A Strategic Review of Agricultural Education

Preparing Students for Successful Transition to College and Careers

The Changing Face of Virginia Agriculture

Virginia Department of Education
October 2013

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Developed by
The Office of Career and Technical Education Services
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A Strategic Review of Agricultural Education
Executive Summary

The Strategic Review of Agricultural Education in Virginia began as a joint venture of the Secretary of Education and Secretary of Agriculture and Forestry in the fall of 2012. The purpose was to review Agricultural Education secondary courses in the context of current and future workforce needs and to make strategic decisions regarding Virginia's course offerings.

To achieve this, several strategies were identified:

- Research, review, and analyze current and projected labor market data regarding all occupations and careers in agriculture and related fields
- Conduct a gap analysis using labor market data, local industry needs, and other relevant information with Virginia's current Agricultural Education course offerings
- Analyze findings and make recommendations to ensure Virginia students are prepared for entry-level jobs that lead to high-skill, high-demand, and high-wage careers in agriculture and related fields.

Through detailed and thorough research, critical review of current course offerings, and in-depth discussions with stakeholders, the Virginia Department of Education carefully evaluated all aspects of Agricultural Education in the commonwealth. A summary of many of the findings is included in the full report.

Major themes evolved from the focus group meetings. The participants pointed out the need for an accurate understanding of agriculture in Virginia, as well as clear and open communication among all stakeholders involved—educators, parents, students, business representatives, and public policymakers. Partnerships will continue to be a key component in ensuring that Agricultural Education is a vibrant, futuristic option for Virginia students and that they are prepared for entry-level jobs that lead to high-skill, high-demand, and high-wage careers in agriculture and related fields.

This report outlines the many aspects of Agricultural Education that will require immediate attention to ensure consistently high-quality programs:

- Comprehensive academic and career planning for students
- Continual teacher retraining and professional development
- Student access to a range of stackable industry credentials or relevant preparatory training to prepare students for entry into technical through professional level occupations
- Comprehensive, rigorous, and relevant curriculum
- Infusion of critical technology requirements for the industry
- Flexible, innovative delivery systems for Agricultural Education courses that reflect coordination between secondary and postsecondary education

The research reinforced the need to be responsive to trends in agriculture, including the infusion of technology, attention to new and emerging industries within agriculture, and the critical impact of global issues on agriculture. Data show that productivity has risen sharply in recent years, resulting in the need for fewer agricultural workers in traditional roles. However, new high-skill areas within agriculture have created many new and exciting career opportunities, which must be reflected in Virginia's curriculum offerings. Several conditions in planning these courses are important:

1. *Career and Technical Education programs in agriculture need to be planned to address the broad career opportunities and in close partnership with employers as relevant.*
2. *Many high-wage careers in agriculture require preparatory training for postsecondary education.*
3. *Most high-paying agricultural occupations require knowledge of agriculture combined with supplementary knowledge and skills.*

Based on the findings in this report, the Virginia Department of Education has identified the following action items for priority attention:

1. Review and update the state-approved Agricultural Education course curriculum frameworks and adhere to the required three- to five-year revision schedule. Pay particular attention to updating scientific and technical competencies and building the broad base of business, management, and marketing knowledge required for current and future occupations in agriculture.
2. Use the nationally recognized 16 Career Clusters and associated Career Pathways as the basis for curriculum frameworks. This system is designed to inform students about the range of occupations available in agriculture and related fields and the educational pathways required to qualify for them.
3. Ensure that students have access to a comprehensive, coherent sequence of courses and programs that provide the necessary academic, technical, and employability knowledge and skills for successful transition to postsecondary education and careers.
4. Increase the enrollment and program completion rates in Agricultural Education courses to meet current and future workforce needs.
5. Facilitate students' transition from secondary to postsecondary agriculture programs by:
   - ◊ implementing blended agriculture/academic courses that engage students in rigorous and relevant problem-based experiences and inquiry-based science
   - ◊ developing and pilot testing selected Agricultural Education courses that incorporate science-area SOL competencies so that successful completion of the course enables a student to sit for the relevant SOL exam
   - ◊ promoting the development and completion of dual and/or concurrent enrollment courses to earn postsecondary certificates, a one-year Uniform Certificate of General Studies, or an associate degree from a community college concurrent with a high school diploma
   - ◊ encouraging the Governor's STEM Academy programs within agriculture career pathways to require at least nine transferable college credits (including dual enrollment, Advanced Placement, and International Baccalaureate options).
6. Support professional development of Agricultural Education teachers, particularly opportunities for secondary teachers to:
   - ◊ address certifications in the context of their curriculum
   - ◊ enhance problem-based learning instruction
   - ◊ acquire and maintain current technology skills
   - ◊ gain expertise in new and emerging agriculture content
   - ◊ expand partnerships with Virginia's two-year and four-year institutions for the recertification of secondary teachers in courses related to emerging high-tech agricultural content.
7. Recruit and retain Agricultural Education teachers through:
   - ◊ motivation of students to enter teacher-education programs
   - ◊ increased student access to agriculture-related college programs.
8. Maintain partnerships with Virginia employers at the state level to ensure that curricula and the overall direction of the agriculture education program stays current and relevant to the demands of industry.
9. Encourage the engagement of local employers and community-based partners to ensure that ag-

riculture programs meet local needs and that students have opportunities for a significant work-based learning experience(s), such as supervised agricultural education programs.

10. Promote, as part of the Virginia Career and Technical Education rebranding initiative, new and innovative 21st-century agriculture, food, and natural resources programs to students, educators, school counselors, parents, businesses, and community partners.
11. Encourage the agricultural industry to establish an Agricultural Education Stakeholders Group that will meet annually in partnership with the Virginia Department of Education and the Virginia Department of Agriculture and Consumer Services for updates on accomplishments and goals for continuous improvement:
    - ◊ Recommend that stakeholders provide updates at regional meetings of local school division superintendents, local CTE directors, and business partners and advisory groups to share Agricultural Education efforts in their region.

The Strategic Review of Agricultural Education in Virginia has become the vehicle through which the commonwealth can acknowledge and embrace the future of the agricultural industry by addressing its corresponding educational offerings. Only by preparing students for the jobs that await them in the wide-ranging field of agriculture can we ensure that Virginia's largest industry will continue to grow and thrive in a global economy.

A Strategic Review of Agricultural Education

Preparing Students for Successful Transition to College and Career

I. Introduction

This comprehensive review of Agricultural Education in Virginia required input from a wide variety of agriculture-related groups: business and industry, education, government, and agriculture-related professional and occupational organizations and foundations. The Virginia Department of Education (VDOE) and the Virginia Department of Agriculture and Consumer Services (VDACS) hosted three open-discussion meetings with these constituents and solicited their comments, concerns, suggestions, and recommendations for Agricultural Education in the commonwealth. Their feedback has become a critical component of this report.

The strategic review included labor market data research, a gap analysis of this data with current course offerings, and, based on the findings, recommendations for ways to ensure Virginia's Agricultural Education prepares students for high-demand, high-skill, high-wage careers.

The VDOE planning team formulated strategies to ensure that its work would produce the needed results. The first step was a review of labor market data to ensure that Virginia is preparing its students to be workforce-ready for the careers of today and for those yet to be defined. Experts from the University of Virginia's Weldon Cooper Center were charged to research, review, and analyze current and projected data regarding all occupations and careers in agriculture in Virginia. The VDOE staff also reviewed Agricultural Education programs in other states.

Second, the planning team identified the need to analyze current program and course offerings and career pathways in the context of current and future economic trends.

The third strategy was to meet with stakeholders to collect feedback and recommendations to incorporate into a strategic plan for Agricultural Education in the commonwealth. The planning team would then analyze findings and identify recommendations to ensure Virginia students are prepared for entry-level jobs that lead to high-skill, high-demand, and high-wage careers in agriculture and related fields.

II. Overview of Focus Group Discussions

In a series of three focus group meetings in the fall of 2012, key stakeholders gathered to discuss the current status of and ways to improve Virginia's approach to Agricultural Education to ensure programs are preparing students to meet the agricultural workforce needs in a complex, global economy.

Wide-ranging discussion took place at these meetings, guided by these questions:

Big Picture Questions

- What do you believe to be the most important agricultural career areas for Virginia's economy now and in the future?
  - ◊ What skills will be needed in these jobs?
  - ◊ How can we prepare our students for these careers?
- What will the major challenges be in ensuring our students are ready for the jobs of the future?
  - ◊ Can you anticipate trends in these career areas for the next five or ten years?

Specific Programmatic Questions

- What do you envision the Agricultural Education curriculum should be?
  - ◊ Are there specific components that should be added now or in the future?
  - ◊ What options might help to ensure that students in agriculture programs have equal opportunities and good choices to transition into college and careers?
- Other than industry-based certifications, what other high-stakes, valid, nationally recognized credentials could be used to reinforce/confirm successful completion of Agricultural Education programs?
- How would you define agricultural literacy?
- Are you aware of good examples of K-12 Agricultural Education literacy programs in other states?
- Do you have specific ideas on how to integrate agriculture into the K-12 curriculum?

Strong beliefs and opinions about Agricultural Education in the commonwealth were evidenced in the comments of the educators, business representatives, policymakers, and professional organization personnel who attended. Comments addressed the topics of perception, public awareness, marketing, communication, course topics, student preparation, teacher preparation and endorsements, credentials for teachers and students, use of technology, course credit (dual enrollment, Advanced Placement [AP]), current trends, and ideas for the future.

Perception

"Agriculture is not understood." Many of the focus group members who attended the strategic review meetings expressed this view. In a broad sense, they felt strongly that agriculture is critical to all who want safe and healthy food to eat. Agriculture is more than just farming; it is part of a global economic network of imports and exports. While it is most certainly farms and crop and animal production, it is also chemical and biological research, bioengineering, genetics, sustainability, energy and alternative energy, environmental science, transportation and logistics, distribution and marketing, global finance, and consumer issues—all of which contribute to a viable industry now and in the future.

Agriculture is more than just farming; it is part of a global economic network of imports and exports.

To ensure that this message is heard, VDOE, VDACS, and the agricultural community must work together to highlight the breadth and depth of the industry and the futuristic nature of agricultural careers within schools, the community, and the media.

This broad concept of agriculture must translate into a better understanding of Agricultural Education

in Virginia, and awareness of its critical contributions must be raised. Part of the issue arises when students, through their dress and actions, perpetuate age-old stereotypes. It is further perpetuated by school personnel who have a limited view of the career opportunities for which these students are being prepared.

Audience

Many people need to hear what Agricultural Education has to offer. The strategic review team members identified various groups that should be targeted:

- Students, beginning with elementary school students and focusing especially on non-rural students
- Parents
- Teachers of non-agriculture subjects, including academic subjects
- School counselors
- School administrators
- Special education teachers (need support/assistance in Agricultural Education classrooms for students who need help)
- Higher education administrators and instructors
- Local government officials
- Urban residents
- Industry leaders

The focus groups were quick to point out that stronger connections and better communication are needed between and among the following audiences:

- State and local leaders
- VDOE and classroom teachers, who often are not aware of all the resources available
- K-12, Virginia Community College System, and public and private postsecondary education institutions
- FFA, 4H, VDOE, local school divisions, and other relevant groups

The focus groups suggested that the agriculture-related organizations should consider hosting an annual showcase of Agricultural Education programs, with additional support of the Virginia Department of Agriculture and Consumer Services and the Virginia Department of Education.

Partnerships

The stakeholders all agreed that partnerships are critical, especially among industry, higher education, and local government. Key personnel from all sectors should discuss and address new agriculture-related industry (existing and potential) in their area and identify Agricultural Education classes that might be offered to address the changing employment and economic needs.

Business and industry can do much to promote Agricultural Education in Virginia. Their expertise could be invaluable in many ways, such as

- developing videos to market the career opportunities in agriculture
- identifying current certifications pertinent to the industry
- assisting rural divisions that cannot afford to pay their part of the tuition to send students to a Governor's School for Agriculture
- supporting dual enrollment and Advanced Placement courses

- encouraging industry members to engage local school leadership, including the superintendent, CTE director, principals, and school counselors in an advisory capacity.

Teachers and business/industry can partner to ensure that up-to-date Agricultural Education programs are offered. Educators can partner with agricultural extension personnel to make students aware of agriculture courses at a younger age and to influence the selection of Agricultural Education courses taught. The State Extension Leadership Council could be a key partner for agricultural teachers.

The focus groups agreed that one way to encourage partnerships is through extended teaching contracts. Such contracts would allow teachers more time to build programs that could benefit from year-round attention and more opportunities to meet with business partners at mutually agreeable times.

Partnerships with school counselors are key in demonstrating the positive influence of Career and Technical Education (CTE) on students. Partnerships help to change counselors' perceptions of Agricultural Education by providing evidence that it can prepare students for college (one, two, four, or more years of postsecondary education) and careers. Connections with school counselors could also happen through

- Agricultural Education presentations at counselor conventions and workshops
- invitations to school counselors to judge local, regional, and state FFA student competitions
- use of professional and student organizations to help promote Agricultural Education.

Marketing and Promotion

A promotional plan is needed for Agricultural Education programs to connect people to all that it has to offer. All targeted audiences must have a better awareness of Agricultural Education and the career opportunities in the field.

