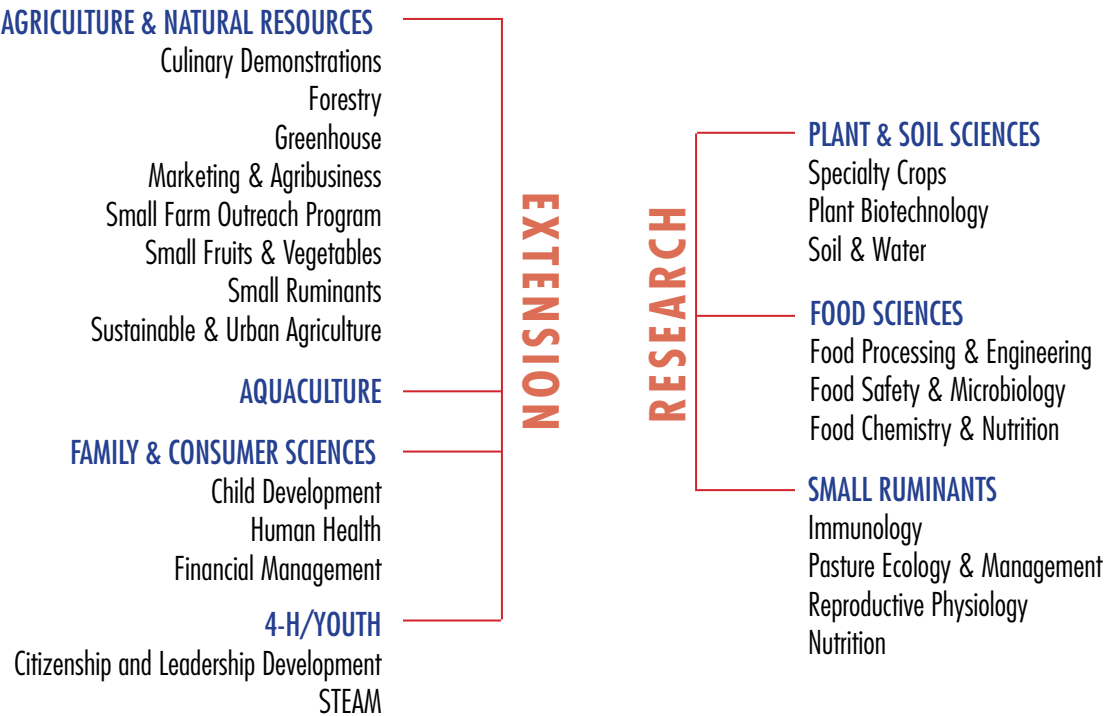
Around the World

VSU agricultural researchers and Extension specialists generate positive impacts on the lives of people far beyond the university walls. The work they do directly affects the health, safety and economic prosperity of people all over the globe. This issue of *Insights* highlights some of those places.



Our Program Areas

VSU addresses critical issues about agriculture, food, the environment and communities in order to help limited resource, socially disadvantaged and at-risk populations be healthy and successful.



Results. Impacts. Making A Difference.

Generating positive effects on people's lives is what Virginia State Agency 234 is in the business of delivering. Through our Cooperative Extension program and our Agricultural Research Station (ARS), Agency 234's mission is to discover and deliver solutions that will improve the lives of Virginians, the nation and the world.

Many of our results are agricultural in nature. That's because agriculture is a big deal in Virginia. It's Virginia's largest private industry, employing nearly 54,000 farmers

and workers and generating approximately \$3.8 billion in total output. In addition, value-added industries—those that depend on farm commodities—employ more than 69,000 workers. Considered together, the employment and value-added impact of agriculture and forestry comprise 9.5 percent of the state's total gross domestic product.

But agriculture isn't Agency 234's only focus. We deliver research-based solutions for myriad problems facing Virginians today: obesity, financial security, early childhood and youth development and more. And we're always looking ahead to determine the next issue that our resources can resolve, so that Virginians and the world can receive the help they need and deserve.

This is the first issue of *Insights*, a publication dedicated to highlighting some of Agency 234's projects and impacts. We hope you enjoy taking a peek into the exciting work we're doing, and more importantly into the positive changes we're making in people's lives.

Dr. M. Omar Faison

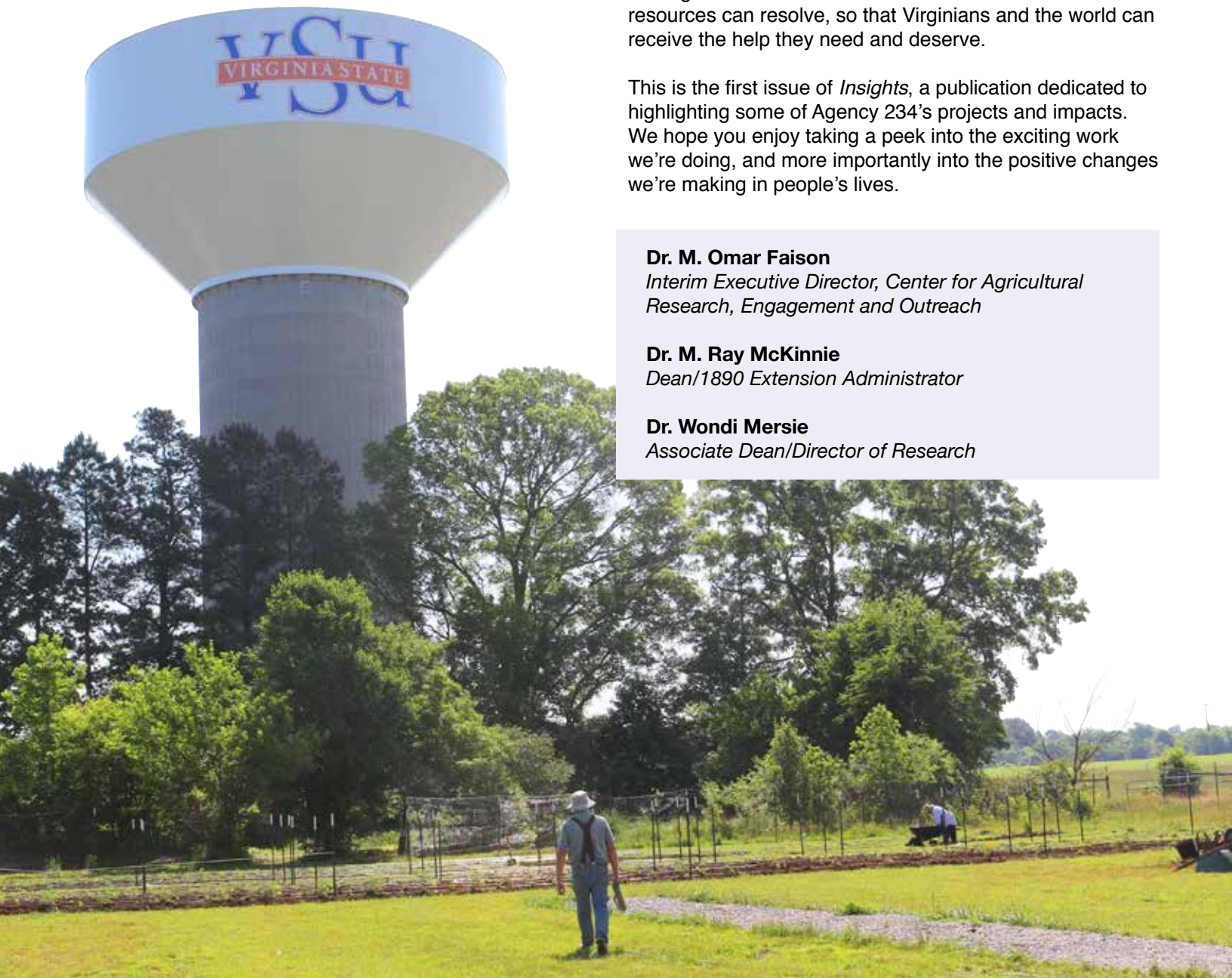
Interim Executive Director, Center for Agricultural Research, Engagement and Outreach

Dr. M. Ray McKinnie

Dean/1890 Extension Administrator

Dr. Wondi Mersie

Associate Dean/Director of Research



Virginia Cooperative Extension

Virginia Cooperative Extension brings research-based knowledge and resources from Virginia’s two land-grant universities, Virginia Tech and Virginia State University, to the people of the commonwealth to help them improve their lives.

