Journal of Extension

Volume 58 | Number 2 Article 25

April 2020

Increasing Participation of Women in Agriculture Through Science, Technology, Engineering, and Math Outreach Methods

Gayle Mitchell
Green Mountain College

Robin C.D. Currey
Green Mountain College

Recommended Citation

Mitchell, G., & Currey, R. C. (2021). Increasing Participation of Women in Agriculture Through Science, Technology, Engineering, and Math Outreach Methods. *Journal of Extension, 58*(2). Retrieved from https://tigerprints.clemson.edu/joe/vol58/iss2/25

This Feature Article is brought to you for free and open access by TigerPrints. It has been accepted for inclusion in Journal of Extension by an authorized editor of TigerPrints. For more information, please contact kokeefe@clemson.edu.

Journal of Extension
www.joe.org

April 2020
Volume 58
Number 2
Article #v58-2a5
Feature

Increasing Participation of Women in Agriculture Through Science, Technology, Engineering, and Math Outreach Methods

Abstract

With a focus on the Commonwealth of Virginia, we reviewed literature and data associated with the prevalence and persistence of women's engagement in agriculture from youth-focused programs through to college and employment in order to learn which models of outreach may best attract women to and retain women in agricultural careers. We found that girls in Virginia have strong participation in early agriculture-related activities but that women constitute the minority of primary farm owners. Our systematic literature review shows that using science, technology, engineering, and math models of outreach and reframing agriculture as a career that builds communities and cares for the planet can engage more women in agriculture.

Keywords: women farmers, girls in agriculture, careers in agriculture, agricultural education, STEM

Gayle Mitchell
Master's of Sustainable Food Systems Degree Candidate
pgaylemitchell@yahoo.com
@gayle_on_the_go

Robin C. D. Currey
Assistant Professor
robin.currey@prescott.edu

Green Mountain College
Poultney, Vermont

Introduction

As elder farmers age out of the business and climate change creates the need for diversified, sustainable, agroecological farming systems, a gender-inclusive approach to engaging more young farmers is needed (Intergovernmental Panel on Climate Change, 2019). Agriculture often involves a high degree of gender stratification and complex social relationships in networks that make it hard for nontraditional farmers to gain access to land, information, and expertise (Leckie, 1996; Pilgeram & Amos, 2015). Female farmers report a sense of isolation within the farming community (Kiernan, Barbercheck, Brasier, Sachs, & Terman, 2012). Women may be discriminated against by other farmers and agricultural service providers and could be better served by Cooperative Extension (Barbercheck, Brasier, Kiernan, Sachs, & Trauger, 2012; Barbercheck et al., 2009). In spite of these challenges, according to the U.S. Department of Agriculture (USDA), the number of women farm operators has grown (USDA National Agricultural Statistics Service [NASS], 2018). That number can continue to grow if girls and women have increased access to agricultural information and expertise made available via programs led by Cooperative Extension.

Women can lead a new generation of farm operators. However, there are structural barriers that prevent women from entering the field of farming. Barriers to access and persistence challenges are seen at all

levels, beginning with students entering the school system in kindergarten and continuing through college. Ensuring access begins with providing girls in kindergarten through grade 12 (K–12) with programming involving agriculture-related activities, such as 4-H, and in-school programs, such as Agriculture in the Classroom. Access is equally important but represented differently for college-aged women. For women in this group, seeing themselves represented in the gender of mentors, faculty, and advisors can influence their occupational choices and persistence (Gjersoe, 2018; Herrmann et al., 2016; Kofoed & McGovney, 2019).

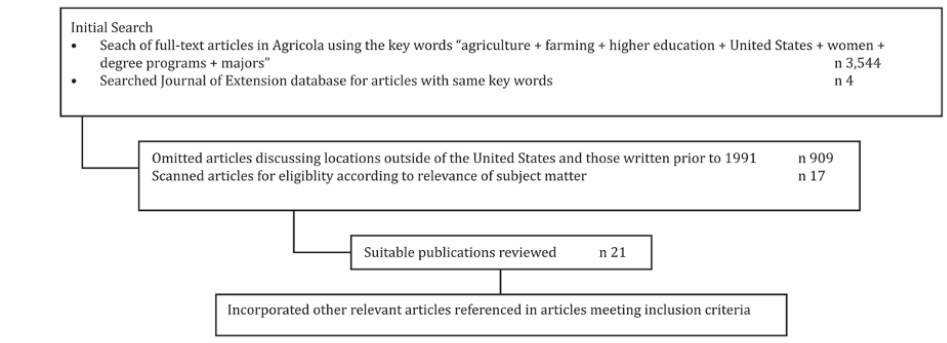
With a focus on the Commonwealth of Virginia (our primary author's state of residence), we conducted a study in which we reviewed the literature and data associated with the prevalence and persistence of women's engagement in agriculture from youth-focused programs through college and employment in order to learn which models of outreach may best attract women to and retain women in agricultural careers.

