SHIFTS IN THE PRODUCTION AND EMPLOYMENT OF BACCALAUREATE DEGREE GRADUATES FROM U.S. COLLEGES OF AGRICULTURE AND NATURAL RESOURCES, 1990-2005[1]

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Introduction

This paper will highlight some of the major trends characterizing the milieu in which agricultural higher education has operated over the past 15 years, including an examination of the shifts in student demographics, graduation and degree patterns, employment opportunities, college structure and majors, the business and social environment, and consumer preferences. In order to better examine the current state of affairs, it might be helpful to first provide a quick review of agricultural higher education history and the involvement of the U.S. Department of Agriculture (USDA).

The 1st Morrill Act of 1862 established the land-grant system to provide for a "practical education" in agriculture and the mechanical arts for the common man. This was in stark contrast to the existing system of private colleges for the elites, which provided training for lawyers, physicians, and the clergy. In those days most people lived on farms, and the "Ag School" was the core of the new land-grant colleges. Not coincidentally, 1862 also saw the establishment of the USDA as "The Peoples' Department" to serve rural America.

Shifting forward 115 years to 1977, the situation had changed dramatically. The land-grant colleges, including the 1862 and 1890 institutions, had evolved into world-class universities, but colleges of agriculture were no longer the entire university, or even a core unit in many cases. Other public and private institutions, including community colleges, became involved in the education of students in the fields of agriculture though not at the same breath and depth as the land grant institutions. Leaders of America's agricultural higher education programs requested Congress to transfer the lead Federal role for facilitating agricultural higher education programs from the U.S. Office of Education to USDA. It was felt that agricultural and natural resources higher education programs could be conducted more effectively in concert with the USDA's agricultural research and extension programs. As a result of these efforts, agricultural higher education program authority was transferred to the USDA in provisions of the 1977 Farm Bill.

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[1] This report draws heavily on material from national data collected by the U.S. Department of Education, the U.S. Department of Labor, the National Science Foundation, the U.S. Census Bureau, and the U.S. Department of Agriculture. The analyses and views expressed here, and any attendant errors or omissions, are the sole responsibility of the authors and do not represent the positions or policies of their employing agencies or the National Academy of Sciences.

Since then, there have been a number of developments. In implementing Congressional authorities and appropriations, USDA established a National Needs Graduate Fellowships program for scientific human capital development in 1984, and in 1990 USDA initiated the Higher Education Challenge Grants program to modernize food, agricultural, and natural resources curricula, improve instructional delivery systems, stimulate student recruitment and retention, encourage faculty development, and expand student experiential learning opportunities.

In 1988, the USDA sponsored a national summit focusing on graduate education in agriculture. In April 199l, the National Research Council's Board on Agriculture held the first conference on higher education to "chart the comprehensive changes needed to meet the challenges of undergraduate professional education in agriculture." Topics of papers and discussions included the core curriculum, diversity and multi-culturalism, scientific literacy, undergraduate research, rewarding teaching excellence, globalism, curricular innovation, agriculture as a science, and the science of agriculture.

USDA now invests over $100 million annually in higher education programs through 20 national initiatives that help support agricultural and natural resources colleges both within and outside the land-grant college system. During the past quarter century, agricultural and natural resources curricula have been transformed to challenge and serve students with broadening professional interests and academic backgrounds. Facilities and equipment have been modernized to incorporate contemporary information technologies and biotechnologies. Increased emphasis is now being placed on active learning methodologies and experiential education, including undergraduate research, internships in the public and private sectors, and study abroad opportunities. Outstanding students have been attracted to graduate study in agricultural and natural resources via graduate fellowships, and faculty recognition programs for outstanding teaching have been initiated. In addition, many colleges have changed their identities from a focus limited to agriculture to one emphasizing a broader scope of study, while other colleges have entirely eliminated a reference to agriculture in their names. As the lead Federal agency for agricultural and natural resources higher education programs, USDA has worked successfully with the nation's colleges and universities to transform programs of study and generate graduates with new and contemporary skills and attributes.