At Virginia State University, Extension specialists specifically focus on providing educational programs and tools, expert advice and a wealth of dependable answers to enrich the lives, the land and the economy of Virginia’s limited-resource individuals, families and communities.

Extension is part of the National Institute for Food and Agriculture (NIFA), an agency of the United States Department of Agriculture (USDA), and is further supported through a cooperation among local, state and federal governments in partnership with tens of thousands of citizens, who, through local Extension Leadership Councils, help design, implement, and evaluate our needs-driven programs. Our program areas include Agriculture & Natural Resources, Aquaculture, Family & Consumer Sciences and 4-H Youth Development.

VSU Agricultural Research Station

The Agricultural Research Station (ARS) is the hub of food-related research at VSU. ARS staff and faculty use advanced scientific techniques in state-of-the art facilities to investigate diverse issues in agriculture, food production and food safety that benefit growers, producers and communities locally and abroad. They explore issues and work to resolve problems with immediate, intermediate and long-term impacts in the areas of food, nutrition and health; agriculture profitability and sustainability; small ruminants; and plant research and sustainability.

VSU undergraduate and graduate students help carry out ARS’s mission as they receive valuable experiential learning in the lab and at VSU’s Randolph Farm. At any given time, 30-40 undergraduates work at ARS, and in 2017, Agricultural Research faculty served as major advisors by guiding 15 graduate students in conducting their M.S. thesis research.

The ARS mission is supported with federal funds that are appropriated by the U.S. Congress and administered by USDA-NIFA. The ARS receives funding annually from the Commonwealth of Virginia and secures financial support through external grants and contracts, as well as the USDA Capacity Building Program.

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Let's Grow!

Building A Sustainable Urban Ag Community

When Curtis Moody enrolled in VSU's Sustainable Urban Agriculture Certificate Program in the spring of 2017, he'd already had a lifetime of farming experience. Raised on a farm in Red Oak, Virginia, Moody started Moody Street Garden in Newport News in April 2013.

Moody, a master gardener and VSU alumnus who earned a bachelor's degree in agriculture, signed up for the inaugural class because, "In agriculture you can always learn more," he said. "I thought the Urban Ag Certificate Program was a great opportunity to put me in a place with like-minded people." And it did exactly that. Being in the program gave him a chance to expand his network throughout Virginia and his gardening knowledge. He learned about soil management, different methods of managing crop pests and diseases, and urban agriculture business planning and entrepreneurship. He also gained expert resources at his fingertips—just a call or email away. "The program gave me an outlet to get the information I needed instead of having to go and research it," Moody said. He considers Dr. Leonard Githinji, sustainable & urban agriculture Extension specialist, his mentor.

The Sustainable Urban Agriculture Certificate Program comprises a 12-week, intensive curriculum to teach participants how to plan and operate a profitable urban farm. A comprehensive hands-on curriculum was developed to teach participants about basic principles of urban agriculture and how to develop an urban farm business plan. Twenty-nine participants enrolled in the pilot program during the spring of 2017, and 24 participants completed the fall program. In total over both programs at least 50 participants were taught how to write a personal urban farm business plan that could serve as the foundation for a profitable urban farm business in Virginia.

"We created the Urban Agriculture Certificate Program based on demand from various target audiences," said Dr. Githinji. "Those involved in educating others, such as Master Gardeners, community-based organizers and school teachers, wanted to gain credentials, while home gardeners and urban farmers were seeking more knowledge to carry out their operations more effectively and profitably."

With its in-depth curriculum that includes hands-on experiential learning, the Sustainable Urban Agriculture Certificate Program can benefit anyone who is working in the field of urban agriculture in any capacity. Program participants gain practical knowledge that they can use in their current or future urban agriculture operations; they interact with others and share their experiences from an urban gardener or farmer's perspective; and they complete a mandatory 80-hour internship in which they gain additional experiences at various urban agriculture sites across the state.

"Since graduating from the program, some participants have started or expanded their own urban farm operations," Dr. Githinji said. "A few have used the urban ag certificate for gainful employment, and others are using the knowledge gained to serve their own communities in the area of urban gardening."

Nearly 75 percent of the U.S. population resides within 200 miles of a city. Consumers are becoming more aware of what they eat and are demanding more local produce. As a result, interest in urban agriculture has grown. Cooperative Extension at VSU is helping aspiring urban farmers gain a foundation of education and experience to help them be successful in their urban ag endeavors. Moody is still actively involved in the program even though he's graduated. His Moody Street Garden site is used for the hands-on part of the urban ag program; other program graduates also volunteer there.

Moody builds gardens on Newport News public school campuses to teach children how to garden and be sustainable. His project is set up so that parents and teachers can volunteer together. Volunteers from the police department, the city, public works and political officials also help out in his garden. Moody said the garden is a low-tension environment that gives people (parents and teachers, public officials and community members) a chance to have conversations they might not have in more formal settings.

"I took what I knew [gardening] and turned it into something that would help the community," he said. "My whole mission is to help the local urban community and food deserts." Moody Street Garden is in a food desert, so he's trying to help local residents have access to healthy, locally grown produce, rather than having to rely on buying sodium-laden canned goods from convenience stores.

He'd like to put together a program that can be implemented in any school. Moody's 10-year goal is to open his own K-12 agriculturally based STEM academy to teach kids about sustainability.

The Sustainable Urban Agriculture Certificate Program can serve as a model for other 1890 institutions seeking to start similar programs in their states. Plans are underway to expand the program through a distance-learning education option.



Spice It Up With Turmeric

Turmeric—a bright, aromatic powder derived from the rhizome of a plant in the ginger family—is a staple of Asian cooking. Researchers have found that turmeric may have important health benefits.

Studies have been conducted regarding turmeric's ability to naturally reduce inflammation that contributes to chronic pain. VSU has received \$100,000 in grant funds from VSU's Center for Agriculture Research, Engagement and Outreach to conduct field and laboratory research into the improved production system and the health benefits of turmeric. The university has partnered with Virginia Tech and Virginia Commonwealth University to conduct this research.

Specialists within VSU's Small Fruits & Vegetables Program have tested whether turmeric can be grown in Virginia. They have planted test plots at VSU's Randolph Farm, conducted on-farm demonstrations and undertaken test marketing. Currently, 35 Virginia farmers are growing and test marketing turmeric for local markets.

The results suggest turmeric can be grown successfully in a high tunnel. A workshop on turmeric production drew 119 participants who received training on turmeric production,

marketing and value-added product development. Thirty-five small farmers grew 500 turmeric plants. On average each plant produced four pounds of fresh turmeric, for a total of 2,000 pounds. The average sale price was \$17 per pound for a total value of \$34,000.

Principal Investigators:

Dr. Reza Rafie, arafie@vsu.edu
 Dr. Rafat Siddiqui, rsiddiqui@vsu.edu
 Dr. Toktam Taghavi, ttaghavi@vsu.edu
 Dr. Theresa Nartea, tnartea@vsu.edu
 Mr. Chris Mullins, cmullins@vsu.edu

Funding Source:

VSU Center for Agriculture Research,
 Engagement and Outreach Grant



Fruits and Veggies Keep the Doctor Away

Virginia has the 29th highest rate of obesity in the United States according to The State of Obesity: Better Policies for a Healthier America published in September 2016. Obesity is a leading contributory factor to developing other chronic diseases such as diabetes, cardiovascular disease and cancer. Cancer is the leading cause of death in Virginia, and second leading cause of death in the U.S. after heart disease.

Many natural foods contain effective disease preventive biomolecules that can improve our health and reduce our risk for obesity, diabetes, cardiovascular diseases, cancer, poor bone health and neurological diseases. VSU scientists are studying the beneficial effects of papaya, plums, ginger and turmeric for preventing and/or treating chronic diseases. In particular, they are exploring papaya seeds' wound-healing properties and anti-cancer properties for prostate cancer; papaya leaves' anti-cancer properties for breast cancer and leukemia; plum skin for

anticancer properties for colon cancer; ginger's active ingredients (6-gingerol and shogaol) for addressing obesity; and curcumin, the active component of turmeric, which has strong anti-inflammatory activity and anti-cancer activity, for breast cancer.