Many marketing strategies could be used to inform parents and school counselors and also encourage students to consider Agricultural Education classes. The focus groups identified the following:

- Create an agriculture component to existing, successful activities, such as Kids' Tech University, to excite elementary students and their parents about agriculture and its career opportunities.
- Add agricultural literacy as part of exploratory lessons taught in middle school.
- Consider a name change that would boost the image of Agricultural Education (e.g., "Agribusiness and Agrisciences").
- Promote CTE successes, such as college graduation rates of CTE completers and data that shows the successes of CTE students in academics.
- Address the stigma of Agricultural Education (and CTE) among college admissions offices (the perception is that a disproportionate number of Agricultural Education students do not earn an Advanced Studies Diploma).
- Promote the summer residential Governor's School for Agriculture.
- Share best practices across Virginia through various channels, including electronic newsletters, VDOE Web site, CTE Resource Center, and other channels.
- Highlight the futuristic nature of agricultural careers.
- Market programs to highlight the leadership skills and life-skill development offered in Agricultural Education programs and FFA.

Student Preparation (Secondary through Postsecondary)

Academic and Career Planning

Communication is critical in planning a student's high school experience and for ensuring college entrance. Group discussions focused on the importance of career assessments and plans of study developed in middle school, so that students can prepare to be a CTE completer and earn an Advanced Studies Diploma.

Suggested activities for parents and educators to ensure good communication when planning a student's secondary school course selections included the following:

- Using course materials available in Verso (www.cteresource.org/cpg/clusters) that provide career planning and course sequences to demonstrate how agriculture education can be incorporated into a student's academic and career plan
- Beginning by looking at middle school courses, not just high school
- Offering an introductory, gateway Agricultural Education course that is common and foundational, and then targeting pathway areas
    - ◊ Example: Loudoun County's health science program is designed with three years of coursework, after which students are prepared to enter the workforce or move on to further education in a specific area of interest. This takes planning and starts with middle school courses.
- Looking at summer school as an option. Careful planning is required, but summer school can be used to catch up if a student gets off schedule or chooses to enter into Agricultural Education later.

Current and new Agricultural Education courses must be reviewed and validated by academic specialists to ensure that they are rigorous, relevant, and appropriate for weighted-credit/AP status.

Additionally, better communication is needed between local teachers and the VDOE. This could be addressed in many ways, including having the VDOE

- share more information with teachers through the Agricultural Education listserv
- forward Superintendent's memos related to Agricultural Education and CTE through the listserv
- share information about state resources and special initiatives with the Agricultural Education community.

Advanced Placement and Weighted Credit

Differentiating courses by adding an "advanced," upgraded curriculum would suggest to college admissions officers a more demanding course background. Whether a simple weighted-credit approach or a more formal Advanced Placement option is used, current and new Agricultural Education courses must be reviewed and validated by academic specialists to ensure that they are rigorous, relevant, and appropriate for weighted-credit/AP status.

Given their emphasis on biology and chemistry, many agriculture courses could be reviewed and considered for additional credit, which could make a difference in recruitment and retention of students in Agricultural Education.

Dual Enrollment

The Virginia Community College System and the State Council of Higher Education of Virginia must work together to figure out how to mirror existing guaranteed-admission programs to include students who pursue coursework in Agricultural Education. Such agreements should allow students who take Agricultural Education courses and earn an associate degree to be automatically accepted into state four-year institutions.

School divisions must create partnerships with their community colleges to offer students courses during the summer. This is especially important in localities that have no summer school.

Dual enrollment or concurrent enrollment is key to elevating and enhancing Agricultural Education offerings. Inconsistencies exist across the commonwealth pertaining to teacher qualifications, fee structures, and cost to the student. Currently, dual enrollment is implemented on a case-by-case, locality-to-community-college approach.

Shared/Blended Classes

The focus groups asked whether Agricultural Education courses could become "blended" courses, tied to academic disciplines such as biology or chemistry, and could therefore be taken and assessed using Virginia SOL tests for verified credits required for graduation. Science, technology, engineering, and mathematics (STEM) are highly regarded and much-needed areas of expertise in the workplace, and agricultural courses can show students how to apply STEM knowledge and use STEM skills. CTE is the place for such blended courses because of its applied methodology of teaching and learning. Blended courses might combine science and agriculture–for example, "Genetics in Reproductive Systems," "Reproductive Physiology" (raising animals, embryo transfer, genetic engineering), and biochemistry. Teacher certification and dual teaching endorsements would have to be reviewed and, perhaps, modified.

CTE is the place for such blended courses because of the applied skills aspect.

Instructional Methodology and Delivery Systems

Project-based learning, including supervised agricultural experience programs, and inquiry-based science could be applied to some of the aforementioned options for Agricultural Education. Project-based learning provides an extended process of inquiry in response to a complex question, problem, or challenge. Working together, academic and CTE teachers would anticipate the types of information students would need to know to carry out the project and plan activities to help provide it. Teachers guide the process, but students must make key decisions about how to conduct the project. Certainly, such projects would work well in shared or blended courses. With this option, teacher training and retraining would likely be required.

Inquiry-based science, which helps students master scientific concepts through inquisitiveness, investigation, and understanding, would add credibility to the sciences and teaching strategies used in Agricultural Education.

Virtual learning works fairly well in urban environments, but perhaps less so in rural areas where Internet access may not be as readily available. Virtual classes could be considered as a new and different delivery option for agricultural courses. Because many CTE courses, especially those in Agricultural

Education, require practical application of knowledge and skills, the focus group members suggested that while a portion of an Agricultural Education class could be offered online, face-to-face classroom experiences would still be needed.

The focus groups noted the need for technology upgrades in laboratories and classrooms to facilitate instruction in the most current agricultural practices. This requires a thorough review of what is actually used in the industry. When equipment is highly specialized or very costly, perhaps partnerships with local businesses could provide a work-based experience for students.

End-of-Course Testing and Industry Credentials

Focus group members discussed the rationale behind industry credentials, including certifications and end-of-course tests. They realize that Standards of Learning (SOL) tests measure core academic performance, and they asked whether students taking a coherent sequence of CTE courses could take the relevant existing SOL test as mentioned in the "Shared/Blended Classes" section above. Additionally, current graduation requirements allow for industry credentials to serve as a verified credit for the student-selected verified credit and also for either a science or a history/social science verified credit. Students should be made aware of this Standard Diploma graduation requirement option. The group also encouraged work with industry certification entities to create and deliver high-quality tests that show student achievement in the agricultural fields.

Agricultural Education teachers' views on certifications mirrored those of the stakeholders in the desire for blended instruction for SOL tests. Because Agricultural Education provides strong mathematics and science components, agricultural courses could be reviewed to verify that specific academic course content is addressed, therefore enabling students to take the corresponding SOL test. Yet, they pointed out that a standardized, multiple-choice test cannot accurately measure the skills gained through a practical experiential course. The teachers also noted that all CTE courses are competency-based, and, therefore, proficiency in these competencies should be self-evident upon course completion.

The focus group members noted that additional industry credentials are needed for Agricultural Education students. However, they quickly added that demonstrating the skills that Agricultural Education students (and CTE students, in general) learn often cannot be assessed using a multiple-choice test.

In an effort to locate or create new industry credentials, perhaps Agricultural Education could partner with industry for funding for certifications, along with job placement. The focus groups offered the following ideas on industry credentials for Agricultural Education courses:

- Continue emphasis on their importance to obtaining employment.
- Ensure that approved credentials prepare students for college as well as for careers (college- and career-ready).
- Tie credentials locally to business/industry.
- Consider seeking Board of Education approval for the following industry credentials:
  - ◊ Forklift Operator
  - ◊ Nutrient Management Planning
  - ◊ Virginia Beef Quality Assurance
  - ◊ Virginia Certified Horticulturist.

Advanced vs. Standard Diploma

The stakeholders debated the current belief that it is impossible for students to take CTE courses for all

four years of high school and graduate with an Advanced Studies Diploma. The perception is that students who seek college admission have two choices: either (1) take Agricultural Education for only two years, then focus on weighted academic classes, or (2) take Agricultural Education for all four years and be resigned to go to a lower-ranked college or to a community college for two years before transferring to a four-year college. "You can't get there from here" with the current Advanced Studies Diploma requirements was the general sentiment.

However, exceptions were noted by local CTE administrators and the Department of Education staff. Access to this pathway could be enhanced when classes are offered at the middle school level for high school credit. Some Agricultural Education students attend a Governor's School and/or participate in Advanced Placement courses and move directly into a four-year college. For example, the Governor's STEM Academy reports show that more than 50 percent of their students graduated with an Advanced Studies Diploma and earned credit in courses taught at technical centers. These students completed the core academic requirements as well as earned nine or more dual-enrolled course credits.

Some Agricultural Education students attend a Governor's School and/or participate in Advanced Placement courses and move directly into a four-year college.

College Admissions

The Agricultural Education focus groups suggested that Agricultural Education students are not viewed favorably among postsecondary education personnel. A college of agriculture recruiter said these students are not recruited to attend the university. To counter this current trend, several ideas could be employed:

- Identify options that would make Agricultural Education students more attractive to the four-year higher education institution admissions officers.
- Offer more high-impact courses (dual or concurrent enrollment) and more weighted-credit courses.
- Employ dual-enrollment (high school/community college) options with guaranteed admission to the state's four-year higher education institutions.
- Address scheduling concerns by offering a portion of Agricultural Education course content online, thus permitting students to expand and enhance their transcripts.
- Increase blended courses (academic and CTE concepts taught together).

Agricultural Education Teacher Preparation

Challenge to Find Qualified Teachers

Some teachers lack specific training in safety, which is a concern voiced by the focus groups. Beyond the safety issue, Agricultural Education teachers need support from their local school divisions, professional associations, and the VDOE to further their professional development in new and emerging topics in their content areas. Teacher training and endorsements should be reviewed as Agricultural Education course content changes and evolves.

To ensure that Virginia can recruit and retain the best Agricultural Education teachers, the commonwealth must

- motivate students to enter teacher-education programs
- increase students' access to all agriculture-related college programs

- establish partnerships with the state's four-year and two-year institutions that can provide avenues for secondary teachers to gain recertification through taking courses related to new, high-tech agricultural content.

Agricultural Education teachers need more professional development if they are to teach new and emerging topics in their field.

Teacher Education Programs

Many Agricultural Education teachers are now provisionally licensed due to fewer teacher-education programs. Often, students complete four years in a college agricultural program but would have to stay a fifth year to earn a teaching endorsement.

People with technical agricultural skills could become teachers in local schools and take education courses along the way. This process has been used successfully in technical fields. Such an approach might help with increasing the supply of qualified Agricultural Education teachers.

The focus groups offered many ideas pertaining to teacher professional development and retraining:

- Address the technology gap between industry and classroom.
- Incorporate the new, high-tech aspects of agriculture.
- Encourage greater involvement in all conferences and courses that provide resources.
- Increase the number of online courses for teachers.
- Offer continual retraining opportunities resulting from stronger connections with business/industry.
- Identify and provide resources for teaching new technologies (tap national FFA and other associations for resources).
- Implement teaching techniques to address various learning styles.
- Encourage teachers to broaden their knowledge base to include other related subjects and to work with academic and technical education teachers to develop and deliver blended courses.

Trends

Agriculture is not what it used to be. The focus groups noted a few examples that show the extent to which agriculture has changed:

- Robotics is becoming more prevalent in agriculture-related jobs (e.g., milking cows).
- Global information and global positioning systems (GIS, GPS) are important to agricultural business.
- Viticulture (grape growing, winemaking) has become a vibrant industry in Virginia.
- There is a growing international appeal for agriculture and the diversity of its products.

The focus groups also noted that most Virginia Agricultural Education programs relate to production agriculture, but, in fact, an increasing number of jobs are in the allied occupations related to fields such as agricultural engineering, marketing, manufacturing, science, fields that keep production agriculture profitable and move produce from fields and forests to consumers.

New and Emerging Topics for Agricultural Education

The current curriculum needs to be reviewed to ensure that new and emerging topics are addressed, such as

- global hunger

- demand on U.S. agricultural production (helped by genetics and biotechnology)
- technological advances within all areas of agriculture
- food safety
- agriculture research (e.g., pharmaceutical application of agricultural products)
- general health and well-being
- climate change and its effect on production and supply-and-demand
- water management
- alternative energy sources (e.g., biofuels, wind)
- new businesses surrounding agriculture
- sustainability
- agricultural economics and finance
- global marketplace, global competition for agriculture products, and international trade
- agricultural engineering and new production equipment.

New Approaches to Offering Agricultural Education

The Agricultural Education focus groups offered ideas on new and different ways to offer Agricultural Education courses:

- Agricultural Education classes could be taught in regional Governor's Schools, especially those agriculture classes with a strong emphasis on science, technology, engineering, and mathematics (STEM).
- Short courses could be offered during the summer.
- Rigor needs to be increased so courses may be considered for two-year or four-year college credit
- Renewed emphasis on leadership skills, as offered through specific course curriculum and co-curricular FFA student organization activities.

A review of the research on other states offered the groups some insights into what new and emerging Agricultural Education courses could be offered in Virginia. (See Appendix F.)

The focus group members strongly believe that Agricultural Education is and should continue be a strong and viable course offering for all students in the commonwealth.

Ideas for the Future

The focus group members strongly believe that Agricultural Education is and should continue to be a strong and viable instructional program for all students in the commonwealth. To ensure this, however, they readily admit that changes are needed. Some suggestions they offered include the following:

- Eliminate logistical issues (e.g., location of technical centers, Agricultural Education classes in a comprehensive high school).
- Develop and offer a portion of agriculture course content through online delivery.
- Offer curriculum with a stronger emphasis on STEM, business management, and finance.
- Raise awareness of agricultural careers through repeatedly exposing students at all levels (K-12) to relevant information.
- Make more agriculture courses available to students in urban/suburban areas.
- Partner with local agriculture-related businesses to encourage summer and after-school internships.
- Continue and strengthen the dialog between business and education; the agriculture industry must help promote the importance of Agricultural Education.