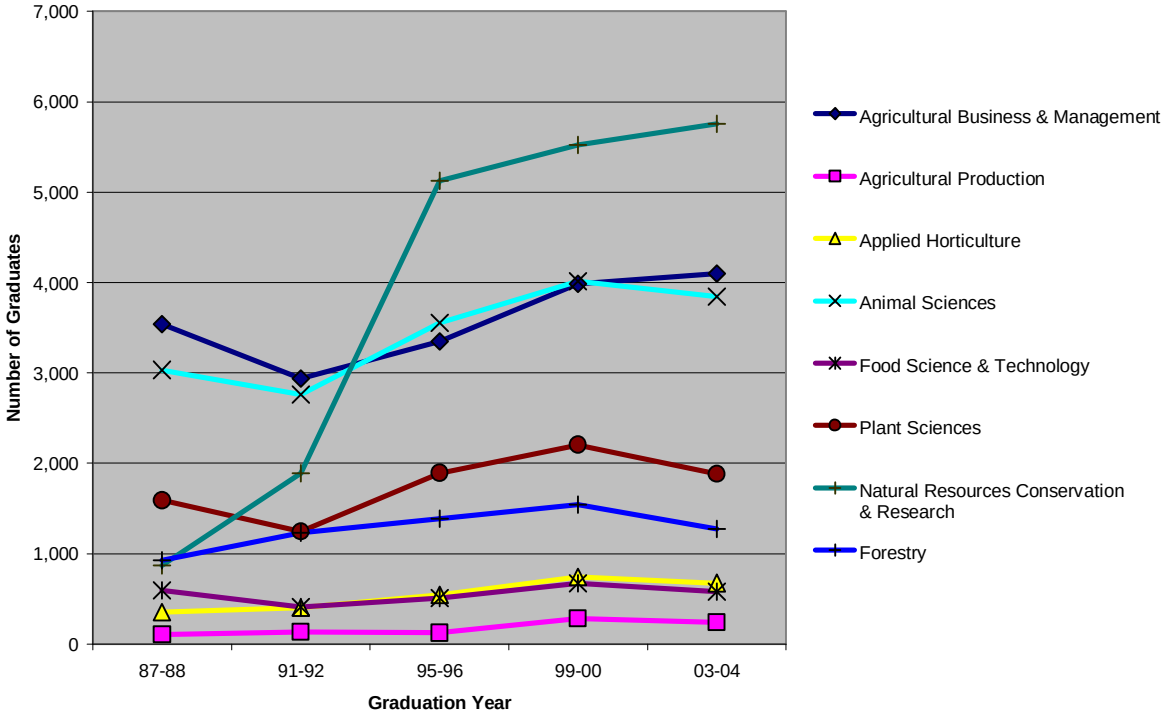
It is against this backdrop that we examine the evolving characteristics of graduates having expertise in food, agricultural, and natural resources disciplines, and set this examination within the current context of changing professional opportunities to meet the human resources needs of employers. It is an exciting and rapidly shifting paradigm requiring careful analyses, visionary thinking, and decisive actions.

Trends in Baccalaureate Degrees Awarded by Colleges of Agriculture and Natural Resources

Significant growth in the number of agricultural and natural resources baccalaureate degree recipients occurred in the United States between 1987 and 2004. In the 1987-88 Academic Year (AY), colleges and universities awarded 18,572 baccalaureate degrees in agricultural and natural

resources disciplines compared to 29,802 in AY 2003-04. Much of the growth in degrees conferred, as reported by the National Center for Educational Statistics, was realized in three areas of study, including Natural Resources Conservation and Research, Animal Sciences, and Agricultural Business and Management.

Figure 1 - Number of Baccalaureate Degrees Awarded In Selected Agricultural and Natural Resources Fields of Study, United States, 1987- 2004



SOURCE: National Center for Education Statistics Completion Reports.