Researchers plan further research in the potential of papaya leaf extract to lower the risk of obesity and diabetes, and as an adjunct therapy to anti-cancer drugs. They will also assess the phytochemical profile of different varieties of ginger and turmeric during cultivation and post-harvest for their preventive effect on obesity and cancer.

Principal Investigator:

Dr. Rafat Siddiqui, rsiddiqui@vsu.edu

Funding Sources:

USDA-NIFA – Evans-Allen Formula Funds
 USDA-NIFA – Capacity Building Grant (2018-2020)

A New Use for Wine Grape Waste

VSU scientists are researching the development of biodegradable films with antimicrobial and antioxidant activities for use in food applications to improve food safety and reduce reliance on non-biodegradable materials.

Starch is used as the base matrix to which cellulose nanocrystals are added. Cellulose nanocrystals are derived from crop by-products or agricultural wastes and are used to strengthen the film and reduce its brittleness. Grape pomace extract (GPE), derived from leftover skins and seeds from winemaking, is also added because GPE contains compounds that have antimicrobial activity. Grape pomace from white grapes appears to exhibit higher antimicrobial activity than does red grapes, possibly because the skin and seeds are not fermented for white wine as they are for red wine.

The antimicrobial activity of the researchers' films was evaluated by two methods. First, the films were incubated in test solutions with and without bacteria. This test demonstrated that films containing GPE had higher antimicrobial activity than films without GPE. Next, they applied the GPE-containing film to ready-to-eat (RTE) chicken meat samples inoculated with either *Staphylococcus aureus* (*S. aureus*) or *Listeria monocytogenes* (*L. monocytogenes*). The results showed that these films had a strong inhibitory effect on *S. aureus* compared to *L. monocytogenes* and that the white grape GPE was most effective against *L. monocytogenes*. Future studies will focus on the ability of starch nanocomposite film containing white grape GPE to inhibit the growth of other bacteria and on the films' antioxidant activity.

Through this research, local grape producers and the wine industry may realize increased profits by having a potential market for sale of grape pomace. Furthermore, the use of compounds such as those found in GPE potentially could help food processors and manufacturers meet increasing consumer demand for natural alternatives to synthetic food additives.

Principal Investigator:

Dr. Yixiang Xu, yixu@vsu.edu

Funding Source:

USDA-NIFA – 1890 Institution Capacity Building Grant





With 'Farm-To-Table' Training,

Dietitians Can Help Clients Eat Healthier

The farm-to-table movement that began more than a decade ago caused local farmers markets to thrive and consumers to pay closer attention to where their food originates. Although the sale of locally grown food benefits small farmers and consumers alike, many of the nearly 90,000 registered dietitians in the U.S. have not received formal training in the local food supply chain from farm to table.

Students enrolled in the dietetics internship program within VSU's Family and Consumer Sciences (FCS) Department complete 1,200 hours of supervised practice in order to meet the Accreditation Council for Education Nutrition and Dietetics' (ACEND) eligibility requirements. The program requires a 40-hour Farm-To-Table rotation within their dietetic internship program. Within the Farm-To-Table rotation, interns learn how to purchase and prepare healthy foods grown and produced locally, which they can share with clients. Interns also learn about the opportunities and challenges local producers encounter in their efforts to grow and sell produce.

In 2017, eight VSU dietetic interns received training about the production and marketing of fresh fruits and vegetables, including superfoods, and to prepare many cost-effective, nutritious recipes. Kierra Wilkins '17 and Meredith Martin '17 were two of the interns. Wilkins is also a VSU '16 graduate, where she completed her bachelor's degree in FACS – DIET concentration.

"The Farm-To-Table rotation encouraged me to research foods that I did not know much about to refer to clients to add variety to their diets. It also gave me knowledge on how to encourage clients to grow their own foods, if possible," Wilkins said. Before completing the rotation, she said she had no idea there were so

many local producers. She thought of farming on a global scale, whereas in reality, most farmers sell closer to home. “I usually shop locally because I like to know where my fresh produce comes from and to keep revenue flowing in my community,” she explained.

Like Wilkins, Martin didn’t have much knowledge about local producers and buying locally before the rotation. “I knew that farmers work really hard and don’t get paid nearly as well as they should. The Farm-To-Table rotation taught me so much about producing and buying locally,” she said. She learned how intensive growing produce is, what mechanisms are used to prevent animals/insects from ruining produce and the marketing aspect of growing locally.

“It was probably my favorite rotation,” Martin said. “As a dietitian it is important to understand all aspects of how we get our food and this rotation did just that—from growing the produce to selling it at the local farmers market.”

The 2017 cohort helped grow, harvest, package and market different crops. They developed four Extension bulletins on superfoods grown at VSU’s Randolph Farm and created five healthy, low-budget recipes that can be used by Virginians on limited incomes and otherwise. “Fruits and vegetables can be rather pricey, so it was eye opening to see all the different recipes we could make at a reasonable price. There are always ways to add fruits and vegetables into your diet,” Martin said.

Practicing dietitians who lack knowledge about the food-to-table process may not encourage clients to include locally grown foods in their diets. “Many times nutrition



students and dietitians give recommendations about fresh fruits and vegetables, but are unaware of the [food-to-table] process,” said Dr. Crystal Wynn, department chair, associate professor and dietetic internship director. “This rotation was designed to increase awareness about all facets of the farm-to-table phenomenon, including planting, harvesting, packaging, culinary and marketing. We hope students gain a greater appreciation for where their food comes from.”



“The Farm-To-Table rotation is important in dietetic training because we often recommend clients to eat more fruits and vegetables, but often [we] do not know how those crops grow or what season they’re harvested in,” Wilkins said. “The rotation gives students knowledge on all aspects of the crops we eat from seed to harvest to market and that’s important to me. It also gives interns insight into another aspect of the field that they can explore career wise.”

“Dietetic interns love the rotation. Alumni are always using it as a tool to recruit future interns. Many have started their own gardens,” said Wynn. Internship graduates have said that the experience has made them more adventurous with foods. Many have shared the health benefits and recipes developed with patients/clients. Moreover, encouraging people to buy local has a positive impact on food access, food security and the viability of small farmers.

Since 2011, 56 VSU dietetic interns have completed the Farm-To-Table rotation. All have completed the credentialing exam and are now registered dietitians. In total, the interns have created 28 superfoods bulletins and 35 healthy, low-cost recipes.



Helping Small Farmers Become Profitable and Sustainable

Small, limited-resource and socially disadvantaged farmers and ranchers in Virginia face several barriers that can make it tough to turn a profit. They may lack skills in farm business and financial planning; knowledge of improved production practices; access to credit and capital, and to existing and viable markets; and knowledge of United States Department of Agriculture (USDA) programs and services.

The Small Farm Outreach Program (SFOP) was created to provide outreach, training and technical assistance designed to give small farmers and ranchers essential tools and skills to make informed decisions in operating profitable and sustainable farm businesses. The SFOP has more than 100 educational offerings, including: farm business planning and financial management workshops; events focused on improved production systems for high-value and profitable crops and livestock; hands-on demonstrations with appropriate small farm tools and equipment; marketing strategies to enhance farm profits; and workshops about USDA programs and services.

In 2017 the SFOP conducted a survey of 1,000 small farmers and ranchers it had provided services to about the program's activities and service offerings. The results were: 77% of respondents indicated that the SFOP has helped them to gain a better understanding of operating and maintaining a small farm; 65% indicated that the knowledge gained from VSU hands-on demonstrations, field days, workshops and other activities has improved their farm business profits; and 51% reported an increase in farm incomes by at least 10% from the previous three years. In addition, 510 small farmers in Virginia who have participated in the SFOP trainings reported a 10% increase in farm income from the previous three years.

Principal Investigator:

William Crutchfield, wcrutchfield@vsu.edu

Funding Source:

USDA-NIFA grant funds



A 'Berry' Good Opportunity

National sales of berries have increased significantly due to the fruits' numerous health benefits. Virginia's climate is well suited to berry production, and small farmers with limited acreages may be able to capitalize on this market opportunity.

