

IMPACTS 2015

Agricultural Research Station

Virginia State University



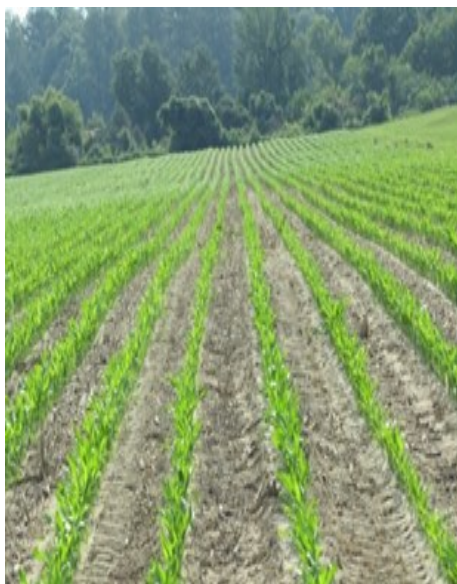
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This report was compiled and edited by Roz Stein.

Contents

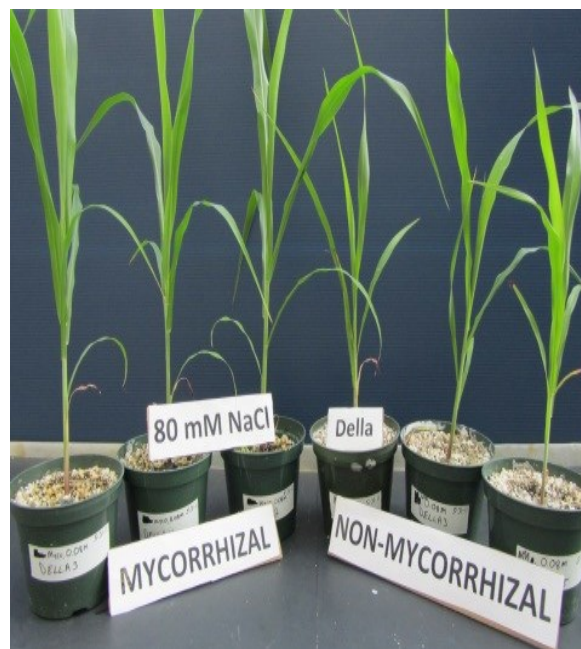
Atalay, Asmare	Salt and drought tolerance of mycorrhizal sorghum	3
Bhardwaj, Harbans	Sesame as new crop for Virginia farmers	4
Corley, Michelle	Interaction of diet, molecular genetics, and immune health in the production of omega-chevon	5
Kering, Maru	Edamame early-season production: plastic covered soil promotes growth and increases yield	6
Kraemer, Mark	Alternative pollinators for fruit trees	7
Ren, Shuxin	Arsenic transport in purslane is controlled by ABCC2	8
Rutto, Laban	Edamame to the rescue?	9
Temu, Vitalis	A potential dual-purpose crop for Virginia	10
Wildeus, Stephan	Using agro-byproducts to improve growth of forage-fed hair sheep	11
Xu, Yixiang	Getting on the hummus bandwagon	12
Yousuf, Adnan	Using sorghum stover as feed for small ruminants	13

Salt and drought tolerance of mycorrhizal sorghum



Who cares and why? Sorghum is an important crop, especially in the semiarid tropical countries of Asia and Africa, where it is raised both as a cash crop and as a staple food source. In 2010, worldwide production of sorghum exceeded 556 million tons; the United States produced the most sorghum at 9.7 million tons, and 15 other countries produce a substantial amount of sorghum, including Nigeria, India, Sudan, Ethiopia, Australia, Brazil, and China. Although the U.S. exports most of its sorghum, many developing countries consume their entire crop internally. Sorghum is used to make many foods, such as bread, syrup, cake, cuscus, tortilla, cereal, porridge, etc., and the U.S. has recently begun exploring its value as a source of green energy for the production of gasohol. There is a great deal of potential for farmers in southeast Virginia to invest in sorghum production both for human consumption (as a gluten-free crop) and for animal feed.