III. The Agricultural Miracle: The Changing Face of Virginia Agriculture

Agricultural Education in Virginia must prepare students for the career opportunities in demand in the agricultural industry today and give them the skills they will need to grow into the career opportunities of the future. To do this, it is important to understand both today's agricultural employment and the trends that are driving change. Advances in science and technology have made it possible to produce more with fewer on-the-land workers than ever before in human history. As a result, more workers than ever before are needed in the off-the-land agriculture jobs that drive productivity, jobs in agricultural science, technology, marketing, manufacturing, engineering, and logistics. This trend is expected to continue. To prepare students for the jobs of the future, we must prepare them for the full diversity of agricultural employment.

Rising Productivity

For hundreds of years, agricultural productivity has risen and the demand for workers on the land has fallen. From the McCormick mechanical reaper to the Green Revolution, American engineers, farmers, and scientists have been steadily increasing the amount that can be produced on every acre of land and decreasing the number of workers needed to produce it, and this trend continued to accelerate through the 20th century. Consider the following statistics:

- Between 1950 and 2000, the average amount of milk produced per cow increased from 5,314 pounds to 18,201 pounds per year;
- The average yield of corn rose from 39 bushels to 153 bushels per acre; and
- Each farmer in 2000 produced on average 12 times as much farm output per hour worked as a farmer did in 1950.[1]

As agriculture has become much more productive, fewer people have been needed in fields and forests to get the job done. The 1950 national census counted 6,706,000 farmers, farm managers, laborers, and foremen, while the most recent Census Bureau data[2] finds only about 1,824,000 people working in these occupations today.

A Miracle Built on Science and Technology

This miracle of agricultural productivity has been made possible by the increasingly sophisticated application of technology and science. For example, after the Second World War, scientists began crossing varieties of wheat to make them more resistant to fungus, a positive side effect of which was that the wheat stalks were stronger and able to hold more grain. Wheat yields increased rapidly during the 1960s, and other types of grain were soon crossed to raise their yields.[3]

While increasing scientific and technological sophistication has decreased opportunities for employment on the land, it has expanded opportunities for employment off the land in the provision of agricultural services. We now have many more high-paying jobs for agricultural and food scientists and technicians, agricultural engineers, and others who design and produce the technology on which modern agriculture depends. For example, soil scientists have made great progress in the past few decades

[1] Keith O. Fuglie, James M. MacDonald, and Eldon Ball, "Productivity Growth in U.S. Agriculture," EB-9, U.S. Department of Agriculture, Economic Research Service, (September 2007), 1.

[2] U.S. Department of Commerce, U.S. Census Bureau, "Equal Employment Opportunity (EEO) Tabulation Based on 2006-2010 ACS, Table Set 10," (2013), http://www.census.gov/people/eeotabulation/data/eeotables20062010.html.

[3] Norman E. Borlaug, "Sixty-two Years of Fighting Hunger: Personal Recollections," *Euphytica* 157 (2007).

in understanding soil management. This has had a large impact on the practice of agriculture, and, consequently, farmers have had to develop new skills. However, rigorous soil management involves more than just up-skilled farmers; it requires expanding the production of soil-testing equipment and the availability of laboratories and technicians, the development of improved seed varieties, equipment for reduced tillage operations, the preparation of new instructional materials, the retraining of marketing and sales agents, and more.

While increasing scientific and technological sophistication has decreased opportunities for employment on the land, it has expanded opportunities for employment off the land in the provision of agricultural services.

The Increasing Range of Jobs in Agriculture

Science and technology have not only made agriculture more productive, they have also allowed us to increase the range of things that we do with agricultural products. Only a small fraction of produce is now consumed on the farm. Instead, it is shipped locally, nationally, and internationally, warehoused, sold, transformed through manufacturing processes, and sold again. Jobs are created at each of these stages, and yet more jobs are created to sustain the agricultural production and manufacturing enterprises: jobs for loan officers who handle farm mortgages, import-export specialists who handle the transit of agricultural cargo, and even for teachers who prepare Agricultural Education students in CTE programs.

In fact, almost all American industries have something to contribute to agriculture, and, as such, many of these industries will need workers who have studied and understand the processes of agricultural production. The real estate and mortgage business needs agents who understand farm land and how to value it. Software developers are needed to create the programs that run agricultural robots or help manage farm accounting. High schools, colleges, and universities need the teachers and scientists who will train the next generation of farmers, agricultural robotics technicians, soil scientists, and teachers.

In short, as agriculture becomes more efficient, scientific, and technical, the number of workers employed on the land shrinks while the number employed in jobs off the land grows. Along with this shift comes a steady increase in demand for higher education. Sophisticated agriculture requires high levels of education for those managing and working in agricultural services.

IV. Agricultural Production and Employment in Virginia

Although agriculture remained a major industry in Virginia throughout the 20th century, the growth in efficiency that characterized American agriculture as a whole also held true here. We made better use of our land and other resources every year, and employment on the land steadily fell.

At the beginning of the 20th century, just under 20 million acres, or 80 percent, of Virginia's land was farmland.[4] As recently as 1960, 13.5 million acres, or more than half, of Virginia's land was farmland.[5] By the beginning of this century, this figure had fallen to about 8.7 million acres.[6] Employment declined

[4]U.S. Department of Agriculture, "Farms and Property" in *Census of Agriculture* – Virginia, (1920), 34.

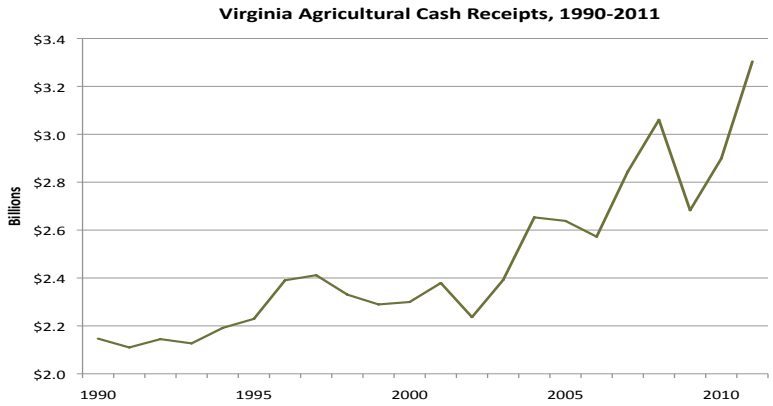
[5]Kevin Schmidt, "Office of Farmland Preservation," Virginia Department of Agriculture and Consumer Services, (2013), http://www.vdacs.virginia.gov/preservation/index.shtml.

[6]U.S. Department of Agriculture, "Land: 2002 and 1997" in *Census of Agriculture* – Virginia, (2002), Table 8.

as well. According to the 1940 census, about 233,000, or 25 percent, of Virginians worked in agriculture, forestry, fishing, and logging occupations, out of an employed population of 933,058. By 1970, employment in these three arenas had fallen significantly to about 73,000 workers, or 4 percent, of the employed population of 1,714,000. By 2000, the census reported about 13,200 farmers and farm managers and 16,200 workers in other farming, fishing, and forestry occupations, for a total of about 29,400 workers, or 1 percent of the employed population.

The 21st century is bringing great changes in the world's agricultural industry, and these are apparent in Virginia as well. We have experienced global increases in the demand for agricultural commodities both to feed the growing world population and as a result of the use of crops for the production of biofuels. This rising demand has lifted commodity prices and brought nationwide growth in financial returns to the agricultural industry and the value of commodities exported.

Through most of the 20th century, increasing productivity allowed agriculture to keep up with food demand even as the population grew, in part because so much of the growing world was so poor. Today, however, rising standards of living in developing countries, particularly in China, have increased demand for grains and produce and, especially, animal products. In 1985, China overall consumed less than half as much meat as was eaten in the U.S., despite having a population four times larger. By 2010, China consumed twice as much meat as the U.S.[7] The growing demand for meat and other animal products such as eggs and dairy has had a particularly strong impact on food prices because animals require large tracts of arable land for pasture and also consume large amounts of grain. Increasing demand is raising prices and increasing the profitability of American agriculture.



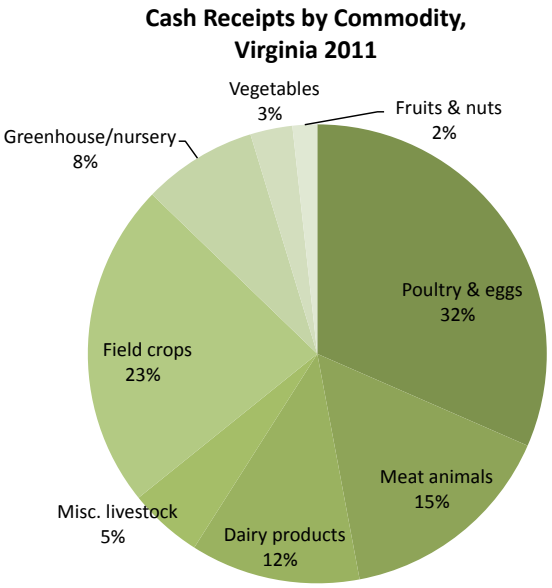
As world demand grew and prices increased, Virginia's agricultural cash receipts increased significantly, from about $2.2 billion in 1990 to about $3.3 billion in 2011.[8] Wheat, corn, peanuts, soybeans, and cotton sales have risen the most, and hogs and vegetables are the only two major commodities to have experienced a recent drop in sales. Despite the big increases in grain and peanut production, however, poultry, meat animals, dairy, and miscellaneous livestock are Virginia's biggest earners, bringing in 64 percent of Virginia's agricultural commodity income.[9]

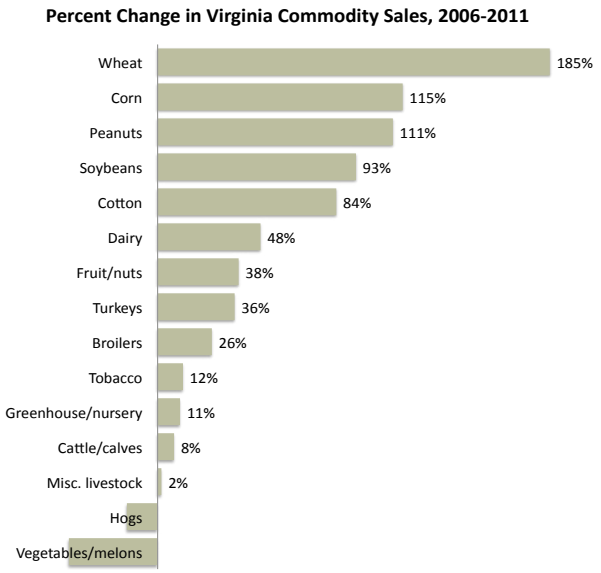
Forestry has faced more difficulty than farming in recent years. Demand for timber has fallen, largely as a consequence of recession and housing market turmoil, and timber harvests have decreased. Some return to growth is expected, however, as the economy gradually recovers, and domestic and international demand for wood products picks up.

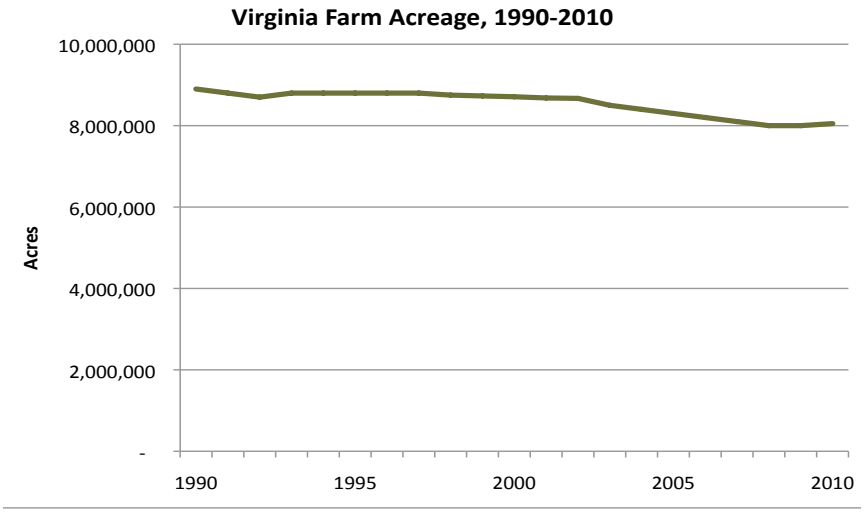
[7]U.S. Department of Agriculture, Foreign Agriculture Service. "Livestock and Poultry: World Markets and Trade," (2012).

[8]U.S. Department of Agriculture, Economic Research Service, Data prepared by Terance Rephann of the University of Virginia Weldon Cooper Center for Public Service for the forthcoming report Economic Impacts of Agriculture and Forest Industries in Virginia, (2013).

[9]Ibid.