The VSU Small Fruits & Vegetables Program is researching almost 60 berry varieties, including 43 of blueberry, 10 of blackberry and four of raspberry to identify which varieties yield the highest quantities and most superior fruit in Virginia. State and federal grants collectively valued at \$720,000 from the Virginia Tobacco Indemnification Community Revitalization Grant and the USDA 1890 Capacity Building Grant, respectively, have been used to train Virginia Cooperative Extension agents statewide to help growers with berry production, food safety and marketing.

VSU Extension specialists and staff are currently working with 55 small farmers in the state who are growing and marketing locally produced berry crops. In the Southside Virginia region, 18 former and current tobacco growers are producing and marketing berry crops. Last year 37 seasonal picker/packer jobs were created in the tobacco region. Those seasonal workers earned a minimum hourly wage of \$10 and were employed for 29 hours per

week for 12 weeks. The seasonal farm workers' gross income was \$128,760.

More than 100 growers and consumers attended the 9th Annual Berry Production & Marketing Conference held last year. In 2017, more than 50 metric tons (30,000 flats comprising 360,000 units of ½ pint clamshell containers) of blackberries and blueberries were produced and marketed locally and regionally. The total wholesale value of berries produced by Virginia Cooperative Extension-trained farmers was \$540,000.

Principal Investigators:

Dr. Reza Rafie, arafie@vsu.edu
Dr. Theresa Nartea, tnartea@vsu.edu
Mr. Chris Mullins, cmullins@vsu.edu

Funding Sources:

Virginia Tobacco Indemnification Community Revitalization Grant
USDA 1890 Capacity Building Grant



Campus Farmers Market Delivers Benefits

Since 1882, VSU has been educating the public about agriculture. Fruits, vegetables, spices, small livestock and fish are grown at Randolph Farm, the university's 416-acre agricultural learning center. It is a well-known fact that consuming fruits and vegetables has a positive impact on one's health. From 2012 to 2016, Farm Stars Entrepreneurship Program interns practiced their marketing skills at Randolph Farm in a farm stand demonstration to gauge employee interest in buying VSU-grown produce. More than 1,100 faculty and staff were informed about the initiative through emails from the provost.



produce. Five campus farmers markets were held from June to October 2017 and were frequented by 350 employees and students.

In total, 600 lbs. of VSU-grown vegetables and 250 lbs. of VSU-grown berries were sold (\$3,200 market value). Students and staff saved \$1,600 in produce purchases. (Farmers market prices were 50% below market value.) This initiative raised the VSU community's awareness of Randolph Farm and the research and Extension projects conducted there. It has also fostered opportunities for cross-campus collaboration in teaching, research and outreach.

Principal Investigators:

Dr. Reza Rafie, arafie@vsu.edu
Dr. Theresa Nartea, tnartea@vsu.edu

In 2017, a campus farmers market was created at VSU to offer students and employees access to fresh, local

Hemp, Hemp, Hooray

Industrial hemp (*Cannabis sativa* L.) is a versatile crop that can be put to multiple industrial applications and has the potential to improve the U.S. economy, and more importantly, that of farming communities. Its fast growth rate helps mitigate climate change by removing and sequestering carbon dioxide in its huge biomass. This crop is able to extract heavy metals from the soil and could be the most environmentally sound and economically viable feedstock compared to alternative crops. The biomass generated finds multiple uses as biofuels, fiber for textiles and the paper industry, and the manufacture of building materials like biodegradable plastic plumbing pipes. Industrial hemp extracts and residual materials have application in pharmaceutical, food, cosmetic, toiletry and the livestock industries.

There is a growing interest to promote legalization of industrial hemp production in the U.S. due to its huge market potential. Virginia State University, Virginia Tech, University of Virginia and James Madison University entered into a memorandum of understanding with the Virginia Department of Agriculture and Consumer Services (VDACS) to grow hemp for research purposes. All three universities are currently conducting industrial hemp research to provide farmers with information that will enable them to grow the crop should it be legalized again.

VSU's industrial hemp research is focused on several agronomic aspects of industrial hemp under climatic and edaphic conditions around Chesterfield, VA. The research group is working on several studies on a number of foreign-developed grain and fiber-type industrial hemp varieties: a nitrogen fertilizer response study; a variety performance evaluation; and a study on optimum planting dates. In 2017, an industrial hemp field day was held at Randolph Farm that drew a sell-out crowd.

Thus far, preliminary results indicate that a number of foreign-developed varieties may have production potential in this part of Virginia. They have also learned that growth responses and yield potentials differ significantly depending on the planting date. In general, early planting (mid-April) leads to poor emergence and low plant populations. Planting in early- and mid-May when soil temperatures are higher resulted in improved plant emergence, increased plant density and a more vibrant and robust crop. Rapid crop growth due to improved conditions led to quick crop canopy establishment, which reduced weed competition for nutrients, water and other resources. This crop showed

a greater potential for high grain and fiber yield. For late planting (early- and late-June), there was greater risk of moisture stress as temperatures rise and precipitation is reduced. Lack of sufficient soil moisture reduced both crop growth and canopy establishment and allowed for increased weed competition.

VSU researchers and colleagues in other Virginia institutions of higher learning are widening their research work in order to determine the economic viability of industrial hemp in the state. Additional work will include studies to gather data on pest and disease infestation and possible remedial measures. Researchers will also explore the economics of production to determine industrial hemp's profitability, market opportunities and potentials, and its competitiveness against established crops that offer similar products.

Principal Investigator:

Dr. Maru K. Kering, mkering@vsu.edu

Funding Source:

Virginia Department of Agriculture and Consumer Services



Taking a Bite Out of the Lamb Market

Virginia producers raise over 89,000 sheep, which equates to more than 2.6 million lbs. of lamb meat each year. Virginia sheep producers face challenges in selling lamb meat directly to mainstream consumers who prefer chicken, beef and pork. Educating consumers on the benefits of regularly eating Virginia-grown lamb can help Virginia's sheep producers be profitable in direct sales market outlets.

In 2017, VSU's Small Ruminant and Marketing & Agribusiness programs collaborated to develop educational materials and conducted multiple demonstrations in Petersburg and Roanoke, Virginia. More than 120 producers, agents and consumers were trained on how to sell Virginia-grown lamb and prepare tasty recipes.

Fifty producers and three Virginia Cooperative Extension agents learned how to display lamb meat. Thirty-six participants who did not eat lamb prior to the tasting events said they would purchase local lamb and would pay up to \$5/lb. for Virginia-grown lamb. More than 120 participants

tried the prepared recipes, including lamb nachos, lamb tacos, lamb sausage and gravy and lamb sliders. These participants said they would consider consuming locally raised lamb rather than chicken, pork and beef.

Additionally, the first VSU-based lamb community supported agriculture (CSA) program was organized. Twenty-one people purchased 151 VSU-raised lamb cuts. The order materials developed for the program now serve as a model for Virginia lamb producers.

Using the CSA and farm stand display marketing techniques they learned, 50 producers estimated they could sell at least \$500 in lamb sales (\$25,000 in total), and thereby increase their existing farm income.

Principal Investigators:

Dr. Dahlia O'Brien, dobrien@vsu.edu

Dr. Theresa Nartea, tnartea@vsu.edu

Ensuring Good Fish Health

There are more than 80,000 farm ponds in Virginia. Many farm pond owners use their ponds for recreational fisheries and cage aquaculture. Specialists within VSU's Aquaculture program provide expertise in fish health, pond management and cage aquaculture to help Virginia farmers ensure their fish stocks are healthy and to create additional revenue-generating opportunities on their farms.

Fish farmers who sell Koi fish and rainbow trout (for consumption and pond stocking) engage with VSU's fish health specialist to test their fish populations for bacteria, parasites and viruses. Ensuring the health of a fish population may be a necessary prerequisite to certify fish for sale across state lines. Farmers save thousands of dollars by being able to have their fish tested at VSU, rather than sending fish samples to a commercial lab. In 2017, a commercial ELISA test was evaluated to test for bacterial kidney disease (BKD) in trout and strengthen the fish health certificate needed for trout inspections.