Figure 1 shows that 872 baccalaureate degrees were awarded in Natural Resources Conservation and Research in AY 1987-88 compared to 5,756 in AY 2003-04. Animal Sciences baccalaureate degrees increased from 3,034 to 3,847 during this time, while Agricultural Business and Management degrees rose from 3,542 to 4,104.

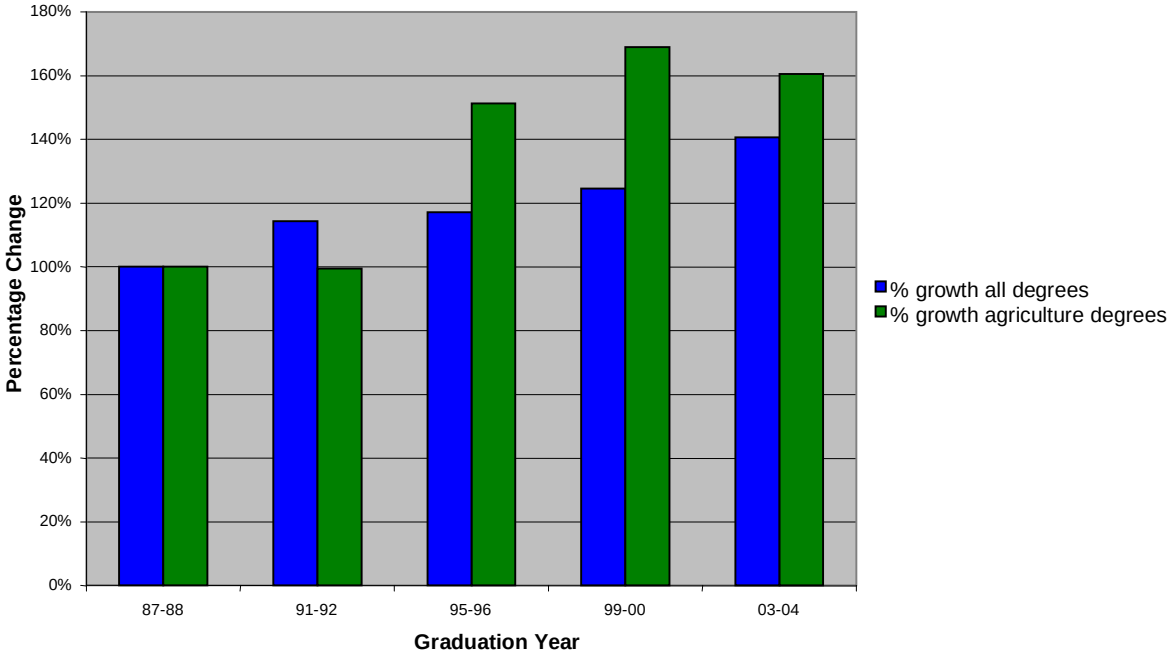
During the period between 1987 and 2004, baccalaureate degrees in Agricultural Production increased from 109 in AY 1987-88 to 242 in AY 2003-04. Applied Horticulture degrees rose from 356 to 679. Plant Sciences degrees increased from 1,592 to 1,883 and Forestry degrees went up from 930 to 1,276. During this period, only Food Science and Technology degree recipients declined, from 596 to 585.

While there was significant expansion in the aggregate number of degrees awarded between 1987 and 2000, the number of degrees awarded after 2000 begins to stabilize, and the total number of agricultural and natural resources degrees in the selected areas of study actually declined from 31,363 in AY 1999-2000 to 29,802 in AY 2003-04. This five percent decrease in degree production is most likely attributable to the decline in new student enrollments into agricultural and natural resources programs after 2000.

Agricultural and Natural Resources Baccalaureate Degrees as Compared to All Baccalaureate Degrees

During the period between 1987 and 2004, the number of baccalaureate degrees awarded in agricultural and natural resources areas of study increased by 60 percent. In contrast to this, baccalaureate degrees awarded in all areas of study increased by only 40 percent.