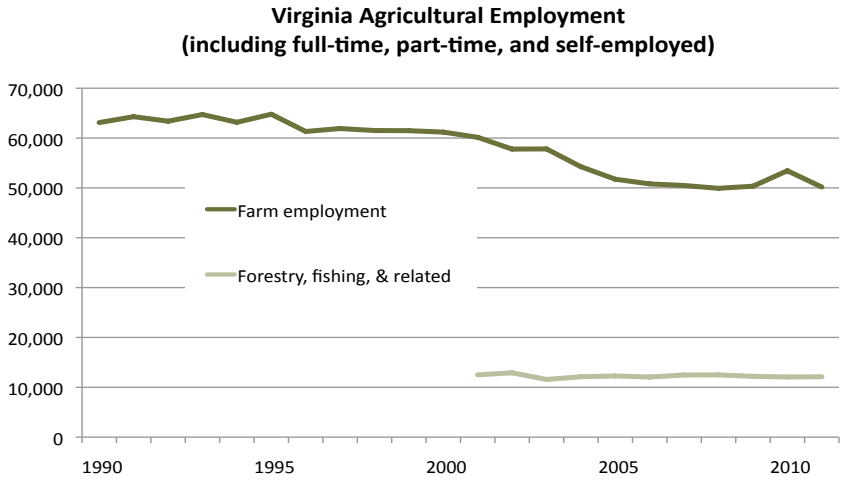
Although Virginia is earning more from agriculture every year, we are doing so using less land. Just as farm land declined in the 20th century, it has continued to fall in the 21st century, from about 8.7 million acres in 2000 to just over 8 million acres in 2010.[10]

Employment on the land in 21st century Virginia is also continuing the 20th century pattern of decline. Industry employment from the Bureau of Economic Analysis on "Farm Employment" and on "Forestry, Fishing, and Related" employment for full-time, part-time, and self-employed workers[11] data are shown in the chart below. Farm employment fell by about 2,000 workers over the 1990s—from 63,110 to 61,438. The decline continued even more rapidly in the first decade of the 21st century, as total employment fell about 22 percent from about 61,000 to 50,000. This is partially in response to the recent recession but is also evidence of continually improving efficiency. Forestry, fishing, and related industry employment is much smaller than farm employment and remained at about 12,000 workers from 2001 to 2011. The decline in farm employment nationwide is somewhat less steep than that found in Virginia. Farm employment was 3,153,000 in 1990, was 3,117,000 in 2000, and fell by about 17 percent to

[10]Rephann, Economic Impacts of Agriculture and Forest Industries in Virginia, (2013).

[11]U.S. Department of Commerce, Bureau of Economic Analysis, "Total full-time and part-time employment by NAICS industry for Virginia," Table BEA CA25N.

2,657,000 in 2010. As in Virginia, employment in the forestry, fishing, and related industries remained roughly constant across the decade at about 850,000.[12]



While the Bureau of Economic Analysis industry data provide a broad-brush look at all farm employment, the USDA Census of Agriculture, conducted every five years and most recently in 2007, provides a much more detailed analysis of farming in Virginia (but not fishing, forestry, or any of the agricultural support occupations). Unfortunately, data from the 2012 census have yet to be released. It is likely, however, that the 2012 data will follow the trend of declining employment shown in the Bureau of Economic Analysis industry employment data.

The Census of Agriculture also reveals that Virginia shares in the nationwide trend of aging farmers. In 2007, almost 8,800 of Virginia's farms had principal operators age 65 and older, while only about 700 had principal operators age 34 or younger. The average age of farmers has been rising steadily for decades and is expected to be higher still when the results of the 2012 Census of Agriculture are released.[13]

Number of Virginia Farms by Age of Principal Farming Operator, 2007						
Age of operator	<25 years	25-34	35-44	45-54	55-64	>65
Farms	78	621	1,573	3,664	5,541	8,817

This raises many concerns about how young workers can be recruited to sustain American agriculture productivity. Nationwide efforts focus both on encouraging young people to pursue careers in agriculture and on finding ways to smooth the transition of farm property to younger generations. It is often difficult for senior farmers who have spent a lifetime accumulating wealth in agricultural assets to withdraw their equity and provide for transition to the next generation.[14] Virginia's Certified Farm Seeker and Farm Link programs work to ease this transition process in the commonwealth by providing management training to young farmers and building connections between farmers who wish to retire and those who are seeking farm access.

[12]U.S. Department of Commerce, Bureau of Economic Analysis, "Total full-time and part-time employment by NAICS industry for the United States," Table SA25N.

[13]U.S. Department of Agriculture, "Summary by Age and Primary Occupation of Principal Operator" in Census of Agriculture – Virginia, (2007), http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/ Virginia/st51_1_063_063.pdf

[14]Peel, Derrell, Doye Damona and Mary Ahern 2013. "Drivers of Agricultural Transition" Choices 2013, 28 (2). Page 4.

V. The Impact of Agriculture Extends Beyond the Farm

Although only a small percentage of Virginians work on the land or on farms (roughly 50,000 on farms and 12,000 in fishing and forestry), Virginia agriculture generates substantial quantities of produce and is a major contributor to the state economy. Cash receipts for all agricultural commodities amounted to about $3.3 billion in 2011.[15] Moving goods of this value from the field to the consumer involves many additional steps, requires many additional workers, and adds billions to the Virginia economy. Transporting, manufacturing, and marketing food and other agricultural products employ large numbers of workers, as does creating and implementing the science behind agriculture, educating farmers and related workers, managing farm finance and farm sales, and supplying farmers with all of the additional support services they need. Additionally, the income that agriculture workers and support workers earn feeds the rest of the economy as they pay taxes and buy products and services.

A 2008 report commissioned by the Virginia Secretary of Agriculture and Forestry and written by Terance J. Rephann of the University of Virginia Weldon Cooper Center[16] estimates the economic impact of agriculture and forestry on the broader Virginia economy.[17] Rephann concludes:

The total economic impact of agriculture and forestry-related industries in Virginia was almost $79 billion in total industry output in 2006.

The total economic impact of agriculture and forestry-related industries in Virginia was almost $79 billion in total industry output in 2006, the base year for this study. The total employment impact was approximately 501,500 jobs, which makes up 10.3 percent of state employment. Every job created in agriculture and forestry-related industries results in another 1.5 jobs in the Virginia economy. Every dollar generated in value-added results in another $1.75 value-added in the Virginia economy.

Rephann looks at three different ways that agriculture impacts Virginia employment and the wider economy:

Direct effects—the result of the initial injection of economic activity or spending (that which takes place in farming or food processing).

Indirect effects—the additional impact on the economy that occurs when money retained in the state circulates through the economy (for instance, when state businesses provide supplies and services to agricultural and forestry industries, which, in turn, purchase some inputs from other state firms in order to produce their products).

Induced impacts—the result of the spending of household income attributable to the direct and indirect effects of agriculture.

Rephann estimates that the combined direct, indirect, and induced impact of Virginia agriculture included employment in 2006 for about 500,000 Virginians. Of this, about 66,931 jobs were in the

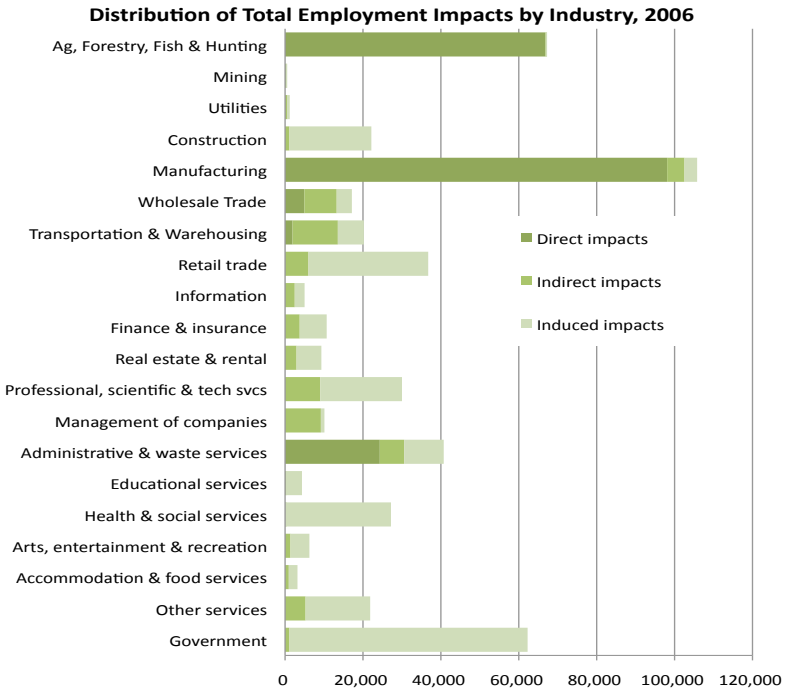
[15]Rephann, *Economic Impacts of Agriculture and Forest Industries in Virginia*, (2013).

[16]Ibid., 39.

[17]A more recent report, also by Terrance J. Rephann of the Weldon Cooper Center, updates the some of the material referenced here. The general pattern of agricultural employment in Virginia is similar to that detailed in the original report, though overall employment has declined. Terance J. Rephann, *The Economic Impacts of Agriculture and Forestry on the Commonwealth of Virginia*, (Charlottesville: University of Virginia Weldon Cooper Center, 2013).

agriculture, forestry, fishing, and hunting industries, and most of these jobs were the result of direct agricultural activity.

About 105,000 additional manufacturing jobs resulted from Virginia agricultural activity. More than 95,000 of these jobs were the result of direct effects, primarily through employment in food processing. Most of these jobs in other industrial sectors were created by indirect or induced impacts of agriculture. The chart[18] below illustrates the 2006 distribution of direct, indirect, and induced employment impacts across Virginia industries.



Employment in Occupations Benefiting from Agricultural Education

Although Rephann's research establishes the importance of agriculture and forestry for the Virginia economy as a whole, it is not particularly helpful for determining how to plan for and invest in Agricultural Education. Induced effect employment is almost entirely in fields not requiring Agricultural Education, as is a large but indeterminable amount of indirect-effect employment. Further, both direct-effect employment and agriculture-related indirect employment are spread over a wide range of different occupations that require different types of educational preparation.

To understand the range of employment that will benefit from agriculture-related education, it is more helpful to look at the most recent occupational employment estimates and projections produced for the state by the Virginia Employment Commission (VEC).[19] These estimates cover workers who are employed in more than 50 different occupations; they do not include the self-employed and consequently miss out on some workers, particularly in farming, where self-employment is common.

Plant Systems, the largest of the seven career pathways, is dominated by one of Virginia's larger occupations—landscaping and groundskeeping. Animal Systems, the pathway predicted to have the fastest growth for the rest of this decade, is dominated by veterinarians, veterinary technicians, and veterinary assistants—occupations serving our fast-growing pet industry.

[18]Ibid., 39.

[19]Virginia Workforce Connection, "2010-2020 Occupational Employment Estimates and Projections (Long Term)." https://www.vawc.virginia.gov.

Table I summarizes Virginia employment in the seven different career pathways within the overarching Agricultural, Food, and Natural Resources Career Cluster. Table II shows detailed information on individual occupations in each pathway.

Table I. Virginia Occupational Estimates and Projections for Career Pathways in the Agriculture, Food, and Natural Resources Career Cluster

Career Pathways	Estimated 2010	Projected 2020	Percent Change	Annual Openings
Agribusiness Systems	41,060	36,110	-12.1	810
Animal Systems	18,817	22,878	21.6	826
Environmental Service Systems	13,648	15,906	16.5	600
Food Products & Processing Systems	18,596	19,917	7.1	685
Natural Resources Systems	6,262	6805	8.7	256
Plant Systems	67,275	75,271	11.9	2,538
Power, Structural & Technical Systems	4,392	4,564	3.9	161
Total Employment	**170,050**	**181,451**	**6.28**	**876**

Occupations in the seven pathways employed about 170,000 workers in 2010, providing about 4 percent of employment in the state. The VEC projects that employment in Agricultural, Food, and Natural Resources occupations will increase by about 6 percent by 2020, growing more slowly than the state average for all occupations, which is projected to be 18 percent. As shown in the detailed occupations in Table II, projected employment growth varies tremendously by occupation. Significant growth is predicted in the veterinary, environmental science, and landscaping fields, but employment for farm managers and farm workers is expected to keep falling, as it has for decades. In addition to estimating and projecting total employment, the VEC makes an estimate of the number of job openings that will be available each year to workers newly entering an occupation. They do this by projecting both the job growth that will take place and the number of workers who will leave an occupation to retire or for other reasons. By this calculation, agricultural occupations in Virginia will generate almost 6,000 openings each year, which can be filled by workers newly entering the field.

As with all career clusters, many job openings are created in large, low-wage, high-turnover occupations. For example, about 20 percent of all job openings are expected to be for landscaping and groundskeeping workers. However, significant numbers of openings are expected for some better-paying jobs, including environmental engineers, environmental scientists and specialists, water treatment plant operators, and veterinary technicians.

Table II includes median annual wage data for Virginia from the U.S. Bureau of Labor Statistics. These data clearly show that wages for most of those who actually work on the land remain low despite the growth in Virginia sales of agricultural commodities. Farm workers, for example, earned median annual wages of less than $24,000 in 2011. The highest median wages were earned by those working in engineering and the sciences.