VSU's aquaculture Extension specialists provide training through workshops, fish schools and field days. Participants learn about good husbandry, how to manage weed problems



in ponds and how to maintain water quality.

Many ponds' water quality parameters are not suitable for sustainable fisheries, so water quality management is key to ensuring a healthy fish population. Farmers also learn tips and tricks for marketing fish sold at farmers markets for consumption.

Farmers can use cage production to raise fish; however, this production method can be difficult because cages need water to circulate in and out of them. At some pond sites, water quality issues can arise due to poor water circulation. The aquaculture Extension specialists teach a cage building workshop and how to integrate an airlift pump to improve water quality in a cage, which in turn leads to higher yields per cage. In particular, rainbow trout, which thrive in temperatures below 65°F are healthier due to the deeper, cooler water being pumped into the cage. The airlift pump system was demonstrated to more than 100 people who attended cage workshops, aquaculture field days, and farm pond management workshops held in 2017.

Principal Investigator:

Dr. David Crosby, dcrosby@vsu.edu

Bah, Bah Blackbelly Sheep



Kristi Burke and her husband Jeff live on an eight-acre farm in Madison County, Virginia. They had a flock of 20 Barbados blackbelly sheep. To care for their flock better, Burke attended workshops on pasture management, integrated methods of parasite control and artificial insemination at VSU.

Sheep are susceptible to internal parasites. “Good pasture management strategies are not only important for small ruminant nutrition, they are also important for internal parasite control,” said Dr. Dahlia O’Brien, small ruminant Extension specialist. “Good pasture management practices, such as maintaining low stocking rates, rotational grazing to manage grazing heights, use of bioactive forages and others can help to control worms, reduce deworming frequency and keep sheep healthy. If a sheep is healthy, it will grow better and be more productive.”

In addition to a good pasture management strategy, two tools for effective parasite control include the use of fecal egg counts and FAMACHA® scores. A fecal egg count is a measure of the parasite load in an animal and is helpful in monitoring the rate of pasture contamination, determining drug resistance and in selecting or culling particular animals. The FAMACHA system is a producer-friendly way of identifying and deworming only those animals showing clinical signs of parasitism. It is an indirect measure of anemia based on the color of the animal’s ocular membrane on a scale of 1–5. A low score (bright red) indicates healthy animals while a high score (pale) indicates severe anemia possibly due to infection with the barber pole worm (bloodsucking and the most devastating internal parasite in sheep and goats). “These tools and others are very important in having an effective parasite control program on producer farms,” O’Brien explained. “This is why we offer a number of programs throughout the year on sustainable methods of parasite control in small ruminants.”

At one of these workshops on pasture management in the fall of 2017, Burke learned about *Lespedeza sericea*, a type of forage with high tannin content that that can be grazed, fed as hay or made into a pelleted feed for effective parasite control in sheep and goats. The tannin makes the digestive tract uninhabitable for

the worms. The Burkes decided they didn't have a sufficient amount of land to do rotational grazing for worm management. However, Burke said, "Learning about lespedeza was one of the best fixes for our little flock and we confirmed that with great FAMACHA scores and very low fecal egg counts. We credit VSU and the communication about different pasture management techniques."

Through her integrated methods of parasite control training at VSU, Burke learned how to collect a fecal sample and count eggs using a specialized slide (McMaster) and microscope in the lab she set up in her basement. She tracked worm count data, which she and her husband used to determine if an animal needed to be dewormed or not. "Dr. O'Brien taught us to think about resistance to the worm population that an animal passes on to its offspring. We were selectively breeding to promote worm resistance in the sheep," she said. "When we looked at the fecal egg counts, we wanted to see very low numbers of worms and those were the animals we used to try to upkeep our flock."

In addition to learning how to do fecal egg counts at this workshop, Burke also received her FAMACHA certification from VSU. Burke explained that with FAMACHA scores, it's important not to deworm the entire flock at once. Only the sheep most in need of deworming (i.e., those with high FAMACHA scores) should be treated; others with some worms (i.e., those with low FAMACHA scores) are not dewormed so they can pass susceptible worm eggs needed to dilute the resistant worm population on pasture. If an entire flock is treated, Burke said the result would be a field of drug-resistant parasite worms, which creates a vicious cycle in which the worms can't be killed. "Dr. O'Brien and Dr. Stephan Wildeus, [Agricultural Research Station researcher] helped us to think through what our goals were, what we could do and what we wanted to do with managing the pasture and managing the worm load on the sheep," she said.

The Burkes have also attended an artificial insemination (AI) workshop and then participated in an on-farm artificial insemination project conducted by Wildeus and O'Brien. Over several years their flock was a test site for a low-input liquid semen vaginal artificial insemination protocol that was established at VSU by Wildeus. Wildeus and O'Brien helped the Burkes develop their skills in vaginal insemination in hair sheep and introduced new genetics into their flock to increase productivity and profitability. "The use of reproductive techniques such as artificial insemination provide a means to transfer genetic material between locations," O'Brien explained. "It also eliminates health concerns associated with the movement of live animals from one farm to the next."

Burke credits VSU's small ruminant program with helping her to care for her flock better. "What I had before was rudimentary knowledge. What I gained from taking the classes at VSU made everything more connected," she said. "I strengthened my understanding of worm resistance and resilience, drug resistance, pasture management in terms of rotation for parasite control, and rotation for growing the pasture for feed." Not only has she used her knowledge for her own sheep, Burke assists with a flock at an Orthodox Christian monastery in Maryland. She helps the nuns check FAMACHA scores and fecal egg counts. She even "trained" a nun visiting from Greece who tends to hundreds of sheep and goats, and makes cheese back home. Burke got the nun a McMaster slide and a precise digital scale so she can do her own fecal egg counts. She remarked, "The knowledge Dr. O'Brien gave me has been shared with these nuns in Maryland and also in Greece."



Photos courtesy of Jeff & Kristi Burke

In the past decade U.S. goat production increased by about one-third due to growing demand for goat meat from specialty markets. Demand is expected to continue to grow as a result of changing demographics. Also, Virginia producers raise over 89,000 sheep in 2017, which equates to more than 2.6 million lbs. of lamb meat. As demand for lamb continues to grow, that figure is expected to climb as well. VSU small ruminant researchers and Extension specialists are dedicated to helping Virginia small ruminant producers profitably and sustainably meet that demand.



Once Popular Forage Shows New Promise

Summer forage shortages (summer slump) and gastrointestinal nematode (GIN) infections impact small ruminant production in Virginia and other southeastern states. Forage shortages may impact animal growth rates and/or make them more susceptible to diseases, thus causing losses in product quantity and quality. Additional losses are also rooted in the prevalence of GIN infections and their resistance to chemical anthelmintics. Additionally, consumer concerns about drug residues in food products have increased demand for forage-based strategies to control parasites affecting small ruminants.

Since feeding usually constitutes the largest proportion of variable costs of livestock production, improving summer forage production is a necessary step for small producers to benefit from the rapidly growing demand for meat goats and related food products in the Mid-Atlantic region. Likewise, the availability of alternative approaches to chemical anthelmintics will enable producers to satisfy the growing consumer preference for animal products from registered/transitional organic farms.

VSU researchers are evaluating the reliability of gamagrass (*Tripsacum dactyloides*) and bio-active forage mixtures to improve profitability of forage-based meat-goat production in Virginia. Gamagrass, which mixes well with other tall-growing forage species, is also less prone to trampling damage caused during grazing. That may be why it was regarded as a high-quality forage crop by early European settlers, before the native stands were grazed out by livestock or otherwise destroyed to open land for row crops. The studies being conducted at VSU are intended to assess how inter-growing gamagrass with bio-active forages such as lespedeza (*Lespedeza cuneata*) and/or chicory (*Cichorium intybus*) may influence the grazing preference and performance of pastured meat goats. Preliminary results indicate a great ability for gamagrass to withstand high stocking densities and regrow quickly during the rest periods.