What has the project done so far? Virginia State University (VSU) agronomists have been exploring the interaction between soil fungi and sorghum plants, which resulted in a “fungus-root” mass termed mycorrhizae. There is a physiological specificity among fungi and plant species during mycorrhizal formation. Greenhouse studies were performed to explore the formation of mycorrhizae and to test the level of salt and drought tolerance in the plants. The symbiotic relationship between soil fungi and sorghum roots, which results in mycorrhizae, benefits both the plant and the fungus. The presence of mycorrhizae in the roots of sorghum plants helps them adapt more readily to dry and salty environments by increasing the surface area of the roots. Likewise, the fungus also benefits from gaining access to the sugar that the plant produces through photosynthesis.



What research is needed? More research is needed to explore the extent to which sorghum benefits from the presence of mycorrhizae. Research projects should explore the benefits of sorghum mycorrhizae to farmers in Virginia and the means through which farmers can take advantage of these benefits.

This project was supported through Evans-Allen funds, 2010-2014.

Impacts

Research showed that the mycorrhizae that formed in sorghum plants helped the plants tolerate salt concentrations up to 200 mg/L. In fact, low levels of salt (80 ppm) had a stimulating effect in sorghum growth regardless of inoculation. Demonstration plots have shown that sorghum grows well in Mid-Atlantic regions, but better growths were observed in mycorrhizal than in non-mycorrhizal plots, with increased yield obtained in inoculated fields.

Want to know more?

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Sesame as a new crop for Virginia farmers

Who cares and why? The American agricultural system is in need of diversification of cropping systems after traditionally relying heavily upon a few crops. In Virginia and the other Southern states, the loss of tobacco as a cash crop has caused disruption in the local economy. Sesame (*Sesamum indicum* L.) provides a potential option for producers interested in diversifying. It is one of the oldest crops known to humans, with sesame seeds being a source of food and oil through the ages. The world's sesame seed trade recently surpassed one million tons per year and was valued at approximately \$850 million.



International demand for sesame continues to grow; in the last 15 years, world trade in sesame has increased by nearly 80%. About 65% of the world's annual sesame crop is processed into oil, and the remaining 35% is used in food. The U.S. imports more sesame than it grows; 2010 imports were valued at \$69.9 million. Considerable demand for sesame exists in Virginia: Sabra Dipping Company, with a plant located in Colonial Heights, needs sesame for its hummus production and currently imports sesame from overseas. The VSU New Crops Program is exploring sesame as a potential crop for Virginia farmers.

What has the project done so far? Research conducted at VSU with improved, proprietary sesame cultivars has indicated that sesame has the potential to be easily produced as a commercial crop in Virginia. Sesame seed yields in Virginia varied from about 870 to 1496 pounds per acre, depending on planting time. The highest seed yields were obtained using close row spacing and early plantings.

What research is needed? Research is needed to identify optimal planting dates, as well as the optimal plant population, for Virginia. Producers need additional information on weed management and fertilizer needs for growing sesame in Virginia.

This project was supported by a grant from the Virginia Tobacco Indemnification and Community Revitalization Commission, 2013-2016.

Impact

- Identified a sesame production system for Virginia
- Demonstrated that sesame can be grown in Virginia and that yield is highest using early plantings and close row spacing
- Concentration of oil in sesame seed has been about 46 percent; oil content in Virginia has been higher than that of sesame produced in Texas

Want to know more?

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Interaction of diet, molecular genetics, and immune health in the production of omega-chevon