Methods

For our research, we used multiple methods. We began with a systematic literature review of full-text articles from the service *Agricola*, following the methods of Jesson, Matheson, and Lacey (2011), using the search terms "agriculture + farming + higher education + United States + women + degree programs + majors" (Figure 1). After reviewing the 3,544 results, we omitted all articles pertaining to locations outside the United States and those published prior to 1991. We limited the research to the 17-year period 1991–2018 because that period reflected the agricultural learning environment during the time frame needed for a person to begin K–12 education, matriculate to college, graduate, and start a career. It also included enough time to show evidence of the changing role of women in the classroom, in the workplace, and in farming. These refinements reduced the number of relevant articles to 909. We screened those articles for eligibility according to the relevance of their subject matter as it pertained to the research topic. We also searched the *Journal of Extension* database for articles, using the same key words. These searches produced a total of 21 articles for the literature review. After reading the 21 articles, we incorporated additional relevant journal articles that were cited in those articles and met our inclusion criteria.

Figure 1.

Summary of Search and Selection Protocols Used to Identify Articles Included in Literature Review



Having identified emergent themes from the systematic literature review, we then examined the prevalence and persistence of girls and women engaged in agriculture in Virginia. We reviewed information from 1991 to 2018, disaggregated by gender, regarding 4-H participation and student enrollment in agricultural classes offered in Virginia high schools from the Virginia Department of Education. We then collected and examined

agricultural enrollment and faculty representation data from Virginia's two land-grant universities: Virginia Tech and Virginia State University (VSU). Due to data sourcing and disaggregation issues, we determined faculty representation in agricultural majors by examining and assigning gender on the basis of information on the institutions' websites (Virginia Polytechnic Institute and State University [VPISU], 2018a; VSU, 2018a). Those whose gender could not be determined were omitted from the study as were those in administrative (nonfaculty) roles.

In the next section, we report the results of our assessment of the statistics on girls and women in the agriculture pipeline in Virginia and identify emergent themes from our literature review. On the basis of those findings, we discuss parallels to science, technology, engineering, and math (STEM) fields, and we provide suggestions for the application of best practices for reaching girls and women.

Results and Discussion

The State of Girls in the Agriculture Pipeline in K–12

The agriculture pipeline is full of women at all stages of development. Girls outnumber boys in 4-H in Virginia, and this trend is reflected nationwide. In 2016–2017 there were 95,839 girls and 92,724 boys in Virginia 4-H programs, and in 2014 there were 189,869 more girls than boys enrolled in 4-H programs nationwide (USDA, 2018). In 2016–2017, 116,541 of those participants came from rural cities and towns with less than 50,000 residents (USDA, 2018). Programs involving animals and livestock attracted 45,480 young people, and 13,876 were involved in plant science activities (USDA, 2018). Although not all 4-H disciplines are solely agricultural, 4-H is an important part of rural communities and reaches children for whom farming is already an accepted way of life. However, as the United States continues to shift away from a rural economy and people concentrate in urban areas, activities that expose all students to agriculture become increasingly important (Powell, 2017).

Virginia also has large numbers of girls taking agriculture classes in high schools across the commonwealth. In the 2001–2002 school year, 28% of the students enrolled in agriculture classes in Virginia high schools were female; by 2015–2016 that number had risen to 40% (Acting Director Office of Career, Technical, and Adult Education, Virginia Department of Education, personal communication, June 26, 2018). The number of females nearly doubled over the 15-year period whereas the number of males stagnated.

College-Aged Women and Faculty

At Virginia's two land-grant colleges, women outnumber men in agricultural majors. In 2017, at VSU (total enrollment 7,100), women constituted 72% of the enrolled undergraduates in the College of Agriculture and 67% when all majors except agriculture were excluded (VSU, 2018b). This is an increase from 10 years prior when, in 2007, women made up 64% of the College of Agriculture and 50% of agriculture majors alone (VSU, 2018b). We found parallel results for Virginia Tech (total enrollment 32,304). Women have consistently comprised about 65% of the students enrolled in the College of Agriculture and Life Sciences over the past decade (VPISU, 2018b). Unlike VSU, Virginia Tech offers a wide variety of agricultural specialties that cover a broad range of interests.