Principal Investigator:

Dr. Vitalis Temu, vtemu@vsu.edu

Funding Source:

USDA-NIFA – Evans-Allen Formula Funds

Can Stinging Nettle Replace Dewormers

Gastrointestinal parasitic infection and parasites' resistance to common dewormers are a serious problem for goat producers. Producers seek ways to curb economic losses arising from these blood-sucking parasites, especially the common, yet hard-to-eradicate barber's pole worm (*Haemonchus contortus*). High-protein, natural bioactive/anti-parasitic alternative feeds such as stinging nettle can aid small ruminants during barber's pole worm infection. Stinging nettle has been shown to curb anemia and has medicinal properties, including anti-hemorrhagic, anti-inflammatory (stems and leaves), antioxidant, hypocholesterolemic, antiviral, antibacterial, antifungal, anthelmintic, anti-diabetic, and anticancer activities. Stinging nettle is also known to cause worm expulsion from the GI tract.

VSU researchers have explored the effect in meat goats of stinging nettle on inflammatory biomarkers, blood volume/anemia status during infection, cholesterol gene expression, host gastrointestinal repair gene expression and anthelmintic effect on parasite load. Goats were pre-screened for initial parasite load and anemia status and fed a diet of 0%, 25% or 75% of stinging nettle for 52 days. Parasite load and anemia



status were monitored biweekly. Biomarker gene expression was determined via quantitative Real-Time PCR (polymerase chain reaction).

Stinging Nettle reduced ($P < 0.05$) the need for expression of GI repair genes (TFF3); increased ($P < 0.05$) blood volume/PCV; decreased ($P < 0.05$) inflammation; reduced ($P < 0.05$) cholesterol gene expression; and reduced ($P < 0.05$) gastrointestinal parasite load/FEC in the meat goats infected with the barber's pole worm. Further research is needed to isolate and evaluate the natural anthelmintic/bioactive compound in stinging nettle; to evaluate if stinging nettle can reduce cholesterol; and whether there are other potential natural anthelmintic alternative feeds for meat goats. Addressing gastrointestinal infections may help meat goat farmers increase profitability through enhanced herd health.

Principal Investigator:

Dr. Michelle Corley, mcorley@vsu.edu

Funding Source:

USDA-NIFA – Evans-Allen Formula Funds

Healthy Gut, Healthy Animals

Small ruminant producers experience losses mainly due to disease conditions associated with gastrointestinal health, especially in young growing animals. The causative agents involved have not yet been fully characterized, but are thought to be an interaction between microbial and parasitic agents. Identifying microbial and parasitic structures in the gut over time since birth will help to identify the critical periods where interventions are needed; specific pathogen/parasites involved; and changes in beneficial commensal bacteria dynamics over time. This information will be used to advise producers on best management protocols to reduce losses and also advance further research on intervention methods.

Researchers are characterizing beneficial (lactic acid bacteria) and pathogenic microbial diversity in healthy and sick meat goats with gastrointestinal disease using microbial isolation, biochemical and molecular tools. This includes characterizing virulence genes in *E. coli* from healthy and sick animals and determining their antimicrobial resistance profiles and respective antimicrobial gene determinants.

Preliminary results indicate the lactic acid bacteria diversity in the growing meat goat is dynamic, and the predominant populations differ over time as well as between young animals and adults. The researchers' findings also indicate that even in the absence of the use of antibiotics, the developing meat goat gut under pasture is colonized early by *E. coli* resistant to antibiotics. These could serve as reservoirs of antimicrobial resistance genes that potentially could contaminate the environment. How this occurs remains a subject for further research. Additionally, virulence genes in *E. coli* are differentially expressed among age groups and also based on the gut health status in goats.

Researchers plan to further conduct molecular analysis using frozen samples to characterize changes in the microbiome and parasitic diversity over time which gives a broader picture on gut dynamics in health and disease. Future studies will also involve evaluating benefits of supplementation of beneficial microbes to goats and sheep in improving gut health, animal performance and meat quality.

Principal Investigator:

Dr. Eunice Ndegwa, endegwa@vsu.edu

Funding Source:

USDA-NIFA – Evans-Allen Formula Funds





Improving Pasture-Based Lamb

In its comprehensive review of the U.S. sheep industry, the National Research Council identified key ways to improve the sheep industry's competitiveness and efficiency. It found forage-finished lamb and the direct marketing of high quality, lighter-weight lambs to expanding niche and ethnic markets as key ways to improve the sheep industry's competitiveness and efficiency. A report commissioned by the American Sheep Industry Association also indicated that the greatest potential for market expansion lies primarily in non-traditional markets using alternative breeds, such as hair sheep. As a result, VSU researchers evaluated the effect of crossbreeding hair sheep and use of agro-byproduct supplementation in a pasture-based lamb production system on growth rate, lamb fitness and carcass quality and composition.

Grazing trials were conducted at different times of the year using purebred and crossbred (Dorset-sired) landrace hair sheep lambs from Barbados Blackbelly and St. Croix ewes managed under an accelerated lambing system. Lambs rotationally grazed cool and warm season forages dependent on time of year, and were individually supplemented using a Calan feeding system. Under summer grazing conditions soy hull supplementation at 2% of body weight increased growth rate by 130% over pasture-only lambs, and growth rates in crossbred lambs by 24% compared to purebred lambs. During spring grazing of fescue pasture, no differences were observed between soy hull and corn gluten feed supplements, but supplementation increased growth rate by 75% and crossbreeding by 32%. Lambs had lower weights, dressing percentage and loin eye area when removed from soy hull supplementation at 21 intervals before harvest during late fall and winter grazing of stockpiled fescue and annual ryegrass.

Gastrointestinal parasite burden was consistently reduced in supplemented lambs, but differences between purebred and crossbred lambs were found only during seasonal peaks of pasture infectivity. Consumer taste testing indicated that pasture-only, crossbred ground lamb was rated least desirable. Fatty acid profiles in fat depots from pasture-only lambs were considered healthier than those of supplemented lambs. Findings from this project will be used to design a system of semi-continuous lamb production on pasture, using warm and cool season annual and perennial forages. Lambs will be produced under accelerated mating using a dual ewe flock system lambing in four-month intervals, and lambs placed into grower flock for continuous harvest at designated target weights.

Principal Investigator:

Dr. Stephan Wildeus, swildeus@vsu.edu

Funding Source:

USDA-NIFA – 1890 Institution Capacity Building Grant

High Protein Diet Shows Dual Benefits in Goat Meats

Nutrition and parasites play a special and essential role in meat goat production. Meat goats' nutritional status is influenced by diet protein level and infection by the gastrointestinal parasites, of which barber's pole worm (*Haemonchus contortus*) is the most important. Feed costs incurred to provide necessary nutrients in the feedstuffs goats consume is the major expense in meat goat production.

The effects of protein nutrition and its interaction with parasite infection and meat quality have been studied less in goats than in sheep. Yet goats are more susceptible to parasitism than sheep because natural resistance develops later in life. Improvement in protein nutrition can enhance an immunologic ability to regulate the parasite population and its negative effects while maintaining reasonable levels of production.

Research was conducted with intact male bucks to study the effects of parasite challenge and diet protein level on animal clinical parameters, performance and meat quality. The study results showed that dietary protein levels influenced the establishment of barber's pole worm in growing meat goats. Higher protein levels improved the animals' resistance and resilience and also enabled the goats to cope with some of the undesirable consequences of parasitism such as loss of weight and lowered animal performance. By contrast, a low-protein diet made the animal more vulnerable to the worm infection and adversely affected its performance. Meat quality traits like crude protein, fat content and meat tenderness remained unchanged, which is important considering the contribution of fat and protein to the nutritional value of meat. Such an effect could be significant in field conditions, where suboptimal nutrition commonly occurs.

Improving resistance and resilience against GI parasitism through supplemental dietary protein could improve production performance against protein deficit animals. Future research will explore the role of feed energy level together with dietary protein levels and possible interactions on animal performance and meat quality characteristics in a larger population of meat goats and sheep. Further research should also include the impact on lifetime productivity.