Figure 2 - Index of Relative Growth in Baccalaureate Degrees Awarded in Selected Agricultural and Natural Resources Fields of Study Compared to All Baccalaureate Degrees Awarded in the United States 1987-2004



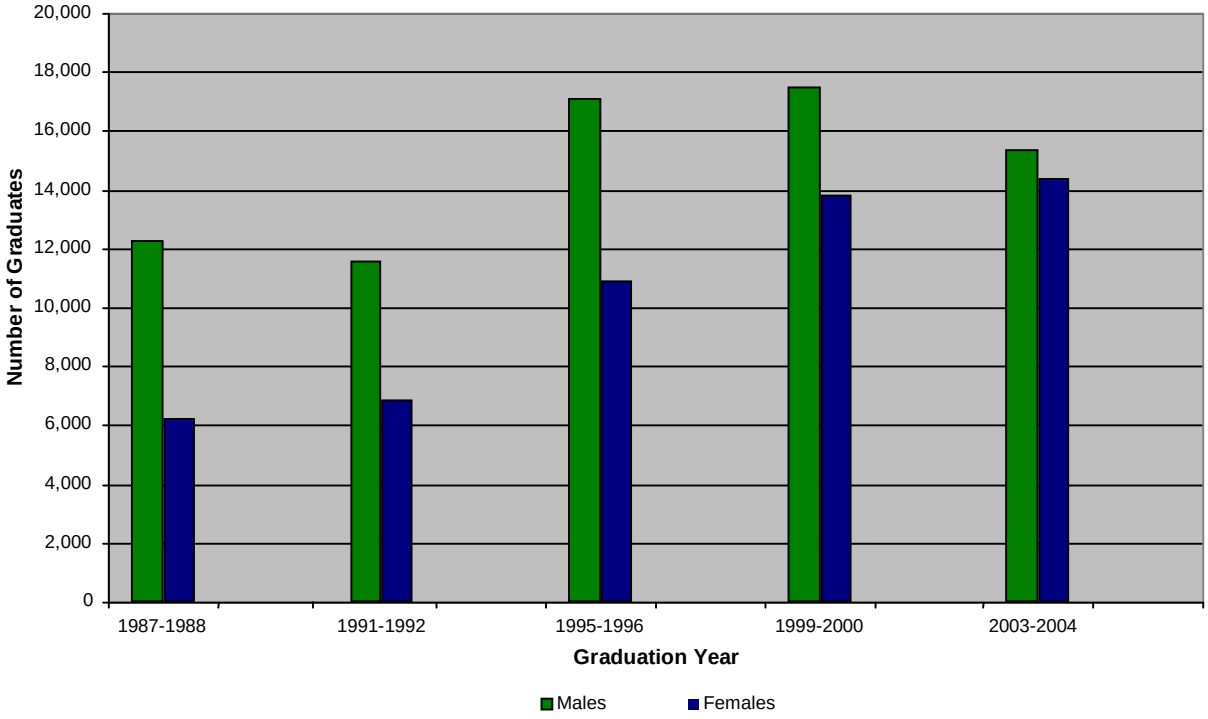
SOURCE: National Center for Education Statistics Completion Reports.

Most of the growth in the number of agricultural and natural resources baccalaureate degrees occurred in the mid and late 1990s, and reflected steep enrollment increases experienced by the nation's colleges of agriculture and natural resources in the late 1980s and early 1990s. (As previously noted, enrollments in these areas either remained stable or declined in recent years.) In comparison, baccalaureate degrees awarded in all fields of study in the United States continued to increase throughout the period from 1987 to 2004.

Demographic Characteristics of Graduates in Agricultural and Natural Resources Fields of Study

During the period from 1987 to 2004, the number of baccalaureate degrees in the agricultural and natural resources fields of study awarded to females rose significantly from 6,284 in AY 1987-88 to 14,410 in AY 2003-04. During the same period, baccalaureate degrees awarded to males increased from 12,288 in AY 1987-88 to 17,509 in AY 1999-2000, but declined to 15,392 by AY 2003-04. These data are depicted in Figure 3.