Table II. Virginia Occupational Estimates and Projections for Sampling of Occupations in the Agriculture, Food, and Natural Resources Career Cluster

Occupations[1]	Estimated 2010[2]	Projected 2020	Percent Change	Annual Openings	Predominant Education/ Experience/On-the-Job Traning[3]	Median Annual Wage, 2012[4]
Total Employment in Virginia	**3,923,952**	**4,623,926**	**17.8**	**163,414**		**$36,630**
Agribusiness Systems Pathway	**41,060**	**36,110**	**-12.1**	**810**		
Farmers, Ranchers, & Other Agricultural Managers	40,681	35,637	-12.4	793	HS or less & Experience	N/A
Farm & Home Management Advisors	379	473	2.2	17	BA/BS or more	$29,630
Animal Systems Pathway	**18,817**	**22,878**	**21.6**	**826**		
Veterinarians	2,171	2,987	37.6	125	BA/BS or more & Training	$87,610
Veterinary Technologists & Technicians	1,338	2,044	52.8	94	Some college & Training	$36,630
Veterinary Assistants & Lab Animal Caretakers	3,478	3,967	14.1	102	Some college & Training	$24,920
Animal Trainers	960	1,118	16.5	25	HS or less & Training	$26,910
Nonfarm Animal Caretakers	6,682	8,719	30.5	352	HS or less	$19,350
Farmworkers—Farm & Ranch Animals	4,188	4,043	-3.5	128	N/A	$23,790
Environmental Service Systems Pathway	13,648	15,906	16.5	600		
Environmental Engineers	2,039	2,454	20.4	87	BA/BS or more	$89,250
Environmental Engineering Technicians	410	500	22.0	17	Some college	$38,950
Conservation Scientists	467	560	19.9	15	BA/BS or more	$64,270
Environmental Scientists & Specialists	3,802	4,630	21.8	195	BA/BS or more	$75,270
Environmental Science Technicians	637	778	22.1	41	BA/BS or more & Training	$41,230
Water Treatment Plant/System Operators	2,814	3,100	10.2	102	HS or less & Training	$37,450
Refuse & Recyclable Material Collectors	3,479	3,884	11.6	143	HS or less	$28,470
Food Products & Processing Systems Pathway	18,596	19,917	7.1	685		
Food Scientists & Technologists	111	110	-0.9	4	BA/BS or more	$42,810
Agricultural & Food Science Technicians	152	152	0.0	5	Some college	$35,610
Supervisors—Farming, Fishing, Forestry	2,125	2,030	-4.5	61	HS or less & Experience	$43,460
Graders & Sorters—Agricultural Products	1,526	1,430	-6.3	37	HS or less	$20,120
Bakers	3097	3437	11.0	124	HS or less & Training	$24,330
Butchers & Meat Cutters	2722	3062	12.5	113	HS or less & Training	$30,090
Meat, Poultry, & Fish Cutters & Trimmers	5504	6315	14.7	241	HS or less	$21,620
Slaughterers & Meat Packers	497	530	6.6	17	HS or less & Training	$23,400
Food & Tobacco Machine Operators	591	567	-4.1	17	HS or less & Training	$28,110
Food Batchmakers	1894	1891	-0.2	53	HS or less & Experience	$26,910
Food Cooking Machine Operators & Tenders	377	393	4.2	13	HS or less & Experience	$25,140

1. *Titles have been abbreviated.*
2. *Estimates and Projections from Virginia Workforce Connections, Labor Market Data.*
3. *Levels assigned by the Weldon Cooper Demographics and Workforce Group based on Bureau of Labor Statistics education and training data.*
4. *U.S. Bureau of Labor Statistics, Occupational Employment and Wage Estimates, Virginia.*

Occupations[1]	Estimated 2010[2]	Projected 2020	Percent Change	Annual Openings	Predominant Education/ Experience/On-the-Job Traning[3]	Median Annual Wage, 2011**
Natural Resources Systems Pathway	**6,262**	**6,805**	**8.7**	**256**		
Natural Sciences Managers	1,202	1,350	12.3	87	BA/BS or more & Experience	$129,770
Landscape Architects	676	785	1.5	25	BA/BS or more & Training	$66,650
Zoologists & Wildlife Biologists	303	319	5.3	9	BA/BS or more	$56,950
Foresters	308	316	2.6	5	BA/BS or more	$53,030
Forest & Conservation Technicians	434	469	8.1	22	BA/BS or more	$34,460
Fish & Game Wardens	255	234	-0.9	6	BA/BS or more & Training	$41,490
Forest & Conservation Workers	113	119	5.3	4	HS or less & Training	$32,060
Fallers	276	279	1.1	7	HS or less & Training	$28,380
Logging Equipment Operators	1,680	1,766	5.1	49	HS or less & Training	$29,980
Log Graders & Scalers	146	174	19.2	7	HS or less & Training	$27,130
Plant Systems	**67,275**	**75,271**	**11.9**	**2,538**		
Soil & Plant Scientists	160	180	12.5	8	BA/BS or more	$56,540
Biological Technicians	953	1,079	13.2	45	BA/BS or more	$38,060
Supervisors/Managers—Landscaping, Lawn Service	5,806	6,996	20.5	203	HS or less & Experience	$43,380
Landscaping & Groundskeeping Workers	31,574	39,933	26.5	1,394	HS or less	$22,670
Pesticide Handlers	461	516	11.9	14	HS or less & Training	$32,950
Tree Trimmers & Pruners	1,158	1,421	22.7	46	HS or less	$32,540
Farmworkers—Crop, Nursery, & Greenhouse	26,585	24,586	-7.5	810	N/A	$21,800
Agricultural Workers, All Other	578	560	-3.1	18	N/A	$23,010
Power, Structural & Technical Systems	4,392	4,564	3.9	161		
Agricultural Engineers	267	360	34.8	15	BA/BS or more	N/A
Agricultural Equipment Operators	2,637	2,447	-7.2	80	N/A	$28,520
Farm Equipment Mechanics	411	454	10.5	15	HS or less & Training	$34,390
Outdoor Power Equipment Mechanics	1077	1303	1.9	5.1	HS or less & Training	$32,120

1. *Titles have been abbreviated.*
2. *Estimates and Projections from Virginia Workforce Connections, Labor Market Data.*
3. *Levels assigned by the Weldon Cooper Demographics and Workforce Group based on Bureau of Labor Statistics education and training data.*
4. *U.S. Bureau of Labor Statistics, Occupational Employment and Wage Estimates, Virginia.*

Tables I and II illustrate the VEC's assessment of employment needs in specific occupations in the agricultural and natural resources arena: farm managers, agricultural engineers, food scientists, and so forth. However, the range of workers who need some level of agricultural knowledge to perform their jobs is broader than this. Some percentage of, for example, claims adjusters, real estate appraisers, loan officers, lawyers, fire inspectors, travel guides, and transportation supervisors need knowledge of agricultural practice, management, and/or finance, but it is extremely difficult, based on available data, to estimate the actual number of workers who will need this knowledge.

Researchers at Purdue University have estimated the need for agricultural employment at the national level with the support of the U.S. Department of Agriculture.[20] Beginning with U.S. Bureau of Labor

[20]Allan D. Goecker et al., "Employment Opportunities for College Graduates, U.S. Department of Agriculture," (2008), http://www3.ag.purdue.edu/USDA/employment/Pages/default.aspx.

Statistics (BLS) data on occupational employment in 2008, they have created estimates of the average annual number of job openings for individuals with a bachelor's or higher degree in a wide range of jobs for which the BLS does not create agriculture-specific estimates. They conclude that nationwide there will be about 54,000 annual agricultural job openings in four main career arenas—Management and Business; Science and Engineering; Agriculture and Forestry Production; and Education, Communication, and Governmental Services—and they have highlighted priority occupations in each arena. It is not possible to determine exactly how many of these 54,000 job openings will be available specifically in Virginia. However, given the size of Virginia's agriculture industry relative to that of other states,[21] 3,000—4,000 job openings in this state seems likely.

Employment Opportunities Nationwide	
Management and Business **About 25,700 average annual job openings**	**Science and Engineering** **About 14,500 average annual job openings**
Agricultural Sales and Service Representative Environmental Compliance Specialist Financial Planner and Manager Food Marketing Manager Forest Products Manager Grain Merchandiser Green Industry Products Manager Human Resources Specialist Land Use Planner Resource and Alternative Energy Economist	Animal Pathologist Biological Engineer Biostatistician Environmental Scientist Food Scientist Human Nutritionist Nanotechnologist Plant Geneticist and Breeder Public Practice Veterinarian Renewable Energy Engineer
Agricultural and Forestry **About 7,900 average annual job openings**	**Education, Communication, and Governmental Services** **About 6,200 average annual job openings**
Crop Management Consultant Food Animal Veterinarian Herd Manager Land Use Manager Poultry Production Manager Precision Agriculture Specialist Organic Agriculture Entrepreneur Renewable Energy Crop Producer Restoration Forester Seed Producer	Climate Change Analyst Computer Graphics Technologist Distance Education Specialist Ecotourism Specialist Electronic Information Architect Food Safety Information Specialist Health Communicator Natural Resources Conservation Specialist Rural Development Specialist Science Communicator

VI. Employment Summary

Agricultural employment is counted in different ways, none of them perfectly satisfactory. To summarize the data presented so far:

- The Bureau of Economic Analysis estimates that about 50,000 persons (including the self-employed) work on Virginia farms. According to the 2007 Census of Agriculture, about 13,600 farm workers were employed full-time, and about 6,000 principal operators earned more than half of their household income from farming.
- The Virginia Employment Commission estimates that about 170,000 persons (or 4 percent of total employment) work in occupations in the Agriculture, Food, and Natural Resources Pathway. About half work on the land and the other half in food processing, agricultural services, or natural

[21]U.S. Department of Agriculture, Economic Research Service, "Value-added to the U.S. Economy by the agricultural sector via the production of goods and services, by component and net farm income, 1949-2011. http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics.aspx#.Ue1QsmRT-1MY

resources (including forestry). These occupations are projected to generate about 6,000 job openings per year. The self-employed are not included in these numbers.

- An additional, unknown number of workers requires agricultural background knowledge to be successful in their particular positions in occupations, such as marketing or logistics, that are not in themselves agricultural. These positions are numerous and important, but there is no way to quantify them.

The greatest opportunities and highest wages are found in off-the-land occupations that require technical and entrepreneurial as well as agricultural knowledge.

Wages for those who are employed on the land as farm workers, loggers, or landscapers, for example, or in the food processing industry, have remained stubbornly low despite the recent increase in profitability of the agricultural industry as a whole. The greatest economic opportunities are available to agricultural entrepreneurs, to those working in agricultural services occupations that require a postsecondary degree (such as agricultural sciences and engineering), and to those in the uncountable occupations that require some specific agricultural knowledge (such as real estate agents who specialize in farm sales, or logisticians who specialize in the international distribution of agricultural commodities).

This information on agricultural employment in Virginia can help us plan Agricultural Education courses and programs that will support the mission of preparing students for high-demand, high-skill, high-wage occupations. It tells us that the greatest opportunities and highest wages are found in off-the-land occupations that require technical and entrepreneurial as well as agricultural knowledge. To meet this need, Career and Technical Education will need to improve both the scientific and technological and the business and managerial content of its offerings while continuing to provide the fundamental training in agriculture that will help students to relate these skills back to “on-the-land” expertise.

VII. Agriculture Trends Impacting Employment Demand and Required Skills

Trends emerging from the wider society and from within agriculture itself will also influence the future of agricultural employment and the skills that will be required in agricultural jobs. Awareness of these trends must also guide Agricultural Education course and program planning. Many important trends emerge from the review of literature on agriculture; this report highlights the following six.

1 Productivity Will Increase and Employment on the Land Will Decrease

Agricultural productivity has risen for hundreds of years, and experts expect it to keep rising as science continues to improve produce, livestock, and their management. In particular, new and improved automation technology, such as global positioning systems (GPS) and agricultural robotics, is expected to become increasingly available over the next few decades. This automation is likely to further cut the demand for low-skilled agricultural workers, just as the automation of factories has cut the demand for manufacturing workers. Demand for high-skilled workers is likely to remain stable or possibly increase.

2 Agricultural Science and Technology Will Drive Increases in Productivity

For more than a century, American agriculture has been increasing production and sales while decreasing labor and land use, a pattern that shows no signs of changing. Major sources of increased

productivity today include the following:[22]

- *Genetically engineered crops, which have expanded from their introduction in the late 1990s, now dominate U.S. grain and cotton production and are significant in many other arenas.*
- *Soil management practices such as crop rotation systems and crop residue management improve soil quality and water management and can lead to higher returns by reducing fuel, labor, fertilizer, and machinery costs.*
- *Pesticide and nutrient use and management have become significantly more sophisticated in recent decades. More options are available, and more care is needed to combine these inputs with judicious soil management practices and appropriate genetically engineered crops to generate the maximum yield at the minimum cost and with the least amount of harm to the environment.*
- *Technological innovations include larger and faster equipment, the widespread use of GPS technologies that allow the automation of cultivating and harvesting machinery, precision agriculture tools such as yield monitors that allow farmers to better match seed, fertilizer, and pesticide applications, and the growing field of agricultural robotics that has the potential to revolutionize the planting and harvesting of many crops that are still hand-cultivated today and to tackle tasks as diverse as milking cows and deboning chickens.*

Science and technology have increased the need for specialized agricultural education at the same time they have increased agricultural productivity.

Science and technology have increased the need for specialized agricultural education at the same time they have increased agricultural productivity. Farmer managers who want to compete in the marketplace need scientific education to understand new crops and new soil and pesticide management practices, and both they and farm workers need to boost their technology skills if they are to take advantage of new equipment, from GPS to agricultural robots. However, farm managers and workers are not the only ones who need this knowledge. Agricultural science and technology employs more people off the farm than on it—scientists and engineers who devise new crops, pesticides, soil management systems, and equipment; educators who explain how to use these innovations; marketers who move these products and ideas from the lab or the factory onto the farm; and technicians who keep all this technology rolling.

3 World Population, Affluence, and International Trade Will Continue to Grow

Booming international trade, the consequence of world population growth, and increasing affluence also affect Virginia agriculture and the skills and education that people need to work in the field. International exports of agricultural products have grown between 43 and 63 percent (depending on the measure used to calculate the increase) between 2006 and 2010.[23] Meeting this international demand will lead farmers to focus on major export crops such as wheat and soybeans.