Principal Investigator:

Dr. Adnan Yousuf, ayousuf@vsu.edu

Funding Source:

USDA-NIFA – Evans-Allen Formula Funds





Tackling the Scourge of the Invasive Weed *Parthenium* in Ethiopia

Workitu Eirgu and her husband Tekele Bekele live in Welenchiti in central Ethiopia with their seven children. The family grows teff, beans, sorghum and maize on 1.25 acres of land. Among many familial and household responsibilities, Eirgu hand weeds her garden to grow vegetables to sell at local markets to earn income. Weeding is onerous because of the noxious weed parthenium (*Parthenium hysterophorus* L.), which grows several times during the rainy season and must be weeded many times.

“Parthenium affects my farm and my family, especially during the wet season, when it invades the farmland, grazing land and our homestead. During this time all family members work on the farm to clear the weed using hand weeding,” Eirgu said. “Parthenium is a dangerous pest.” The invasive weed makes it harder for crops to grow and also taints cows’ milk when they feed on it, consequently reducing its market value. When the infestation is high, families must recruit labor for 100–150 Birr (USD \$4–6) per day for 10–15 days each year. It’s an expense local families can barely afford.

Since parthenium arrived in Ethiopia and other Sub-Saharan African countries in the mid-1970s, it has wreaked havoc. It displaces all native plants, grasses and broadleaf plants and becomes the only viable plant species. There are no natural enemies in Africa to thwart the spread of parthenium. The Parthenium Project, led by Virginia State University (VSU) and funded by the U.S. Agency for International Development (USAID) through the Integrated Pest Management Innovation Lab (IPM–IL) at Virginia Tech, has introduced two of parthenium’s natural enemies—a leaf-feeding beetle (*Zygogramma bicolorata*) and a stem-boring weevil (*Listronotus setosipennis*)—in Ethiopia to abate the spread. Dr. Wondimagegnehu Mersie, associate dean and director of research with VSU’s Agricultural Research Station, said he undertook this project

because “I felt I could make a contribution towards the effort in abating the spread and reducing the impact of this invasive weed.”

The adult beetle and its larvae feed on the parthenium leaves and defoliate it. Repeated defoliation by several beetles weakens parthenium and allows the natural vegetation to come back. In contrast, the weevil kills it from the inside. The adult weevil lays its eggs on the parthenium flower and the larvae that hatch enter the stem to feed. Five or six larvae feeding inside the stem can kill a parthenium plant. The beetle has been effectively deployed against parthenium in Australia and India for more than 30 years, and in South Africa for five years, with no reported damage to any other plant. Similarly, the weevil has been released in Australia and South Africa to control parthenium without any reported damage to other plant species. The beetle and the weevil are now reared and being released throughout Ethiopia.

On August 2, 2017, Parthenium Project staff members released 200 adult weevils around Eirgu’s house and 500 adult beetles on nearby land that was also afflicted. When the staff returned to Eirgu’s property on September 18, 2017, to evaluate the conditions of the insects and parthenium, they found the beetle growing on parthenium plants far from the release site. The grass and broadleaf plants had also come back vigorously after the parthenium was weakened by the defoliation. At the nearby homestead, most of the parthenium was either dead or wilting as a result of weevil damage.

“The results of the project will enable them [local residents] to devote their time to more productive activities than weeding this plant, allow them to have milk free of the chemicals that come from parthenium and increase the yields of food crops that are being reduced by competition from this weed,” said Mersie. “The project will improve the lives of farmers and rural communities.

Neither bio-agent needs to be reintroduced every year at Eirgu’s homestead; they will reemerge and start to control parthenium with no cost to her. Both bio-agents spend the dry season in the soil but reemerge during the rainy season and begin feeding on parthenium when it begins to grow again. “Before I started working with this project, I use to clear my homestead every time [parthenium grew] After the bio-agents, the density of parthenium was significantly reduced, so I saved my time and energy by not having to hand weed as frequently,” she said. “My family’s gotten relief because the population of parthenium is not like before.”

Eirgu said her neighbors have also benefited from this project as the beetles have moved from her homestead to theirs. Neighbors have observed reduced parthenium density after the bio-agents were released. “The future looks brighter for me and my family because when the density of parthenium is reduced, our yield improves,” Eirgu said. “I have seen some improvement after the release of the bio-agents. In the future, we will use this bio-agent on our farmland and we will save time, energy and the money we spend to hire labor.”

Once established in an area, the bio-agents will provide long-term sustainable control of parthenium with no cost to farmers, but the effort that began at Welenchiti needs to be repeated in all parthenium-infested regions of Ethiopia.



Craft Beer Industry Fuels Local Hops Demand

A growing craft beer industry in Virginia and the Mid-Atlantic has created opportunities for farmers to supply ingredients used in brewing. Among them, hops (*Humulus lupulus*) (used for bittering and aroma in beer) has attracted the most attention. Growers are seeking research-based information on varieties suited to the region, agronomic practices, including pest and disease management, and postharvest handling of the crop. Similarly, brewers require reliable data on quality and chemistry of locally grown hops.

Researchers at VSU have built a research hop yard and established experiments to: evaluate different hop varieties; determine nutrient and irrigation requirements; observe pest and disease interactions under Virginia conditions. A multi-location evaluation of five popular varieties (involving two cooperating farms) is also underway, and the program is working to establish a statewide pest and disease forecasting system.

The research hop yard has attracted significant stakeholder interest and support, hosting more than 500 visitors since it began operation two years ago. Linkages with growers have been established to leverage resources in support of the hops industry. Critical data have been collected on

varietal performance and pest/disease interactions. Further research is needed to identify hops varieties that can be grown by farmers in the mid-Atlantic. There is also a need to define agronomic benchmarks for the region, to recommend interventions for dealing with common pests and diseases and to identify cost-effective postharvest handling solutions for small growers.

Principal Investigator:

Dr. Laban Rutto, lrutto@vsu.edu

Funding Sources:

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USDA-NIFA through the Virginia Department of Agriculture and Consumer Services
1890 Institution Capacity Building Grant



A New Plant Fertilizer

Phosphorus and nitrogen, which enrich algae growth, negatively impact the aquatic environment. Confined animal feeding operations (CAFOs), application of animal manure and chemical fertilizer on agricultural land, and municipal as well as industrial wastewaters are the main contributors to eutrophication, or the excessive richness of nutrients, of surface waters, estuaries and lakes. This problem is commonly resolved by removing these nutrients on-site through the treatment of wastewater from high-volume fish producers, CAFOs, and domestic septic systems in rural homes.

Dittmarite is a colorless mineral containing hydrogen, magnesium, nitrogen, oxygen and phosphorus that is recovered from wastewater or synthesized from off-the-shelf chemicals. Researchers investigated dittmarite as a potential source of phosphorus, nitrogen and magnesium fertilizer in a greenhouse study using sorghum as a test crop. Plants were grown under optimum conditions with humidity control. Plants were watered as needed after soil moisture determination. Dittmarite was compared with a 10-10-10 fertilizer to supply these macronutrients to the plant. Until now, limited research had been conducted to evaluate dittmarite as a fertilizer

additive, although several studies have shown promising results for struvite, the hexahydrate form of dittmarite.

Laboratory solubility tests indicated that dittmarite is more soluble than commercial 10-10-10 fertilizer. There were no significant differences in plant dry matter production or total phosphorus uptake at greenhouse conditions, and both dittmarite and the 10-10-10 fertilizer performed similarly. However, micronutrients may need to be supplied to ascertain that there are no “hidden hunger effects” during the growth period. These findings support previous research showing that waste products like dittmarite are effective fertilizer sources, and also provide evidence that dittmarite may have economic value to farmers as a value-added nutrient supplement to commercial fertilizers.

Principal Investigator:

Dr. Asmare Atalay, aatalay@vsu.edu

Funding Source:

USDA-NIFA 1890 Institution Capacity Building Grant

Corn and Soy Growers May Stop Sweating the Heat

Many crops are experiencing heat stress caused by rising global temperatures, which can result in lower crop yields. With the first 17 years of this century being the hottest on record since 1880 when modern recordkeeping began, staple crops are under increasing threat, especially during summer's elevated temperatures. Genetic improvement for heat tolerance among staple crops will be critical to sustainable agricultural production in the coming years.