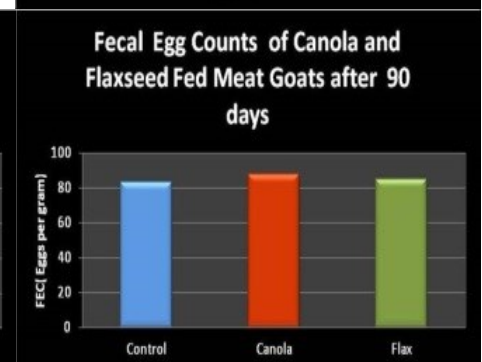
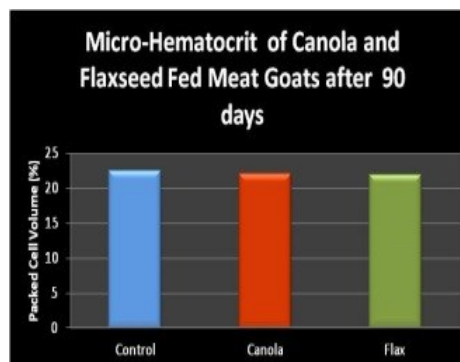
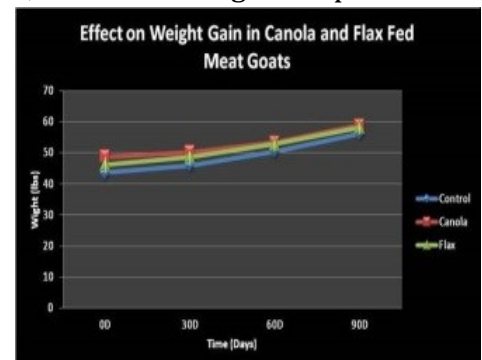
Who cares and why? Virginia meat goat farmers contribute 3% to the total U.S. market for goat meat, also known as chevon. World-wide, demand for goat meat exceeds supply, and most chevon in the U.S. is imported. Given the growing concerns about human obesity and cardiovascular disease, the meat industry has been forced to consider the issue of fat content in meat products, which has increased as a result of genetic selection for rapid feed conversion and growth. One way to address these concerns may be by increasing the amount of omega-3 and -6 fatty acids in meat. Chevon is generally lower in fat and cholesterol than beef, and an increase in the levels of omega-3 and -6 fatty acids may make it a truly heart-healthy meat. Developing an industry that produces enhanced heart-healthy meat for human consumption will improve the economics of meat goat production in Virginia.



What has the project done so far? Scientists at VSU have fed goats a diet supplemented with canola and flaxseed, both of which are high in omega-3 and -6 fatty acids. Scientists are analyzing the blood, serum, and meat of goats to determine levels of omega fatty acid and cholesterol, as well as the gene expression.

What research is needed? Research is needed to examine the effect that a diet supplemented with flaxseed and canola seed has on the serum and meat fatty acid profile, as well as on total and fractions of cholesterol in goat meat. Additionally, research should explore the effects that this diet might have on goats' immune response to natural gastrointestinal nematode infection. The genomic proteomic and metabolomic expression of genes that regulate immunity, fatty acid profile, and cholesterol biosynthesis also needs further investigation.

This project was supported with Evans-Allen funds and runs from 2012-2015.



Impacts

Initial data show no issues related to palatability, average daily gain, or general health for meat goats given feed supplemented with canola and flaxseed.

Want to know more?

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Edamame early-season production: plastic-covered soil promotes growth and increases yield

Who cares and why? Virginia agribusiness has experienced economic turmoil as a result of the 2005 mandate to end the federal tobacco price support program. Vegetable soybean (edamame) is an ideal substitute for tobacco because it can be grown by the same methods as grain-type soybean, but marketed as a high-value vegetable crop. Domestic demand for edamame has increased because of its health benefits, which include contributing to a decrease in levels of total and bad cholesterol. Most edamame sales in the U.S. market are of frozen product imported from China and Taiwan, but, because the quality of frozen edamame quickly drops in storage, many consumers prefer fresh produce. The local fresh edamame supply, however, only lasts a few days each year due to the short harvest window. To meet increased demand for edamame, researchers need to identify production systems that ensure a sustained supply over an extended period so that farmers can capture higher market prices during times when supplies are low.



Figure A

What has the project done so far? Researchers at VSU are investigating four released edamame varieties of different maturity groups. These varieties are sown in greenhouses and transplanted into high tunnels and plastic-covered plots in spring, from early April to June. The crop is also established in the field from seeds that are directly sown. Due to low soil temperatures early in the season, crop from seeds drilled directly into non-plastic-covered plots (Figure A) showed poor growth performance when compared to crop from seedling transplants established in plastic-covered seed beds (Figure B). Because the plots were planted on the same day, it is expected that total pod yield and marketable pods will be significantly higher for crop from those seedlings established in a covered seed bed.



Figure B

What research is needed? Further research is needed to determine the optimal varieties and methods for growing, and for lengthening the growing season of, edamame in Virginia. Additionally, researchers must explore the best methods for storing the fresh crop.