It is possible that increasing world demand will eventually lead America's farmers to expand the amount of land in cultivation, though this trend is not now evident. The amount of land being

[22]Erik Donohue et al., "The Changing Organization of US Farming," USDA Economic Research Service, Economic Information Bulletin 88 (December 2011), Chapter 4.

[23]Rephann, *Economic Impacts of Agriculture on Forest Industries in Virginia*, (2013), 12.

farmed in Virginia has decreased for decades, and, consequently, there may be considerable room for re-expansion. Given the vast new efficiencies expected in agriculture, however, even an expansion in land use is unlikely to lead to significant increases in on-the-land employment. Rising international demand for Virginia's agricultural products is more likely to increase demand for those working in agricultural services, particularly fields that serve international trade, including agricultural product transportation, storage, shipping, logistics, and commodity brokerage.

Rising international trade puts additional demands on the skill levels of farmers and those working in agriculture service industries. Competitive international trade rewards economies of scale, investment in the latest technology, and market knowledge more than it rewards the customer relations and direct marketing skills that are so important for success in the also-growing arenas of agritourism and local foods.

4 Agricultural Business Will Continue to Become More Complex

The business of modern agriculture is complex, and farmers face many economic choices every year.[24] Should they incorporate as a business or run as a sole proprietor? Rent or buy their land, equipment, or livestock? Negotiate marketing or production contracts for their commodities or try to make a go as an independent seller? Buy insurance, and from whom, or do without? Enter the daunting world of government subsidies and payment, or stay away? Making the best choices among these options every year likely determines the success or failure of every farm. Consequently, students who go into farm management need sophisticated agribusiness education; they cannot survive as producers on their knowledge of agriculture alone.

Moreover, farm managers are not the only ones who need this education. The business side of agriculture may well offer more employment off the farm than on it—employment in agricultural real estate, contracting, finance, insurance, marketing, and even in the U.S. Department of Agriculture, which is reported to have more than 100,000 employees itself, including experts in agribusiness and government subsidies as well as scientists and technicians.

5 Agritourism Will Increase

The USDA began collecting data on agritourism in 2002, and by 2007, income from this sector had risen considerably. In 2002, farmers in Virginia reported $2.7 million in income from agritourism; by 2007, this figure had risen by five times to $13 million.[25] The results of the 2012 Census of Agriculture are not yet available, but it is anticipated that they will show continued significant growth in this arena over the past five years. Many of Virginia's localities have put significant effort into developing agritourism in recent years, and they report significant success.

For instance, the Shenandoah Valley has developed a wide variety of agritourism activities, with total sales reaching an estimated $22.4 million in 2011 in the central Shenandoah Valley and more than 700 directly employed in agritourism businesses.[26] A recent study of agritourism in Virginia

[24]Donohue, *"The Changing Organizaton of US Farming,"* Chapter 2.

[25]U.S. Department of Agriculture, "Summary by Age and Primary Occupation of Principal Operator" in *Census of Agriculture* – Virginia, (2002), Table 61, and "Summary by Age and Primary Occupation of Principal Operator," (2007), Table 63.

[26]Chmura Economics & Analytics, "The Economic Impact of Agritourism in Virginia's Fields of Gold Region," (2012), http://www.cspdc.org/fieldsofgold/documents/FieldofGold_Final.pdf, 30.

Beach[27] found that even in that urbanized area, agritourism had a nearly $8 million direct output in the city in 2010 and accounted for a third of the direct employment in agriculture.

Increasingly, Virginia's farmers are supplementing their agricultural incomes with income from agritourism. In some cases, this exceeds crop and livestock income, and in many cases it can make the difference between profit and loss. Virginia's wine industry has blossomed in part because our wineries offer tourist experiences as well as bottles of wine. They host weddings, tastings, concerts, and all sorts of other events and maintain a countryside environment that they carefully market to a range of consumers. But wineries are only our best-known type of agritourism venue; much more is on offer here, including specialist on-farm markets, fairs and festivals, inventive new forms of outdoor recreation, home stays, petting zoos, and pick-your-own operations.

In order to keep up with the demands of agritourism, agricultural education will have to expand well beyond its traditional boundaries.

Each of these enterprises requires imagination, a keen eye for consumer tastes, and sophisticated marketing skills that were not often demanded of traditional farmers. In order to keep up with the demands of agritourism, Agricultural Education will have to expand well beyond its traditional boundaries.

6 Demand for Fresh, Local, and Organic Food Will Grow

Virginia consumers are increasingly concerned about the quality, healthfulness, and environmental effects of food and are demanding that more be locally and/or organically grown. This trend is reflected in the increase in the amount of produce that is sold directly to consumers from Virginia farms. Although still only a tiny portion of total farm receipts, direct sales have been growing. According to the Census of Agriculture, they increased from about $11 million to $29 million between 1997 and 2007,[28] and the 2012 census is expected to show even more dramatic growth. The market for fresh, local, and organic food is also expanding well beyond the direct sales market as Virginia entrepreneurs develop new marketing enterprises that connect small producers with stores and restaurants whose customers want to be part of this movement. Farmers and agricultural marketing entrepreneurs who deal in fresh, local, and organic food need to develop new skills, many of which overlap with those required in agritourism, including marketing and customer service skills.

These are just a few of the trends that are emerging in modern agriculture and will impact agricultural jobs and the education students need to enter these occupations. Automation and other new technologies are likely to reduce the demand for low-skilled, on-the-land workers and continue reducing the demand for low-skilled workers in food processing. Farm managers will need additional marketing skills to understand the complex customer relations required in agritourism and the local food movement. Those working in mass market agriculture will need modern management and business skills. And both groups of managers will need to keep up with science and

[27]Terance J. Rephann, *Agriculture in Virginia Beach: Impact on the City Economy*, (Charlottesville: University of Virginia Weldon Cooper Center, 2012), 17.

[28]2002 Census of Agriculture, Summary by Tenure of Principal Operator and by Operators on Farm, Table 61 and 2007 Census of Agriculture, Summary by Age and Primary Occupation of Principal Operator, Table 63.

technology in order to remain competitive. The larger arena of agricultural service employment is also demanding new and expanded skills, in science, technology, marketing, and business.

International agriculture is becoming more competitive as prices rise and nations invest more in commodity production. Without a continuing focus on global competitiveness and investment in skills and technology, American agriculture could find itself in a difficult position, despite the natural advantage that our vast land resources give us. Fortunately, however, we are by no means in this position today. The U.S. Department of Agriculture forecasts a record $142 billion in agricultural exports for 2013, and a trade surplus of almost $30 billion and says that "overall, world macroeconomic factors will be very favorable for U.S. farm export volumes in 2013."[29]

VIII. Conclusions and Recommendations for Course and Program Planning in Career and Technical Education

This report makes it obvious that maintaining and upgrading the scientific and technical content of CTE Agricultural Education courses is essential to prepare students for agriculture-related jobs of the future. However, several other strategies are also important:

1. *Career and Technical Education programs in agriculture must focus on preparing students for entry-level jobs that can lead to high-skill, high-demand, and high-wage careers in agriculture and related fields in close partnership with employers.* A broad view such as is provided in this paper is useful but is not a substitute for direct advice from local employers on the programs, skills, and certifications that are in demand in the local workplace.
2. *Many viable careers in agriculture require postsecondary education or further training.* Students in Agricultural Education should receive academic and technical preparation and career planning that qualifies them for admission to postsecondary institutions or for futher technical training.
3. *High-paying agricultural occupations require knowledge of agriculture combined with supplementary knowledge and skills.* The most commonly valuable of these are in the fields of business management, marketing, science, and technology, and students should be prepared for postsecondary programs that combine agricultural studies with studies in one or more of these areas. *Agricultural Education programs need to prepare students to develop a broad knowledge base, not a narrow one.*

With business and industry input, rigorous and relevant educational offerings in agriculture will address new and emerging fields in the commonwealth's largest industry.

The findings from this strategic review reveal that Agricultural Education in Virginia, by any name and offered at any educational level, must partner closely with the public and private sectors to ensure long-term success of its programs and, more importantly, its students.

Priority attention will be given to the following recommendations:

1. Review and update the state-approved Agricultural Education course curriculum frameworks and adhere to the required three- to five-year revision schedule. Pay particular attention to

[29]U.S. Department of Agriculture, "Summary by Age and Primary Occupation of Principal Operator" in *Census of Agriculture* – Virginia, (2002), Table 61 and "Summary by Age and Primary Occupation of Principal Operator," (2007), Table 63.

updating scientific and technical competencies and building the broad base of business, management, and marketing knowledge required for current and future occupations in agriculture.

2. Use the nationally recognized 16 Career Clusters and associated Career Pathways as the basis for curriculum frameworks. This system is designed to inform students about the range of occupations available in agriculture and related fields and the educational pathways required to qualify for them.

3. Ensure that students have access to a comprehensive, coherent sequence of courses and programs that provide the necessary academic, technical, and employability knowledge and skills for successful transition to postsecondary education and careers.

4. Increase the enrollment and program completion rates in Agricultural Education courses to meet current and future workforce needs.

5. Facilitate students' transition from secondary to postsecondary agriculture programs by:
   - ◊ implementing blended agriculture/academic courses that engage students in rigorous and relevant problem-based experiences and inquiry-based science
   - ◊ developing and pilot testing selected Agricultural Education courses that incorporate science-area SOL competencies so that successful completion of the course enables a student to sit for the relevant SOL exam
   - ◊ promoting the development and completion of dual and/or concurrent enrollment courses to earn postsecondary certificates, a one-year Uniform Certificate of General Studies, or an associate degree from a community college concurrent with a high school diploma
   - ◊ encouraging the Governor's STEM Academy programs within agriculture career pathways to require at least nine transferable college credits (including dual enrollment, Advanced Placement, and International Baccalaureate options).

6. Support professional development of Agricultural Education teachers, particularly opportunities for secondary teachers to:
   - ◊ address certifications in the context of their curriculum
   - ◊ enhance problem-based learning instruction, including teaching and learning science through intensive training workshops
   - ◊ acquire and maintain current technology skills, including offerings through the IT Academy initiative
   - ◊ expand partnerships with Virginia's two-year and four-year institutions for the recertification of secondary teachers in courses related to emerging high-tech agricultural content.

7. Recruit and retain Agricultural Education teachers through:
   - ◊ motivation of students to enter teacher-education programs
   - ◊ increased student access to agriculture-related college programs.

8. Maintain partnerships with Virginia employers at the state level to ensure that curricula and the overall direction of the Agricultural Education program stays current and relevant to the demands of industry.

9. Encourage the engagement of local employers and community-based partners to ensure that agriculture programs meet local needs, and that students have opportunities for a significant work-based learning experience(s), such as supervised agricultural experience programs.

10. Promote, as part of the Virginia Career and Technical Education rebranding initiative, new and innovative 21st century agriculture, food, and natural resources programs to students, educators, school counselors, parents, businesses, and community partners.

11 Encourage the agricultural industry to establish an Agricultural Education Stakeholders Group that will meet annually in partnership with the Virginia Department of Education and the Virginia Department of Agriculture and Consumer Services for updates on accomplishments and goals for continuous improvement:

- ◊ Recommend that stakeholders provide updates at regional meetings of local school division superintendents, local CTE directors, and business partners and advisory groups to share Agricultural Education efforts in their region.

With business and industry input, rigorous and relevant educational offerings in agriculture will address new and emerging fields in the commonwealth's largest industry. Working with the strong research entities and teacher preparation programs in higher education institutions across the state, Agricultural Education will infuse the latest technology, teaching methodologies, and curricular content into its course offerings. Virginia must continue to prepare students for the many agriculture-related jobs that exist now and in the future. This is critical for the economic growth and well-being of the commonwealth and its vital contributions to the ever-changing global economy.

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Appendices

PATHWAYS TO COLLEGE & CAREER READINESS

CareerClusters™ The 16 Career Clusters™

One of the keys to improving student achievement is providing students with relevant contexts for studying and learning. Career Clusters™ do exactly this by linking school-based learning with the knowledge and skills required for success in the workplace. The National Career Clusters™ Framework is comprised of 16 Career Clusters™ and related Career Pathways to help students of all ages explore different career options and better prepare for college and career.

Each Career Cluster™ represents a distinct grouping of occupations and industries based on the knowledge and skills they require. The 16 Career Clusters™ and related Career Pathways provide an important organizing tool for schools to develop more effective programs of study (POS) and curriculum.

- **Agriculture, Food & Natural Resources**

  The production, processing, marketing, distribution, financing, and development of agricultural commodities and resources including food, fiber, wood products, natural resources, horticulture, and other plant and animal products/resources.

- **Architecture & Construction**

  Careers in designing, planning, managing, building and maintaining the built environment.

- **Arts, A/V Technology & Communications**

  Designing, producing, exhibiting, performing, writing, and publishing multimedia content including visual and performing arts and design, journalism, and entertainment services.

- **Business Management & Administration**

  Careers in planning, organizing, directing and evaluating business functions essential to efficient and productive business operations.

- **Education & Training**

  Planning, managing and providing education and training services, and related learning support services such as administration, teaching/training, administrative support, and professional support services.

- **Finance**

  Planning and related services for financial and investment planning, banking, insurance, and business financial management.

- **Government & Public Administration**

  Planning and executing government functions at the local, state and federal levels, including governance, national security, foreign service, planning, revenue and taxation, and regulations.

- **Health Science**

  Planning, managing, and providing therapeutic services, diagnostic services, health informatics, support services, and biotechnology research and development.

- **Hospitality & Tourism**

  Preparing individuals for employment in career pathways that relate to families and human needs such as restaurant and food/beverage services, lodging, travel and tourism, recreation, amusement and attractions.