The makeup of faculty, however, does not mirror that of the student bodies. Virginia Tech had 118 men and

57 women faculty members in agricultural majors (10 not counted) (VPISU, 2018a), and VSU had 19 men and 10 women (23 not counted) (VSU, 2018a). Virginia Tech's male agriculture faculty make up 67% of the total, nearly the same as the percentage of *female* agriculture students. VSU has nearly identical statistics, with 66% male faculty compared with 72% of their agriculture majors being women.

The State of Women in Virginia Farming

A review of 2017 USDA Census data indicated that there were 17,126 women principal producers out of a total of 57,204 (30%), with 51% of those women producers being full owners of farms under 49 ac, as compared to 40% of men producers (USDA NASS, 2018). With regard to Virginia farmers, women comprised 33% of those making "day to day" decisions about the operation of Virginia's farms but only 29% of those making "land use and/or crop decisions" and 32% of those making "livestock decisions" (USDA NASS, 2018). The number of female farm operators continues to increase despite the number of farms, overall, continuing to decrease (USDA NASS, 2018). This scenario is part of a national trend in growth of women and minority farm operators (Kiernan et al., 2012). From the results presented thus far, it is clear that girls and women represent the majority in the agriculture pipeline (4-H, school-based agriculture classes, and college) but not in agricultural careers.

Themes from the Systematic Literature Review of Women in Agriculture

Research has shown that girls need to be exposed to agricultural careers and topics prior to the eighth grade, as do teachers working in the lower grades, for the number of underrepresented students to increase and diversity to be created in the fields of food, agriculture, and natural resources (Foster & Savala, 2012; Powell, 2017). This exposure can include programs such as school learning gardens (Gomez & Albrecht, 2014) or agriculture-across-the-curriculum programs (Carbonneau, 2018).

Women are more likely to be innovators in agricultural practices and creators of new farm-based business opportunities such as value-added production, organic products, or direct marketing operations that add profit to small or medium-sized farms (Barbercheck et al., 2009; Brasier et al., 2009). Women farmers are more engaged in civic agriculture, providing a benefit to the community in response to its social and cultural needs, and they also "tend to operate smaller farms; tend to be involved in livestock production; and are less likely to be the primary operator of farms that produce major commodities" (Trauger, Sachs, Barbercheck, Brasier, & Kiernan, 2009, p. 43).

Reframing agriculture as a career that helps nourish both the people and the planet, helps care for and support local communities and economies, and is a creative and profitable business could contribute to overcoming misconceptions about agricultural careers and their significance to communities and their inhabitants (Gibson, Benjamin, Chapin, Oseto, & Lucietto, 2014; Gomez & Albrecht, 2014). Success in farming can be seen in care and responsibility for the community and connection to the farm (Trauger et al., 2009). As business owners and community members, female farmers are innovators on small and medium-sized farms and can help bring about gender equity through their work (Trauger et al., 2009).

Girls do not generally see science-based careers, such as agriculture, as offering opportunities to connect with and care for community and the farm (Gharis, Laird, & Osborne, 2017; Gomez & Albrecht, 2014;

Leckie, 1996). One reason may be related to "social belongingness," where teens select fields in which more people are representative of their own gender and "self-efficacy," which is the belief that one can succeed in a chosen field (Gjersoe, 2018, "Then Why Are There Fewer," para. 2). Ganley, George, Cimpian, and Makowski's (2018) study showed that gender bias, not the perception that a field is math or science oriented, is the primary selection criterion for women choosing a college major. In 2003, Beck and Swanson noted that 94% of full professors in science and engineering were White and 90% were male. When tenure was factored in, only 46% of female faculty members were tenured, compared with 76% of male faculty (Beck & Swanson, 2003). However, as the authors pointed out, "the single most important predictor of future success is the percentage of like role models at their undergraduate college" (Beck & Swanson, 2003, p. 2898). Addressing the discrepancy in representation is a critical factor in the retention of women in agriculture.