Funding for this project came from a Southern Sustainable Agriculture Research and Education grant.

Impacts

- Determined that the seeds started in greenhouses and planted in high tunnels show better growth performance than those directly sown into uncovered plots
- The findings of this project will help farmers optimize profits from extended edamame production in the Mid-Atlantic region.

Want to know more?

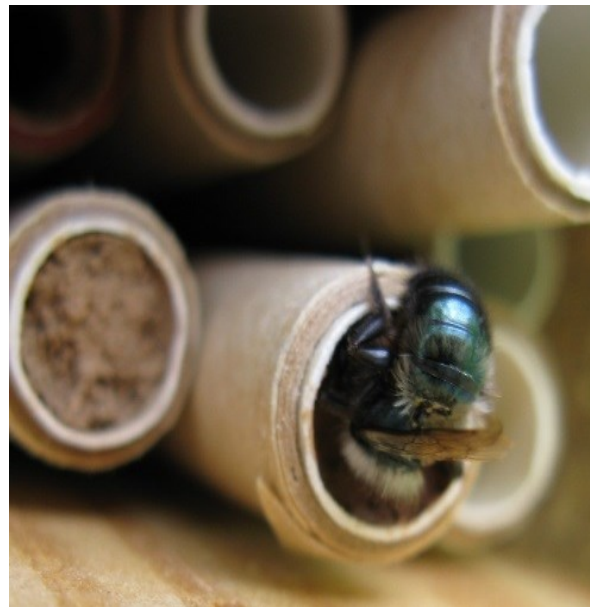
Dr. Maru Kering, mkering@vsu.edu

Alternative pollinators for fruit trees

Who cares and why? Crop pollination in the U.S. is valued at nearly \$10 billion, with Virginia apple crops alone valued at \$35 million. Overreliance on a single pollinator species, the European honey bee, puts these crops at risk. Honey bees have many threats from parasites, predators, diseases, and disorders. To enhance diversity and food security, we need to learn more about alternative pollinators, especially those that could be managed for spring fruit pollination.

What has the project done so far? Scientists at VSU have studied the biology and natural history of a native bee, *Osmia lignaria* Say, commonly known as the blue orchard bee.

Because these bees nest in cavities rather than within the soil, they are easily managed and transported to orchards using artificial shelters provided with nesting tubes. Bee populations were established within 5 orchards in North Carolina and Virginia. Nesting behavior, emergence dates, pollen preference, and potential pests were determined. Bee populations increased up to several-fold per year. There were only a few significant parasites, most of which could be controlled by using cardboard tubes thick enough to prevent parasitoids from penetrating and by providing fresh nesting material each year. The most serious pest was a metallic-green colored wasp (*Chrysura kyrae*) that sneaks into a nest tube and lays an egg on the pollen provisions while the mother bee is off foraging.



The blue orchard bee has only one generation per year, with adults emerging in early spring. The greatest nest building activity occurred during apple bloom. However, emergence was a week or two earlier than apple bloom and was in close synchrony with the bloom of the Eastern redbud tree (*Cercis Canadensis* L.). When present, blue orchard bees collected pollen from this tree in preference to orchard pollen. Thus, the presence of this common understory tree within 600 meters of an orchard would likely reduce orchard pollination. Redbud may, however, be used to increase bee populations in the commercial rearing of the blue orchard bee for later use in orchards.



What research is needed? Nesting cues and control of *C. kyrae* need to be studied. The related Japanese bee, *Osmia cornifrons* L., should be investigated for use where Eastern redbud is common.

This project was supported by a USDA Capacity Building Grant, 2008-2012.

Impacts

- Determined the potential of *O. lignaria* for pollination of Eastern apple orchards
- Established the natural history of *O. lignaria* in the Mid-Atlantic region with respect to its use as an orchard pollinator

Want to know more?