- **Human Services**

  Preparing individuals for employment in career pathways that relate to families and human needs such as counseling and mental health services, family and community services, personal care, and consumer services.

- **Information Technology**

  Building linkages in IT occupations for entry level, technical, and professional careers related to the design, development, support and management of hardware, software, multimedia and systems integration services.

- **Law, Public Safety, Corrections & Security**

  Planning, managing, and providing legal, public safety, protective services and homeland security, including professional and technical support services.

- **Manufacturing**

  Planning, managing and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance and manufacturing/process engineering.

- **Marketing**

  Planning, managing, and performing marketing activities to reach organizational objectives such as brand management, professional sales, merchandising, marketing communications and market research.

- **Science, Technology, Engineering & Mathematics**

  Planning, managing, and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.

- **Transportation, Distribution & Logistics**

  The planning, management, and movement of people, materials, and goods by road, pipeline, air, rail and water and related professional and technical support services such as transportation infrastructure planning and management, logistics services, mobile equipment and facility maintenance.

Virginia Career and Technical Education is organized into the nationally recognized 16 Career Clusters. The Agriculture and Natural Resources Career Cluster is composed of seven Career Pathways, described here.

Learning that works for Virginia CTE™

AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER

Production, processing, marketing, distribution, financing, and development of agricultural commodities and resources including food, fiber, wood products, natural resources, horticulture, and other plant and animal products/resources

Career Pathway

1. Agribusiness Systems

Agribusiness is the coordination of all activities that contribute to the production, processing, marketing, distribution, financing and development of agricultural commodities and resources. This includes food, fiber, wood products, natural resources, horticulture, and other plant and animal products and services. Agribusiness is a high-tech industry that uses satellite systems, computer databases and spreadsheets, biotechnology and many other innovations to increase efficiency and profitability.

2. Animal Systems

People who work in the Animal Systems pathway work to develop better, more efficient ways of producing and processing meat, poultry, eggs and dairy products. They study genetics, nutrition, reproduction, growth and development of domesticated farm animals. Some individuals inspect and grade livestock food products, purchase livestock or work in technical sales or marketing. Others advise agricultural producers on how to upgrade animal housing facilities properly, lower mortality rates, handle waste matter or increase production of animal products, such as milk or eggs. Animal care workers train, feed, water, groom, bathe and exercise animals. They also clean, disinfect and repair their cages.

3. Environmental Service Systems

People who work in the Environmental Service Systems pathway are involved in water and air pollution control, recycling, waste disposal and public health issues. Environmental engineers and technicians conduct hazardous waste management studies, evaluate the significance of the hazard, offer analysis on treatment and containment, and develop regulations to prevent mishaps. They design municipal sewage and industrial wastewater systems. They analyze scientific data, research environmental projects and perform quality control checks.

4. Food Products and Processing Systems

People who work in the Food Products and Processing Systems pathway discover new food sources, analyze food content and develop ways to process, preserve, package or store food according to industry and government regulations. They create new food products to meet consumer needs and inspect food-processing areas to ensure that sanitation, safety, quality and waste management standards are met.

5. Natural Resources Systems

People who work in the Natural Resources Systems pathway perform a variety of tasks from helping to develop, maintain, and manage the forest and natural environment to catching and trapping various types of marine life for human consumption, animal feed, bait and other uses. Forest and rangelands supply wood products, livestock forage, minerals and water; serve as sites for recreational activities; and provide habitats for wildlife. Conservation scientists and foresters manage, develop, use and help protect these and other natural resources.

6. Plant Systems

People who work in the Plant Systems pathway study plants and their growth. This helps producers of food, feed and fiber crops continue to feed a growing population while conserving natural resources and maintaining the environment. Individuals in this pathway also develop ways to improve the nutritional value of crops and the quality of seeds. They use genetic engineering to develop crops resistant to pests and drought.

7. Power, Structural, and Technical Systems

People who work in the Power, Structural and Technical Systems pathway apply knowledge of engineering, hydraulics, pneumatics, electronics, power, structures, and controls to the field of agriculture. They design agricultural structures as well as machinery and equipment. They develop ways to conserve soil and water and to improve the processing of agricultural products.

Appendix C

CURRENT AGRICULTURAL EDUCATION COURSES

offered by the Virginia Department of Education's
Office of Career & Technical Education Services

Courses have been aligned to pathways within the Agriculture and Natural Resources Career Cluster and, in some cases, the Science, Technology, Engineering & Mathematics Career Cluster.

	Agribusiness Systems	Animal Systems	Environmental Service Systems	Food Products and Processing Systems	Natural Resources Systems	Plant Systems	Power, Structural, and Technical Systems	STEM
MIDDLE SCHOOL COURSES								
Agriscience Exploration ©2006	•	•	•	•	•	•	•	
Agriscience and Technology ©2006	•	•	•	•	•	•	•	
Introduction to Agriscience ©2009	•	•	•	•	•	•	•	
HIGH SCHOOL COURSES								
Agricultural Business Fundamentals ©2010	•	•				•	•	
Agricultural Business Management ©2010	•	•				•	•	
Agricultural Business Operations ©2010	•	•				•	•	
Agricultural Education--Development ©2008		•				•		
Agricultural Education--Preparation ©2008	•	•	•	•	•	•	•	
Agricultural Fabrication and Emerging Technologies©2012							•	•
Agricultural Power Systems; Advanced Ag. Power Systems ©2012							•	•
Agricultural Production Management ©1998	•	•	•	•	•	•	•	
Agricultural Production Technology ©1998	•	•	•	•	•	•	•	
Agricultural Structural Systems ©2012							•	•
Applied Agricultural Concepts ©1998		•			•	•		
Aquaculture Infusion Units ©2007					•			
Biological Applications in Agriculture ©2004		•	•	•	•	•	•	•
Biotechnology Applications in Agriculture ©2004		•	•	•		•	•	•
Biotechnology Foundations ©2011		•	•	•		•	•	•
Ecology and Environmental Management ©1998			•			•		•
Equine Management Production ©1998	•	•						•
Farm Equipment Operator ©unknown						•		
Fisheries and Wildlife Management ©2012		•	•		•			
Floral Design I, II ©2003						•		
Floriculture ©2003						•		•
Forestry Management; Advanced Forestry Management ©2012			•		•	•		•
Foundations of Agriculture, Food, and Natural Resources ©2010	•	•	•	•	•	•	•	
General Mechanics--Preparation ©unknown							•	
Greenhouse Plant Production and Management ©2003						•		
Horticulture Sciences ©2003			•			•		•
Introduction to Animal Systems ©2011	•	•	•	•	•		•	
Introduction to Leadership ©2005	•	•	•	•	•	•	•	•
Introduction to Natural Resources and Ecology Systems ©2010			•		•	•		•
Introduction to Plant Systems ©2010	•		•	•	•	•	•	
Introduction to Power, Structural, and Technical Systems ©2012							•	•
Land Use and Conservation Management ©2010			•		•			
Landscaping; Landscaping II ©2009			•			•		
Operating the Farm Business ©unknown	•	•	•	•	•	•		
Outdoor Recreation, Parks, and Tourism Systems Management ©2009					•			
Small Animal Care I, II ©2012		•						•
Small Engine Repair ©1998							•	•
Specialty Horticulture Arts ©2003						•		
Turf Grass Establishment and Maintenance ©2003			•			•		•
Turf Grass Applications, Advanced ©2003			•			•		•
Urban Forestry ©2009					•	•		
Veterinary Assistant I, II, III ©2012		•						
Veterinary Science ©2013		•						•

Virginia Department of Education
Career and Technical Education
Agricultural Education Course Enrollment 2011 - 2012

Course	Schools	Total
8002 - INTRODUCTION TO AGRISCIENCE G6 6/9/12/18 WKS	48	5,853
8003 - AGRISCIENCE EXPLORATION GR 7	60	5,067
8004 - AGRISCIENCE & TECHNOLOGY GR 8 18/36 WKS	58	3,532
Middle School Subtotal	**166**	**14,452**
8006 - FOUNDATIONS OF AGRICULTURE, FOOD, & NAT RESOURCES	96	3,930
8007 - INTRODUCTION TO PLANT SYSTEMS	4	123
8008 - INTRODUCTION TO ANIMAL SYSTEMS	51	1,396
8010 - AGRI PRODUCTION TECHNOLOGY	45	914
8012 - AGRI PRODUCTION MANAGEMENT	24	345
8014 - OPERATING THE FARM BUSINESS	8	156
8015 - EQUINE MANAGEMENT PRODUCTION - 18 WKS	6	167
8016 - INTRO TO POWER, STRUCTURAL & TECHNICAL SYSTEMS	22	664
8017 - AGRI STRUCTURAL SYSTEMS	6	79
8018 - AGRI POWER SYSTEMS	14	265
8019 - AGR FABRICATION & EMERGING TECHNOLOGIES	14	294
8020 - AGRI POWER SYSTEMS, ADVANCED	10	89
8021 - SMALL ENGINE REPAIR -18 WKS	7	227
8022 - AGRI BUSINESS FUNDAMENTALS	14	258
8024 - AGRI BUSINESS OPERATIONS	18	246
8026 - AGRI BUSINESS MANAGEMENT	5	73
8034 - HORTICULTURE SCIENCES	73	1,897
8035 - GREENHOUSE PLANT PROD & MGT	30	506
8036 - LANDSCAPING	38	635
8037 - SPECIALITY HORTICULTURE ARTS	2	26
8038 - FLORICULTURE	15	289
8039 - LANDSCAPING II	5	75
8040 - INTRO TO NATURAL RESOURCES AND ECOLOGY SYSTEMS	23	426
8041 - FISHERIES AND WILDLIFE MANAGEMENT	10	202
8042 - FORESTRY MANAGEMENT	15	235
8043 - OUTDOOR RECREATION, PARKS & TOURISM SYS MGMT	1	20
8044 - FORESTRY MANAGEMENT, ADVANCED	1	10
8045 - ECOLOGY & ENVIRON MANAGEMENT-18 WKS	4	105
8046 - ECOLOGY & ENVIRON MANAGEMENT-36 WKS	1	12
8050 - AGRICULTURAL EDUCATION - PREPARATION	3	24
8051 - TURF GRASS ESTABLISHMENT & MAINTENANCE	11	187
8053 - AGRICULTURAL EDUCATION - DEVELOPMENT	5	68
8054 - TURF GRASS APPLICATIONS, ADVANCED	3	46
8055 - FLORAL DESIGN I	9	173
8056 - FLORAL DESIGN II	6	143
8070 - GENERAL MECHANICS - PREPARATION	3	50
8072 - APPLIED AGRI CONCEPTS -18 WKS	4	212
8073 - APPLIED AGRI CONCEPTS -36 WKS	6	90
8080 - EQUINE MANAGEMENT PRODUCTION -36 WKS	21	405
8082 - SMALL ENGINE REPAIR -36 WKS	20	590
8083 - SMALL ANIMAL CARE I - 18/36 WKS	41	1,658
8084 - SMALL ANIMAL CARE II - 36 WKS	14	270
8086 - BIOLOGICAL APPLICATIONS IN AGRI	6	108
8087 - BIOTECHNOLOGY APPS IN AGRI	2	22
8088 - VETERINARY SCIENCE	20	407
8095 - AGRICULTURAL EDUCATION - DUAL ENROLLMENT	1	17
High School Subtotal	**737**	**18,134**
Program Totals:	**903**	**32,586**

Virginia Career and Technical Education: Agriculture, Food and Natural Resources

Virginia Department of Education, Office of Career and Technical Education Services

Learning that works for Virginia CTE™

February 2013

Virginia's 16 Career clusters and career assessments help students investigate careers and design their plan of study to advance their career goals. Within each career cluster, there are multiple career pathways that represent a common set of skills and knowledge, including academic, technical, and career readiness skills that lead to credentials necessary to pursue a full range of career opportunities from entry level to management, including technical and professional career specialties. CTE actively partners with business and industry to design and provide high quality, dynamic programs to meet current, emerging, and projected labor market needs. Relevant work-based learning opportunities and leadership development offered through career and technical student organizations are incorporated into the academic and career plan.

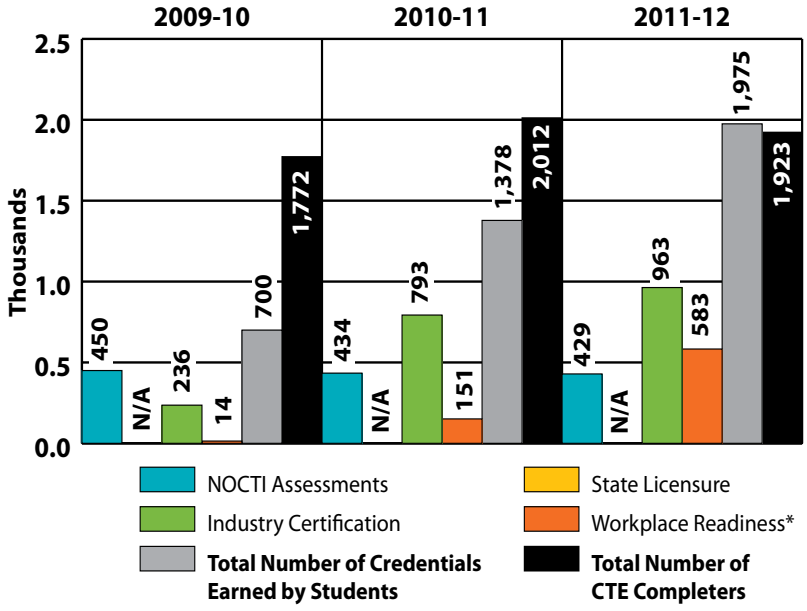
A CTE completer is a student who has met the requirements for a CTE concentration and all requirements for high school graduation, or an approved alternative education program. A concentration is a coherent sequence of state-approved courses. Students may take additional CTE courses that will enhance their career pathway goals. Completion of certain skill sets and coursework enables students to participate in Board-approved external examinations that test essential employability and technical skills.