Addressing the Leaky Pipeline in STEM—A Model for Retaining Girls and Women in Agriculture

Though not a cohort study, the numbers reported in this article for Virginia show a trend: engaged girls in K–12, female majority in college-level agriculture programs, and then female minorities as agriculture faculty and farm operators. Women in STEM fields have faced many of the structural barriers also faced by women in agriculture, including masculine stereotypes, peer norms, lack of female role models, gender bias in hiring and promotion, fewer speaking invitations, and bias against scientific work (Dasgupta & Stout, 2014). As in agriculture, girls are prevalent in STEM in numbers comparable to men throughout K–12 education but as women fail to persist in college and careers (Jones, 2017). This effect is known as the "leaky pipeline" (Dasgupta & Stout, 2014). Agriculture is occasionally being included in STEM disciplines (McKim et al., 2017), but its more typical exclusion in itself is a barrier to agricultural careers. As we found in Virginia, women enter the agriculture pipeline in K–12 and persist into college, but they are not proportionally transitioning to careers as faculty or farm owners. Because women comprise more than half of the college-bound population (Dasgupta & Stout, 2014), it is important to consider how tailored, early outreach will affect the workforce in the future.

The problem of the leaky pipeline is being addressed in STEM contexts through expansion of the length and variety of outreach methods that target girls at different points in their development (Dasgupta & Stout, 2014). Barriers to STEM engagement during childhood and adolescence were identified, and they included perpetuation of gender roles in STEM stereotypes, parental influence, peer influence, and contrast between personal goals or values and experiences (Dasgupta & Stout, 2014). More barriers occurring during preadulthood also were identified: women's lack of belonging, being outnumbered by male peers, and lack of same-sex role models or mentors (Dasgupta & Stout, 2014). When all three stages of development are targeted with multiple intervention types in STEM, barriers to female participation can be overcome and participation can be expected to grow (Dasgupta & Stout, 2014). A similar "STEM approach" in agriculture could, ultimately, grow the number of female primary farm operators.

There is evidence of the efficacy of STEM approaches in agriculture. Girls in precollege summer agricultural intern programs had a much higher degree of likelihood of choosing an agricultural major at Virginia Tech (Foster & Savala, 2012), a land-grant university with connections to careers in Extension. A residential summer program for underrepresented high school students sponsored by Michigan State University, also a

land-grant university, changed the perceptions students had about careers in agriculture and natural resources (Foster & Savala, 2012). That program promoted the idea that careers in these fields both are science-based and help protect the environment (Foster & Savala, 2012), concepts that are important factors in the majors selected by women (Gharis et al., 2017).

Brown (2002) noted the benefit of bringing students on campus for educational enrichment activities as a key factor in overcoming educational exclusion. He also noted that the recruitment of women into medical schools has helped allay a shortage of doctors in the United States (Brown, 2002). Without women and minorities participating equally, especially in fields where they have traditionally been excluded, the United States will lack enough technically trained and culturally adaptable employees to compete in an international economy (Brown, 2002; Gomez & Albrecht, 2014).

Afterschool programs linked with a local university, possibly conducted through Cooperative Extension, are another way of addressing the lack of hands-on experience with careers in agriculture (Dasgupta & Stout, 2014; Gharis et al., 2017; Powell, 2017). The importance of Extension serving as "an informant of leadership development for women working in agriculture" (Griffeth, Tiller, Jordan, Sapp, & Randall, 2018, "A Need to Explore the *How*," para. 2) has been shown to be a key factor in reducing structural barriers to women in agricultural fields.

Expansion and support of programs such as these would expose girls to careers in horticulture or agricultural extension where they could help build their own farms and support the farms of other women, further supporting the diversification of agriculture. Developing university, science museum, or nonprofit environmental educational outreach programs built around mentors who create a supportive and inclusive environment, keeping students together by cohort, and providing a network of like-minded individuals all can help students who may have previously experienced discrimination (Gharis et al., 2017) gain social capital through their new network (Kiernan et al., 2012). Allowing girls to be decision makers in these settings, instead of assuming the stereotypical role of farmer's helpmate, gives them confidence in the field. All of these are tenets of reducing the leaky STEM pipeline that could be implemented to do the same in agriculture.

Conclusion

Girls and women are already abundant in the agriculture pipeline. Extension is in a prime position to convert women interested in agriculture to careers in farming. Having access to girls and women from their earliest 4-H experiences to those enrolled at land-grant universities creates an opportunity for Extension to create outreach programs that girls and women can connect to in order to facilitate this transition.