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Arsenic transport in purslane is controlled by ABCC2

Who cares and why? Arsenic is an extremely toxic metal that causes serious health problems to people worldwide. High levels of arsenic in soils can potentially lead to water and food contamination. Arsenic is carcinogenic, and exposure through drinking water, foods, or other sources can lead to various types of cancer, including cancer of the skin, lung, bladder and prostate. Although low concentrations of arsenic exist naturally in soil, its widespread uses as an herbicide, as an insecticide and in wood preservation have led to dangerous concentrations in many areas in the U.S. The Environmental Protection Agency reports that about 25% of wells in the U.S. contain amounts of arsenic that are higher than the levels allowed by that agency. Arsenic contamination is a local issue, too, occurring throughout Virginia, including in populated areas like Richmond. Removal of arsenic-contaminated soil from the environment will help clear the contaminant from our food supply, thus benefiting human health.

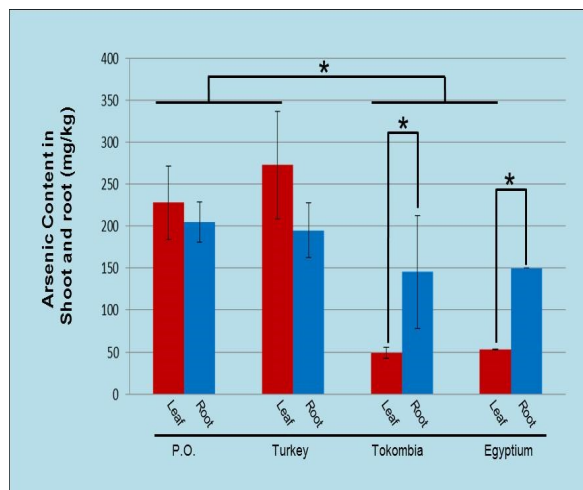
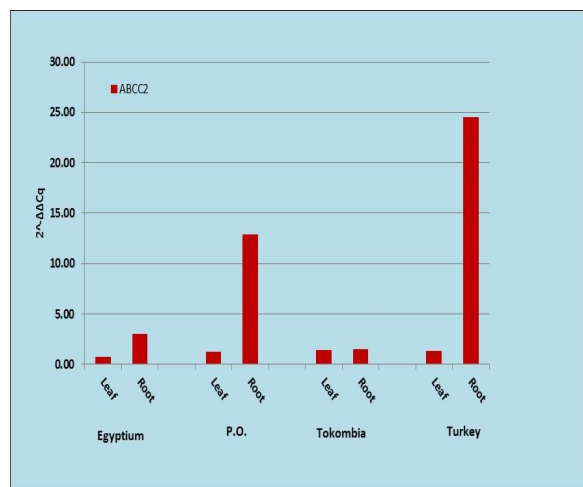
What has the project done so far? Researchers at VSU have identified a novel gene responsible for arsenic transport in purslane. In previous work, they identified two purslane accessions with tolerance to arsenic and two accessions that show sensitivity to arsenic. Building on that, the VSU team has found that tolerant accessions have a significantly reduced ability to transport arsenic to their shoots. Using the genomic approach, scientists have identified a multidrug-resistant gene, ABCC2, the expression of which is highly inducible by arsenic in the roots of arsenic-sensitive purslane accessions, but not in the roots of arsenic-tolerant accessions, indicating that ABCC2 acts to control arsenic transport in plants. Understanding how arsenic is transported to shoots may lead to genetic engineering that will improve arsenic accumulation in purslane, and thus the plant's potential for use in cleaning arsenic-contaminated soil. Cost-effective removal of arsenic from contaminated soil will benefit farmers and agriculture on local and international levels by making more clean and arable land available for agricultural production, especially in urban areas.

What research is needed? Further research is needed to determine the effectiveness of using purslane in cleaning soils with different levels of arsenic contamination.

This project was supported by the USDA-NIFA Evans-Allen Program.

Impacts

- Identified two arsenic-tolerant purslane genotypes
- Identified the gene responsible for arsenic transport in plants
- These findings have the potential to contribute to developing methods for cost-effective removal of arsenic from soil.



Want to know more?

Dr. Shuxin Ren, sren@vsu.edu

Edamame to the rescue?