Figure 3 - Gender of Baccalaureate Degree Recipients in Selected Agricultural and Natural Resources Degree Fields of Study, United States, 1987-2004

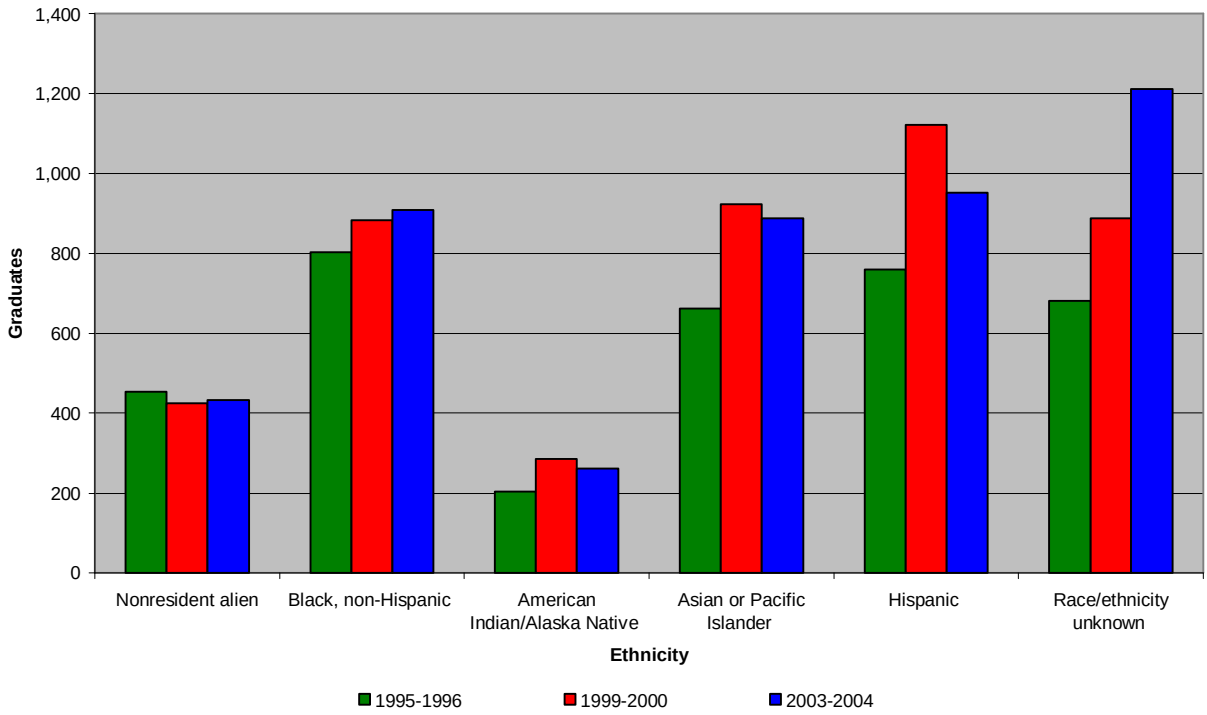


SOURCE: National Center for Education Statistics Completion Reports.

During the period from 1995 to 2004, there was relatively little change in the racial and ethnic characteristics of baccalaureate degree recipients in agricultural and natural resources programs of study. In AY 1995-96, a little over 87 percent of the graduates were White, non-Hispanic compared to 84.4 percent in AY 2003-04. Black, non-Hispanic graduates increased very little, from 2.9 to 3.0 percent, American Indian/Alaska Native from 0.7 to 0.9 percent, Asian or Pacific Islander from 2.4 to 3.0 percent, and Hispanic from 2.7 to 3.2 percent.