The STEM fields offer models for outreach best practices to help address the "leaky pipeline." Agriculture must be reframed as a helping career that is important to community development and survival. Agricultural careers are catalysts for social change and community building that create opportunities for positive impacts in the lives of others. Exposure to agroecological farming methods that benefit the community and awareness of other women who have succeeded and are leaders in the field is critical to supporting women who want to pursue agriculture as a career.

Single-gender agricultural camps, campus trips, or all-female field days also can enhance the engagement and persistence of girls in agriculture. Integrating these program elements ensures that K–12-aged girls feel

welcome and are respected in agricultural education. It also provides hands-on learning experiences to increase their confidence in their agricultural skills and abilities.

Colleges and universities, particularly land-grant institutions where Extension is embedded, are influencers. When women see themselves in their faculty mentors, it influences their career choices. More women should be hired and promoted into faculty and leadership positions in agricultural programs at universities and in Extension roles.

A better understanding of the reasons agriculture appeals to women coupled with Extension's conducting outreach and using teaching practices informed by the STEM model could result in success in transitioning women from students with an interest in agriculture to primary farm owners.

What will contribute to the persistence of girls and women in agriculture beyond the classroom is multilayered outreach at a variety of age levels, including the elements and ideas that we describe in this review of the literature. The opportunity to target girls and women in the effort to feed the future is ripe. The number of girls and women interested in and participating in agriculture at every age opens the door to opportunities to increase the role of Extension in developing leaders for the future of agriculture.

Author Notes

Gayle Mitchell is currently serving as the director of the Rappahannock Scholars Program at the University of Mary Washington, Fredericksburg, Virginia. Dr. Robin Currey is professor of sustainable food systems and director of the Master of Science in Sustainable Food Systems program at Prescott College, Prescott, Arizona.

Acknowledgments

Special thanks to Shannon O'Sullivan, Ph.D., assistant professor of communication studies at Salisbury University, for her help and encouragement with this paper.

References

Barbercheck, M., Brasier, K., Kiernan, N. E., Sachs, C., & Trauger, A. (2012). Use of conservation practices by women farmers in the northeastern United States. *Renewable Agriculture and Food Systems*, *29*(1), 65–82.

Barbercheck, M., Brasier, K. J., Kiernan, N. E., Sachs, C., Trauger, A., Findeis, J., . . . Moist, L. S. (2009). Meeting the extension needs of women farmers: A perspective from Pennsylvania. *Journal of Extension*, *47*(3), Article v47-3a8. Available at: https://www.joe.org/joe/2009june/a8.php

Beck, M. M., & Swanson, J. (2003). Value-added animal agriculture: Inclusion of race and gender in the professional formula. *Journal of Animal Science*, *81*(11), 2895–2903.

Brasier, K., Barbercheck, M., Kiernan, N. E., Sachs, C., Schwartzberg, A., & Trauger, A. (2009). Extension educators' perceptions of the educational needs of women farmers in Pennsylvania. *Journal of Extension*, *47*(3), Article v47-3a9. Available at: https://joe.org/joe/2009june/a9.php

Brown, R. H. (2002). Overcoming educational exclusion: Is diversity an appropriate model for democratic higher education? *The American Behavioral Scientist*, *45*(7), 1061–1087.

Carbonneau, L. (2018). *Food systems education: The case for interdisciplinary lesson plans in high schools* (Unpublished master's capstone). Green Mountain College, Poultney, VT.

Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences*, *1*(1), 21–29.

Foster, E. F., & Savala, L. A. (2012). Engaging under-represented youth in food, agriculture and natural resources through pre-college residential summer programs. *NACTA Journal*, *56*(2), 38–46.

Ganley, C. M., George, C. E., Cimpian, J. R., & Makowski, M. B. (2018). Gender equity in college majors: Looking beyond the STEM/non-STEM dichotomy for answers regarding female participation. *American Educational Research Journal*, *55*(3), 453–487.

Gharis, L. W., Laird, S. G., & Osborne, D. C. (2017). How do university students perceive forestry and wildlife management degrees? *Journal of Forestry*, *115*(6), 540–547.

Gibson, K. D., Benjamin, T. J., Chapin, B. R., Oseto, C. Y., & Lucietto, A. M. (2014). Engaging undergraduate students from two institutions in a multicultural synchronously taught agriculture course. *NACTA Journal*, *58*(1), 32–38.