Who cares and why? Since the peanut and tobacco quota buyouts of 2002 and 2004, farmers in Southside Virginia and the southwestern part of the state have experienced loss of income and cropland. In the search for alternative crops to replace the two former mainstays of Virginia agriculture, researchers at Virginia State University (VSU) have identified vegetable soybean (edamame) as a potentially profitable option for former tobacco farmers. Unlike commodity soybean, edamame is harvested green and marketed as a specialty vegetable. Similar to tobacco in that it lends itself to intensive cultivation in small holdings, edamame can, with proper marketing, emerge as a lucrative cash crop. For example, sales have averaged \$2 per pound of fresh in-the-pod edamame, and one grower was able to sell half-pound packs of shelled edamame for \$6.

What has the project done so far? With support from the Virginia Tobacco Commission, VSU is working with Southside growers to commercialize three edamame varieties developed by the Soybean Breeding Program at the VSU Agriculture Research Station. So far, 25 growers have been contracted to grow and market edamame. The project has purchased harvesting and processing equipment and set up a centralized processing facility in Farmville, Va. VSU Cooperative Extension continues to provide marketing support.



What research is needed? Edamame has a short harvest window and limited shelf life. So far, the biggest challenges to growers have been coordinating a timely harvest of all fields and processing/delivering the crop to market before spoilage occurs. To address these problems, VSU researchers are looking at combinations of planting dates and varieties that will widen the window for planting. Breeding of short-season varieties would greatly benefit this effort. There is also a need to diversify the market for edamame, which includes the use of edamame as raw material for value-added products, such as “ready-to-eat” snack packs, succotash or hummus. The market cannot absorb all the fresh harvest; consequently, preservation methods such as freezing or canning need to be investigated. If all goes as anticipated, edamame will become a new cash crop that will supplement farm income and help small farmers salvage their livelihoods and legacies.

This project has been supported by two grants from the Virginia Tobacco Indemnity and Community Revitalization Commission, 2010-2013 and 2013-2016.

Impacts

- Twenty-five former tobacco farmers have been trained to grow and market edamame.
- A consumer base for Southside-grown edamame has been established and continues to expand.
- Edamame is beginning to be recognized as a specialty crop in Virginia.

Want to know more?

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A potential dual-purpose small grain for Virginia

Who cares and why? Teff, a warm-season, tropical, small grain, originally from Ethiopia, is a fast-growing annual grass that is gaining popularity as forage and/or as a grain crop in some states of the U.S. Teff produces highly nutritious forage biomass that can allow multiple cuts depending on the weather and other growing conditions. As a forage crop, teff is drought-tolerant and less prone to diseases than other crops. Because of its fast germination and rapid establishment, teff also makes a good spring smother crop for weed control in organic corn fields. As a grain crop, teff has unique nutritional benefits as a gluten-free cereal and thus a healthy alternative for individuals with gluten intolerance. Teff is a good source of iron and some amino acids that are essential to human health, and it is higher in calcium, the most common mineral in the body, than any other cereal crop. Given growing consumer interest in healthy diets and the high demand for gluten-free foods, the market for teff-based products is likely to continue expanding. In fact, Ethiopian restaurants are multiplying, and several food companies have indicated an interest in producing teff bread if a sustainable supply of the flour can be secured. Several small producers are also anxiously seeking information on cost-effective teff production strategies.

What has the project done so far?

Several teff varieties (brown and white) have been evaluated at VSU and have demonstrated potential for multiple grain crops within a growing season. The project is evaluating the performance of teff in response to seedbed compaction and row spacing, and researchers are looking into weed control strategies.

What research is needed?

Several challenges to teff production need to be addressed to make it a viable crop option for the U.S. Lodging and weed

competition from annual grasses (e.g., barnyard grass and crabgrass), coupled with the absence of selective herbicides that are less/unharmful to teff, threaten producer interest in grain-teff production. Weed control strategies involving planting dates and selective herbicide use are being studied. Sowing difficulties associated with teff's small seed size complicate achievement of close seed-soil contact at shallow depths while avoiding excess seed rates.

This project was supported by Evans-Allen funds beginning in 2012.



A small producer being briefed on teff production.

Impacts

Teff varieties tested at VSU show potential for multiple grain crops within a growing season.

Want to know more?