As Figure 4 shows, in AY 2003-04 a total of 908 agricultural and natural resources baccalaureate degrees were awarded to Black, non-Hispanics, 261 to American Indian/Alaska Native, 888 to Asian or Pacific Islander, and 951 to Hispanic populations. The remainder of the 25,151 degrees awarded went to White, non-Hispanic students. While overall numbers have not changed much, a significant development is in the number of Hispanic graduates, which has increased and recently surpassed the number of Black, non-Hispanics and Asian or Pacific Islanders. The number of Non-resident aliens and American Indian/Alaska Natives has remained constant.

Figure 4 - Number of Baccalaureate Degrees Awarded in Agricultural and Natural Resources Fields of Study by Selected Ethnic Groupings, United States, 1995-2004



SOURCE: National Center for Education Statistics Completion Reports.

As Table 1 shows, somewhat greater variations in demographic characteristics are observed between the degree levels in agriculture, natural resources, and veterinary medicine specializations.

Table 1 – Selected Demographic Characteristics of Graduates in Agriculture, Natural Resources, and Veterinary Medicine Fields of Study, United States, 2001-02

Degree Level	Females	Ethnic Minorities	Non-U.S. Citizens
		PERCENTAGES	
Baccalaureate	53	16	2
Master's	55	14	15
Doctor of Philosophy	41	17	35
Doctor of Veterinary Medicine	72	9	1

Source: National Center for Education Statistics Completion Report 2001-2002.

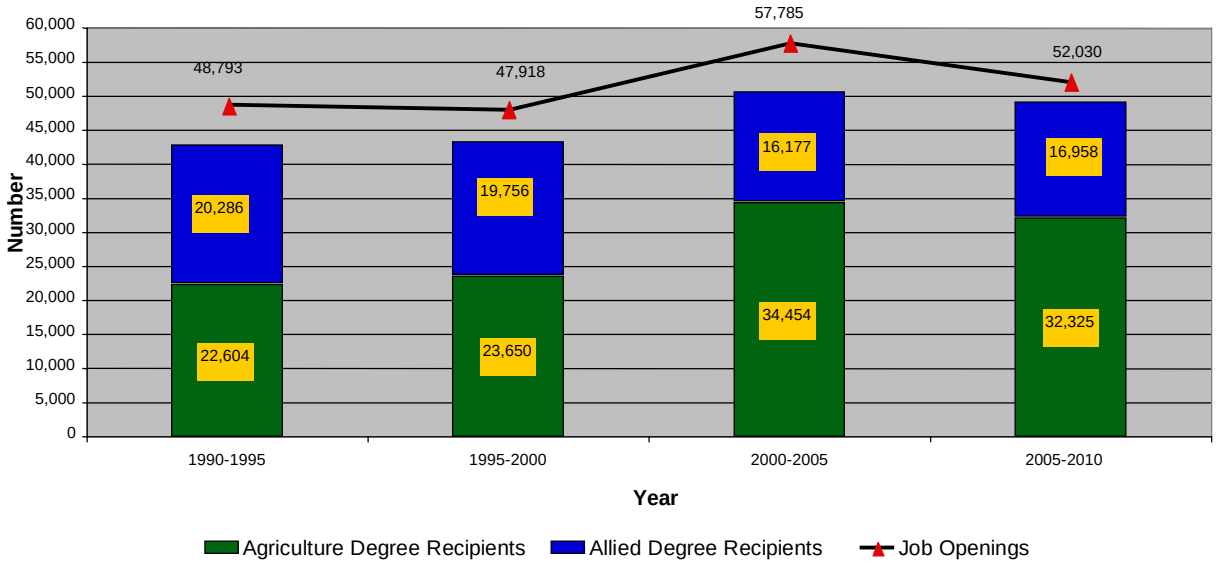
Projected Average Annual Employment Opportunities and Available Graduates in Agricultural and Natural Resources

During the past three decades, a series of 5-year studies has been sponsored by the Higher Education Programs unit of the USDA Cooperative State Research, Education, and Extension

Service. The purpose of these studies is to project and compare the number of qualified college graduates that are available to fill the expected number of employment opportunities requiring expertise in food, agricultural, and natural resources specialties.