Current Agriculture Credentials Offered

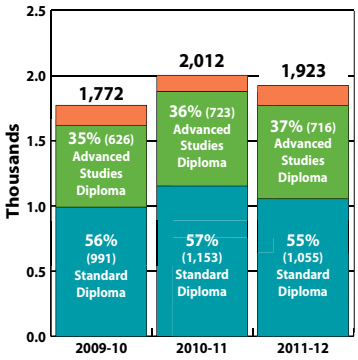
1. Agribusiness Examination - NY State/Cornell
2. Agricultural Biotechnology - NOCTI
3. Agricultural Mechanics and Technology - NY State/Cornell
4. Agriculture Mechanics - NOCTI
5. Animal Systems - NOCTI
6. Certified Veterinary Assistant - Animal Care Technologies
7. Commercial Pesticide Applicator - VDACS
8. Floriculture - NOCTI
9. Floriculture: Greenhouse - NOCTI
10. Forestry Products and Processing - NOCTI
11. Greenhouse Operator - Virginia Flower Growers Association
12. Horticulture: Landscaping
13. Natural Resource Systems - NOCTI
14. Outdoor Power Equipment Technician - EETC
15. Pet Sitters - National Association of Professional Pet Sitters
16. Private Applicator - VDACS
17. Production Agriculture - NOCTI
18. Registered Technician - VDACS
19. Small Animal Care - NY State/Cornell
20. Small Animal Science and Technology - NOCTI

Students who earn these credentials are eligible to earn verified credit towards graduation requirements.

Credentials Earned by CTE Students



Completers Graduated with Standard and Advanced Studies Diplomas



NOTE: *Completers may participate in one or more Board-approved credentialing test(s). Not all completers participate in the credentialing tests. There are age restrictions set by certain credentialing entities which would prohibit the student from testing until after high school. The cost of credentialing tests ranges from $9 to $155 per test or an approximate average cost of $54 per test.*

**Prior to 2010-11, Workplace Readiness Skills assessments were included in the Industry Certification category, but now are reported separately.*

Source: *Virginia Department of Education*

Virginia Career and Technical Education: Agriculture, Food and Natural Resources

continued

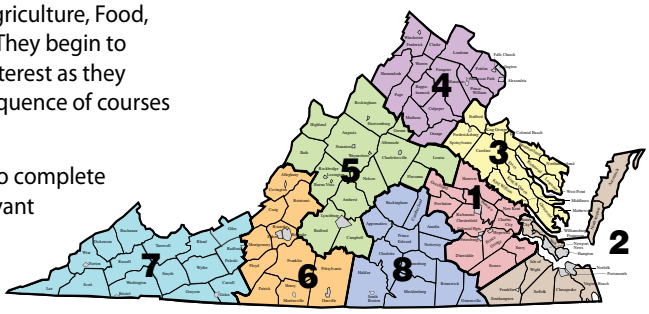
Learning that works for Virginia
CTE™

February 2013

The ***Agriculture, Food, and Natural Resources Career Cluster*** prepares you for careers that involve the science and mechanics of improving the quality and safety of food, cultivating and preserving our natural resources and caring for livestock and other animals. Careers in conservation, including reducing the use of chemical fertilizers and pesticides, soil and water conservation, sustainable forestry and wildlife are some options in this diverse cluster. Additionally, you can learn about the business aspects involved in this broad field.

Virginia high school students learn the essential academic skills that are critical for all careers and the foundational skills needed for careers in Agriculture, Food, and Natural Resources. They begin to specialize in a field of interest as they complete a coherent sequence of courses within a pathway.

Secondary students who complete these rigorous and relevant pathway programs are ready for entry into postsecondary education and Virginia's highly competitive work force.



Agriculture, Food and Natural Resources 2011-2012 Enrollments**

Pathways	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Region 8
Agribusiness Systems	2,336	533	1,073	5,630	4,769	4,564	3,953	2,177
Animal Systems	2,548	666	1,598	6,576	5,098	4,994	4,534	2,337
Environmental Service Systems	2,723	716	1,209	6,473	5,394	4,971	4,538	2,418
Food Products and Processing Systems	2,314	520	819	5,483	4,601	4,258	3,748	2,054
Natural Resources Systems	2,363	553	900	6,233	5,013	4,580	4,023	2,120
Plant Systems	2,858	658	1,280	6,649	5,279	5,112	4,327	2,446
Power, Structural, and Technical Systems	2,709	600	1,014	6,440	5,056	4,830	3,816	2,403

*** NOTE: Duplicated Pathway student enrollments*

Source: *Virginia Department of Education*

High Demand Occupational Projections

Occupation	2011 Median Wage	2020 Projected Employment	Typical Education Needed for Entry
Landscaping and Groundskeeping Workers	$22,430	39,933	High school diploma
Farmworkers and Laborers, Crops	$22,190	24,586	High school diploma
Landscaping Supervisors	$43,500	6,996	High school diploma
Environmental Scientists and Specialists	$74,610	4,630	Bachelor's degree
Farmworkers, Animals	$23,970	4,043	High school diploma
Veterinary Assistants	$23,910	3,967	Postsecondary certificate
Water Treatment Plant Operators	$37,190	3,100	High school diploma
Veterinarians	$85,420	2,987	Professional degree
Environmental Engineers	$81,880	2,454	Bachelor's degree
Veterinary Technologists and Technicians	$35,470	2,044	Associate's degree
Farming, Fishing, and Forestry Supervisors	$44,230	2,030	High school diploma
Natural Sciences Managers	$136,120	1,350	Bachelor's degree
Biological Technicians	$42,510	1,079	Bachelor's degree
Environmental Science Technicians	$42,110	778	Associate's degree
Geoscientists	$74,880	657	Bachelor's degree
Conservation Scientists	$66,500	560	Bachelor's degree
Environmental Engineering Technicians	$42,800	500	Associate's degree
Forest and Conservation Technicians	$32,340	469	Associate's degree
Soil and Plant Scientists	$49,010	180	Bachelor's degree
Agricultural and Food Science Technicians	$31,700	152	Associate's degree

Source: *Virginia Employment Commission, Virginia Occupational Employment Projections 2010-20*

Appendix F

STATE-BY-STATE LIST OF AGRICULTURAL EDUCATION COURSES DIFFERENT FROM VIRGINIA OFFERINGS

[NOTE: Content of some listed courses may be included as a part of Virginia courses.]

STATE	AGRICULTURAL COURSES DIFFERENT [or differently named] FROM VIRGINIA'S AGRICULTURAL OFFERINGS	COMMENTS
Alabama	Aquatic Biology Floral Design and Interiorscaping Forestry Equipment Poultry Science Sports Turfgrass Production and Management Two- and Four-Stroke Engines	
Alaska	Course listing not available	Their curriculum seems aligned with WorkKeys.
Arizona	Environmental Service Systems	
Arkansas	Agricultural Graphics Approved Meat Processing Lab Agricultural Marketing Agricultural Surveying Ag Electricity Ag Metals	
California	Course listing not available	
Colorado	Course listing not available	CTE seems to be organized by clusters and not courses. The Ag cluster is "Agriculture, Natural Resources & Energy."
Connecticut	Principles of Natural Resource Conservation Protecting Natural Resources Disease Management Survey of the Animal Industry	
Delaware Click on "Current Year State Approved CIP"		
District of Columbia	Issues of Biotechnology and Senior Project Environmental Science: Marine Science Environmental Science: Urban Ecology	
Florida	Water Treatment Technologies/ Advanced Water Treatment Technologies Environmental Water Reclamation Technology Environmental Water Technology Solid Waste Disposal Operation Sports and Recreational Turf Management Sports and Recreational Turf Operations Wastewater Treatment Technologies Water Distribution Systems Operations	
Georgia	Cooperative Agribusiness Sales and Marketing I, II Marketing Agricultural Commodities Agricultural Electricity and Electrical Controls Food and Fiber Science Technology Soil Science Technology Urban and Community Forestry	See also Georgia Virtual Learning, which enables students in grades 9-12 to "recover credit from an unsuccessful course." One of these online courses is Basic Agriculture. [For others, see Shared Content]
Hawaii	Course listing not available	In Hawaii, Agricultural Education is called the Natural Resources Pathway and includes • the financing, processing, marketing, and distribution of agricultural products • farm production supply and service industries • health, nutrition and food consumption

STATE-BY-STATE LIST OF AGRICULTURAL EDUCATION COURSES DIFFERENT FROM VIRGINIA OFFERINGS

[NOTE: Content of some listed courses may be included as a part of Virginia courses.]

STATE	AGRICULTURAL COURSES DIFFERENT [or differently named] FROM VIRGINIA'S AGRICULTURAL OFFERINGS	COMMENTS
		• the use and conservation of land and water resources; • development and maintenance of recreational resources; • economic, sociological, political, environmental, and cultural characteristics of the food and fiber system.
Idaho	Course offerings are similar to Virginia's.	
Illinois	Agricultural Sales and Marketing Food Science Technology Agronomy	
Indiana	Sustainable Energy Alternatives	
Iowa	Ag Chemicals Application Management	Not sure if they still have this course, which is dated 1999.
Kansas	Hydroponics Ag Sales & Service Ag Marketing	
Kentucky	Agriculture Sales & Marketing Landscape Maintenance (plus lab) Greenhouse Construction (+lab) Greenhouse Technology Garden Center Management (+lab) Herbaceous Plant Identification Food Science and Technology Food Processing, Distribution and Marketing	KY has several dual-enrollment courses for students pursuing the path of agricultural education.
Louisiana	Meat Processing Precision Instrumentation in Agriscience	
Maine	Course offerings are similar to Virginia's.	
Maryland	Animal and Plant Biotechnology Food Science and Safety Agricultural Business, Research and Development	
Massachusetts	Research Animal Management Concentration (Strand)	
Michigan	Course offerings are similar to Virginia's.	See "Green Initiatives and CTE."
Minnesota	Course listing not available	
Mississippi	Course offerings are similar to Virginia's.	Agriculture Teachers Tasklist
Missouri	Crop Science I, II Agribusiness Sales, Marketing & Management Agriculture Management & Economics Agriculture Marketing Processing & Marketing Forest Products	
Montana	Course offerings are similar to Virginia's.	
Nebraska	Course offerings are similar to Virginia's, except AgMET-specific courses.	
Nevada	Course offerings are similar to Virginia's.	
New Hampshire	Course offerings are similar to Virginia's.	
New Jersey	Course offerings are similar to Virginia's.	See NJ Green Program of Study for Sustainable Design, Construction, and Energy. New Jersey seems to follow the CASE model for their state Ag curriculum.
New Mexico	Course listing not available	The Dept. of Ed. site shows that NM has a

Appendix F

STATE-BY-STATE LIST OF AGRICULTURAL EDUCATION COURSES DIFFERENT FROM VIRGINIA OFFERINGS

[NOTE: Content of some listed courses may be included as a part of Virginia courses.]

STATE	AGRICULTURAL COURSES DIFFERENT [or differently named] FROM VIRGINIA'S AGRICULTURAL OFFERINGS	COMMENTS
		cluster called "Engineering, Construction, Manufacturing, and Agriculture," but on their state CTE spreadsheet, there were no Ag courses listed and no schools cited that offered Ag programs.
New York	Course offerings are similar to Virginia's.	
North Carolina	Agribusiness Management Trends & Issues I, II Biotechnology and Agriscience Research I, II Project Management I, II GlobalProject Management II – Technology	
North Dakota	Agricultural Processing World Agricultural Science and Technology	
Ohio	Did not find a clear-cut course list, but one of their "field standards" is Food Science and Technology	Ohio seems to place a strong emphasis on agriculture biosecurity throughout its Ag program.
Oklahoma	Course listing not available, but some interesting pathways are • Agricultural Communications • Food Products and Processing	The only resource found was the Oklahoma Dept. of Career and Technology Education. Thus, CTE does not seem to be a part of the OK Dept. of Education, but rather an agency in and of itself.
Oregon	Course offerings are similar to Virginia's.	
Pennsylvania	Agricultural Mechanization	(Scroll down to Programs of Study)
Rhode Island	Course offerings are similar to Virginia's.	Course listing not available
South Carolina	Agribusiness and Marketing Golf Course Technology Soils and Soilless Research Sports Turf Management	
South Dakota	Agribusiness Sales and Marketing Ag Communications Ag Processing Technology	
Tennessee	Agricultural Sales & Marketing	
Texas	Professional Standards in Agribusiness Agribusiness Management and Marketing Food Technology and Safety Food Processing Range Ecology and Management	Texas CTE courses are under the heading "Texas Essential Knowledge and Skills."
Utah	Agricultural Supplies and Services Agriculture and Food Products Processing	Dual enrollment courses: Dairy Herd Management Farm and Ranch Management Ornamental Horticulture Swine Herd Management
Vermont	Diversified Agriculture	
Washington	Agricultural Economics International Agriculture Agricultural Communications/Journalism Water/Wetlands, Marine Resources Management	
Wisconsin	Surveying and Mapping the Environment Principles of Food Processing Food Product Development Food Laws, Regulations and Regulatory Processes Disease Management	

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