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Using agro-byproducts to improve growth of forage-fed hair sheep

Who cares and why? A comprehensive 2008 review by the National Research Council of the sheep industry in the U.S. identified forage-finished lamb meat, along with the direct marketing of high quality, lighter weight lambs to expanding ethnic markets, as key opportunities to improve the competitiveness and efficiency of the sheep industry. The report also recognized the role that hair sheep play in addressing these structural changes in the industry. A 2010 report commissioned by the American Sheep Industry Association, “Nontraditional Lamb Market in the United States: Characteristics and Marketing Strategies,” echoed a similar sentiment, indicating that the greatest potential for sheep industry expansion lies primarily in the area of non-traditional markets, and that alternative breeds, such as hair sheep, are well-suited to serve these markets. Hair sheep can be raised with limited management inputs such as de-wormers, and they lamb readily on pasture, making them the prototype of the ‘easy care’ sheep. Hair sheep lambs should be targeted at consumers and markets that will pay a premium for this type of product (grass-fed, organic or naturally raised). However, mature size and growth rates in hair sheep are generally lower than they are in traditional wool sheep, and management tools that improve growth performance will benefit this industry.



What has the project done so far? This project evaluated soy hull and corn gluten feed as supplements for hair sheep lambs fed forage-based diets. These agro-byproducts are sources of highly digestible fiber and may be better suited for hair sheep than the more expensive traditional grain supplements. Two pen-feeding trials using high-quality orchard grass hay as a forage source showed that the total feed intake and the growth rate of hair sheep lambs increased linearly as supplement feeding increased from 0 to 3% of body weight. Growth rates were higher, and adaption to the diet was faster in the lambs supplemented with soy hull than in those supplemented with corn gluten feed. When trials were moved to pasture, hair sheep lambs rotationally grazing fescue pasture had higher growth rates when supplemented with soy hull than with cracked corn at 2% of body weight. Supplementation with soy hull improved growth rate in lambs by 80% compared to lambs grazing pasture only.

What research is needed? Additional research is needed on the most cost-effective level of supplementation of soy hull, as well as on the effect that supplementation has on the quality and composition of the lamb carcass. There is also a need to test market lamb products from these rearing systems in direct marketing channels to determine consumer acceptance.

This project is supported by USDA-NIFA Capacity Building Grant No. 2013-38821-2118, 2013 to 2016.

Impacts

- Quantified improvements in growth rates derived from supplementing forage-based diets with agro-byproducts
- Identified soy hull as a supplement with considerable potential for integration into hair sheep management systems

Want to know more?

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Getting on the hummus bandwagon

Who cares and why? Chickpea is one of the most important food legumes in the world. Based on the National Agricultural Statistics Service, in 2012 206,300 acres of chickpeas were harvested in the U.S., and total chickpea production in this country amounted to roughly 370 million pounds. Currently, the majority of chickpeas produced in the U.S. are exported. Chickpea is a major ingredient in hummus, a Middle Eastern and Arabic food dip or spread that is gaining in popularity in the U.S. Sales of hummus in the U.S. reached nearly \$530 million in 2012, according to food retailers. Sabra Dipping Company, which manufactures and distributes hummus worldwide, has opened a new facility in Chesterfield, Virginia. Sabra is currently collaborating with food-science faculty at VSU to investigate chickpea processing properties and the effects of processing. In addition, researchers are seeking more information on novel packaging technologies that will potentially increase the shelf-life of hummus, thus benefiting the industry as a whole.



What has the project done so far? Researchers at VSU conducted studies to determine the optimal processing method of chickpeas for hummus preparation. They evaluated three chickpea varieties using boiling, microwave-cooking, and pressure cooking, and techniques; they found that pressure cooking was the best method for preserving the nutritional quality and functional properties of chickpeas for hummus production. The nutritional, physicochemical, and functional properties of six raw, commercially available chickpeas were evaluated to serve as the standard criteria for selecting the best chickpea varieties to use in hummus preparation.

Scientists are also investigating the effect of using modified atmosphere packaging (insertion of a modified gas into a package's headspace) for extending product shelf life, which is currently 70 days. Information related to standard criteria and modified packaging is not currently available due to proprietary considerations.

What research is needed? More research is needed to determine which chickpea varieties are best suited to processing, as well as to look into the correlations of changes in functional properties and structural properties of chickpeas during processing.