Gjersoe, N. (2018, March 8). Bridging the gender gap: Why do so few girls study Stem subjects? *The Guardian*. Retrieved December 5, 2018, from https://www.theguardian.com/science/head-quarters/2018/mar/08/bridging-the-gender-gap-why-do-so-few-girls-study-stem-subjects

Gomez, A., & Albrecht, B. (2014). True STEM education. *Technology and Engineering Teacher*, *73*(4), 8–16.

Griffeth, L. L., Tiller, L., Jordan, J., Sapp, R., & Randall, N. (2018). Women leaders in agriculture: Data-driven recommendations for action and perspectives on furthering the conversation. *Journal of Extension*, *56*(7), Article v56-7a2. Available at: https://joe.org/joe/2018december/a2.php

Herrmann, S. D., Adelman, R. M., Bodford, J. E., Graudejus, O., Okun, M. A., & Kwan, V. S. (2016). The effects of a female role model on academic performance and persistence of women in STEM courses. *Basic and Applied Social Psychology*, *38*(5), 258–268.

Intergovernmental Panel on Climate Change (2019). *Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.* Retrieved from https://www.ipcc.ch/srccl-report-download-page/

Jesson, J., Matheson, L., & Lacey, F. (2011). *Doing your literature review.* Thousand Oaks, CA: SAGE Publications Ltd.

Jones, C. (2017, March 12). Girls draw even with boys in high school STEM classes, but still lag in college and careers. Retrieved from https://edsource.org/2017/girls-now-outnumber-boys-in-high-school-stem-but-still-lag-in-college-and -career/578444

Kiernan, N. E., Barbercheck, M., Brasier, K. J., Sachs, C., & Terman, A. R. (2012). Women farmers: Pulling

up their own educational boot straps with Extension. *Journal of Extension*, *50*(5), Article v50-5rb5. Available at: https://joe.org/joe/2012october/rb5.php

Kofoed, M. S., & McGovney, E. (2019). The effect of same-gender or same-race role models on occupation choice: evidence from randomly assigned mentors at West Point. *Journal of Human Resources*, *54*(2), 430–467.

Leckie, G. J. (1996). 'They never trusted me to drive': Farm girls and the gender relations of agricultural transfer. *Gender, Place and Culture: A Journal of Feminist Geography*, *3*(3), 309–325.

McKim, A. J., Sorensen, T. J., Velez, J. J., Field, K. G., Crannell, W. K., Curtis, L. R., . . . Gaebel, K. (2017). Underrepresented minority students find balance in STEM: Implications for colleges and teachers of agriculture. *NACTA Journal*, *61*(4), 317–323.

Pilgeram, R., & Amos, B. (2015). Beyond "inherit it or marry it": Exploring how women engaged in sustainable agriculture access farmland. *Rural Sociology*, *80*(1), 16–38.

Powell, L. (2017). Urban cowboys: Demographics confirm that agriculture and natural resources recruiting plans cannot be one-size-fits-all. *NACTA Journal*, *61*(2), 121–126.

Trauger, A., Sachs, C., Barbercheck, M., Brasier, K., & Kiernan, N. E. (2009). "Our market is our community": Women farmers and civic agriculture in Pennsylvania, USA. *Agriculture and Human Values*, *27*, 43–55.

U.S. Department of Agriculture. (2018). *Research, education & economics information system*. Retrieved July 21, 2018, from https://reeis.usda.gov/reports-and-documents/4-h-reports

U.S. Department of Agriculture National Agricultural Statistics Service. (2018). *USDA census of agriculture*. Retrieved November 25, 2019, from https://www.nass.usda.gov/AgCensus/

Virginia Polytechnic Institute and State University. (2018a). College of Agriculture and Life Sciences faculty and staff. Retrieved July 21, 2018, from https://www.cals.vt.edu/faculty-staff.html

Virginia Polytechnic Institute and State University. (2018b). Facts and figures. Retrieved July 21, 2018, from https://www.ir.vt.edu/data.html

Virginia State University. (2018a). College of Agriculture faculty and staff. Retrieved July 2018, 2018, from http://www.agriculture.vsu.edu/agricultural-research-station/faculty-and-staff.php

Virginia State University. (2018b). Facts and quick charts. Retrieved July 21, 2018, from http://www.vsu.edu/opie/institutional-research/facts-quick-chart.php

---

Office, *joe-ed@joe.org*.

If you have difficulties viewing or printing this page, please contact *JOE* Technical Support