Researchers at VSU are investigating ways to help crops better tolerate extreme temperatures. They are focused on purslane (*Portulaca oleracea*), a xerophyte adapted to many hostile environments, including very hot climates. Researchers conducted a comparative genomic study of purslane in an effort to identify novel genes for crop heat tolerance improvement. A potential candidate, HTP1 (for Heat Tolerance Phenotype 1, now renamed as PoBAG6), a homologous gene associated with programmed cell death was highly expressed in response to heat stress. Researchers successfully cloned the full-length cDNA from purslane and consistently overexpressed it in *Arabidopsis thaliana*. Independent transgenic *Arabidopsis* plants showed significant heat tolerance at the vegetative, and reproductive growth stages.

The confirmed strong heat tolerance phenotype in *Arabidopsis* makes the purslane PoBAG6 gene a great candidate for use in improvement of crop tolerance to heat stress. The novel gene PoBAG6 from purslane may provide a new strategy to improve crop heat tolerance. Mechanisms of PoBAG6-mediated heat tolerance will deepen our knowledge regarding how plants defend against heat stress. Unique species like purslane hold great potential as sources of novel genes that can be used to improve heat tolerance or other abiotic stress tolerance in crops.

Researchers will transfer the PoHTP1 gene into corn and soybean to see if it can be used to improve heat tolerance in both monocot and dicot crops. There is also a plan to use transcriptome analysis to elucidate mechanisms responsible for BAG6-mediated heat tolerance in plants.

Principal Investigator:

Dr. Shuxin Ren, sren@vsu.edu

Funding Sources:

USDA-NIFA – Evans-Allen Formula Funds

USDA-AFRI – USDA Foundational Program

VSU Research Helps Feed the World

Feed the Future (FTF), the U.S. government's global hunger and food security initiative, aims to sustainably reduce global poverty and hunger. Guatemala is one of FTF's candidate countries. Through its pigeonpea (*Cajanus cajan* L.) breeding program, VSU is helping to alleviate hunger and improve food production in Guatemala. Pigeonpea (known locally as "gandule") has a long history of production in Guatemala; however, the country's pigeonpea yield level is quite low (approximately 400 pounds/acre).

VSU provided 100 pigeonpea breeding lines to its field crop cooperator in Guatemala. These lines were planted at three locations in the country during 2015 and 2016 to identify high-yielding lines for commercial production. This project has been successful. One breeding line (Line number 1), when grown in the Petén region, yielded approximately 2,100 pounds per acre. This entry was multiplied in 2016 and 2017 in Guatemala in order to distribute seed to all

interested farmers with the assistance of the Guatemalan Ministry of Agriculture. The program's success has sparked the need for further research to further increase pigeonpea yields in Guatemala.

Principal Investigator:

Dr. Harbans L. Bhardwaj, hbhardwaj@vsu.edu

Funding Source:

USDA-Foreign Agricultural Service – Scientific Cooperation Research Program



Extending the Shelflife of Edamame

Americans annually consume approximately 25,000 to 30,000 tons of edamame, most of which is imported frozen from Asia. The 2014 market for edamame was valued at approximately \$175 to \$200 million.

But restaurants and wholesale outlets prefer to purchase fresh edamame. The legume has been labeled a “superfood,” which has contributed to its rise in popularity and created a potential niche market for small-scale producers. A small amount of the crop is produced in the West and Upper Midwest regions of the U.S. It is a promising cash crop for Virginia farmers too. However, edamame has a narrow harvest window, a short shelf life and is highly perishable, which can hinder further commercialization.

In an effort to prolong post-harvest shelf life and minimize the physicochemical and microbial deterioration that causes degradation of its color, texture and flavor, researchers at VSU have developed three edamame cultivars that are suitable to Virginia growing conditions (Asmara, Owens and Randolph), which have been registered with the United States Department of Agriculture (USDA). Researchers investigated the use of the combination of steam blanching, vacuum packaging and

cold storage for prolonging the physical and microbiological quality of edamame.

Steam blanching for 30 seconds at 90°C did not significantly change the hardness of the whole pod, though the green color intensity of edamame significantly increased by 32%. Steam blanching of whole pods significantly reduced the total counts of aerobic mesophiles ($> 5.1 \log \text{CFU/g}$), yeasts and molds ($> 4.3 \log \text{CFU/g}$), and psychrotrophs ($> 4.0 \log \text{CFU/g}$), with no significant increase in overall microbial counts during 4°C refrigeration for nine days. Overall, use of the combination treatment showed consistent and significant reduction of microbial counts with no significant effects on physical quality. The results of this research bring edamame one step closer to being a viable profitable crop for Virginia’s small farmers.

Principal Investigator:

Dr. Chyer Kim, ckim@vsu.edu

Funding Source:

USDA NIFA – Evans-Allen Formula Funds



Transitioning from Tobacco to Edamame in Southside VA

Farmers in parts of Southside Virginia who used to rely on tobacco as a cash crop before the quota buyout of 2004 are still struggling to identify an alternative lucrative crop. Small, limited-resource farmers in particular struggle because they lack the acreage and resources to grow corn and soybean for the grain market.

VSU, with support from the Virginia Tobacco Region Revitalization Commission (TRRC), has been working to develop edamame-based agribusiness as an alternative to tobacco in affected counties. More than \$250,000 from the Virginia Tobacco Region Revitalization Commission has been invested in edamame harvesting and processing equipment and facilities to be used by small farmers. The project recently purchased two ASA-Lift CB1000 harvesters whose versatility will facilitate recovery of not only edamame, but also Lima, butter and string beans. Researchers are also working with partners to explore opportunities for value-addition and to develop a market for secondary products.

More than 30 small, limited-resource and socially disadvantaged farmers have participated in the project over

the last six years. Moreover, more than 100 stakeholders have been reached through field days and other public education events. VSU researchers have established connections with state, non-profit and private sector entities to develop edamame-based agribusinesses in Southside Virginia. Extensive efforts have been undertaken to establish a market and consumer base for edamame in the region.

Further research is needed to overcome challenges with managing harvest, postharvest and marketing logistics to ensure that growers can deliver high-quality fresh products to consumers. Researchers are working with other stakeholders, including the Virginia Department of Corrections, to explore various postharvest handling approaches such as flash freezing to extend shelf life.

Principal Investigator:

Dr. Laban Rutto, lrutto@vsu.edu

Funding Source:

Virginia Tobacco Region Revitalization Commission

Breeding a Better Edamame Variety

VSU has established a vegetable soybean (edamame) research program, exploring its potential as an alternative cash crop for former tobacco farmers in Virginia. Researchers have developed three varieties that are suited to growing conditions in Southside Virginia: Asmara, Owens and Randolph. They've also tested the cultivars with farmers in the region.

Marketing edamame is a challenge because of its short harvest window and shelf life. For this reason researchers have investigated extending the harvest period by identifying varieties that can be grown in multiple seasons. Additionally, due to some unsatisfactory traits like small seed size, researchers are continuing to improve the genetics of edamame through breeding and selection. Conventional food-grade specialty soybeans have also been integrated into the research program.

Re-selection of individual plants and breeding lines has been performed for three years. In 2015–2016, hundreds of breeding lines were evaluated for agronomic performance, yield and nutrients (seed protein and oil). Based on that initial research, promising lines were selected for further purification and seed multiplication. Unique edamame and specialty soybean genotypes were introduced, and new crosses were made to develop segregating/breeding populations for selection. Researchers have collaborated with the USDA Agricultural Research Service (USDA-ARS) to plant the United Soybean Board Diversity Trials. VSU also co-organized and hosted the Southern Soybean Breeders Tour in 2016. In 2017, research efforts focused on evaluation, seed purification and increase of superior lines. It is hoped new, superior cultivars and elite germplasm lines can be released in the next few years.

To meet the need for superior varieties, future research will focus on: (1) evaluation and selection of breeding lines for yield and quality characteristics of edamame and grain; (2) further purification and increase of superior lines/varieties for release; and (3) development of breeding populations integrated with high yield potential and high-quality traits for edamame and specialty/food-type uses. Additionally, research is needed on postharvest processing, storage and marketing of edamame and specialty soybeans.

Principal Investigator:

Dr. Guo-Liang Jiang, gjiang@vsu.edu

Funding Sources:

USDA-NIFA – Evans-Allen Formula Funds

USDA-NIFA – 1890 Institution Capacity Building Grant



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