This project is supported by the Virginia Department of Agriculture and Consumer Services through a Specialty Crop Block Grant through, 2013-2015, and through USDA Evans-Allen Program, 2014-2017.

Impacts

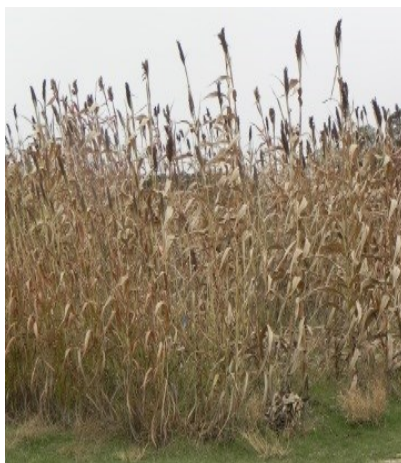
- Identified pressure cooking as the optimal process for maximally preserving nutritional and functional properties of chickpea for food production
- Helped industry professionals determine standard criteria regarding nutritional, physicochemical and functional properties of chickpeas used for hummus preparation

Want to know more?

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Using sorghum stover as feed for small ruminants

Who cares and why? Goat production in the U.S. is characterized as an emerging non-traditional agricultural enterprise. The production of goats has increased by about one-third over the past decade due to their economic value and the increasing demand for goat meat, specifically from specialty markets connected to changing U.S. demographics. Nutrition plays an essential role in meat goat production, with feed costs accounting for the major cost in a



meat goat operation. Meeting future small ruminant feed demands at a lower cost will be challenging, and identifying alternative feed sources will be beneficial. One such possibility is crop residue, the plant parts that are left in the field after crops have been harvested and thrashed. Despite the low digestibility, metabolizable energy, mineral element contents and generally low forage quality, crop residues can be used to fulfill the maintenance requirements of ruminants, particularly during time of feed shortage. The use of alkali or oxidizing chemicals to treat straws and other crop residues can increase the digestibility and nutritional value of the material to ruminants.



What has the project done so far? Researchers at VSU performed a study to determine the effects of ammonium hydroxide (NH_4OH) treatment of sorghum stover residue on composition and in vitro dry matter disappearance (IVDMD) of two sorghum varieties, Dale (a tall sweet sorghum variety) and Brown Mid Rib (BMR) (a short grain sorghum variety). The fiber (both ADF and NDF) content was not affected by the levels of alkali treatment, but the crude protein (CP) and soluble protein contents were both increased. Additionally, there was an increase in IVDMD by NH_4OH treatment.

What research is needed? The development of more economical and safe procedures to improve the digestibility of the structural cell wall components would be very beneficial for improving the use of crop residue as feedstock for livestock. This can also be beneficial in bioethanol production.

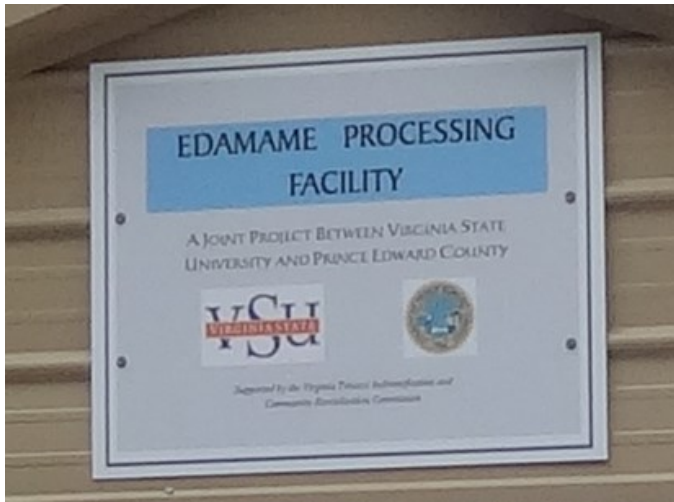
This project was supported in part by a National Science Foundation HBCU-UP grant, from 2013-2014.

Impact

- Identified a means of increasing digestibility of sorghum stover, which may lead to its use as a supplemental feed source for small ruminants.

Want to know more?

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Randolph Farm
Photo by William Porter

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