Summary data from the four most recent studies are presented in Figure 5. These graphs are based upon analyses of Bureau of Labor Statistics and Department of Education data, and show projected job openings in agricultural and natural resources occupations (broadly defined) compared to projected numbers of qualified graduates from 1990 to 2010. Strong U.S. economic conditions in the late 1990s, when the 2000-2005 projections were developed, contributed to the relatively higher number of projected employment opportunities during the period.

Figure 5 - Projected Average Annual Employment Opportunities and Available Graduates in Agricultural and Natural Resources Fields of Study, United States 1990-2010



SOURCE: U.S. Department of Labor Monthly Labor Review, February 2004 and National Center for Education Statistics Completion Reports.

Two sources of graduates with requisite expertise in agricultural and natural resources specialties have been utilized to project the average annual availability of qualified graduates charted in Figure 5. "Agriculture degree recipients" are the baccalaureate, master's, doctoral, and doctor of veterinary medicine degree graduates generated by colleges of agriculture and natural resources, and by colleges of veterinary medicine. "Allied degree recipients" are graduates of other academic units, including colleges of engineering, arts and sciences, and business schools, who are deemed to have the requisite expertise necessary to fill job openings in agricultural and natural resources occupations. It is important to note (as stated above) that graduates at all degree levels, not just baccalaureate degrees recipients, are included in the Figure 5 analyses.

Projected areas of employment strengths and weaknesses for 2005 to 2010 are discussed below.

Management and business occupations: Strong employment opportunities are expected for technical sales representatives, accountants and financial managers, market analysts, landscape

managers, and international business specialists. Weaker employment opportunities are forecasted for sales and business representatives who provide services to farmers and ranchers, and grain and food animal merchandisers.

Scientific and engineering occupations: Most employment opportunities are expected for graduates with skills in precision agriculture, functional genomics and bioinformatics, forest science, plant and animal breeding, biomaterials engineering, food quality assurance, nanotechnology, animal health and wellbeing, nutraceuticals development, and environmental science. Expect relatively fewer opportunities for agricultural machinery engineers, wildlife and range scientists, and veterinarians in general practice.

Agricultural and forestry production occupations: Good job opportunities are projected for producers of fruits and vegetables, growers of specialty crops that provide raw materials for medical and energy products, managers of specialized livestock operations, forest resources managers, growers of landscape plants and trees, managers of aquaculture operations, turf producers, organic farmers, and providers of outdoor recreation. However, as agricultural production units continue to consolidate, there will be fewer opportunities for producers of traditional commodities (e.g., wheat, corn, cotton, soybeans, cattle, and hogs).

Education, communication, and governmental services occupations: Most opportunities are projected in plant and animal inspection, public health administration, biotechnology impact assessment, nutritional and health occupations geared to serve an aging population, outdoor recreation, food system security, consumer information technologies, and environmental and land-use planning. More limited opportunities will be found for farm and ranch advisors, and government farm service agents.

Results of the most recent study are available at: http://faeis.usda.gov/supplydemand/2005-2010/.

Some significant assumptions regarding socio-economic forces and anticipated technological advancements must be factored into the model to project employment opportunities for graduates. What follows is a discussion of the four factors that were considered to be most important when generating the projections for 2005-2010. The factors are:

(1) Consumers and their preferences dictate that products and services derived from agricultural and forest raw materials must help them maintain contemporary lifestyles. Population growth, changing ethnic and age demographics, and evolving food and health literacy strongly influence both what is produced and the expertise required to meet consumer demands.

(2) The evolving business structures that support the U.S. food system continue to be influenced by globalization and consolidation. Expertise needs will evolve and create a need for graduates with excellent business skills, international understanding, and leadership qualities. Graduates must deal with increasing market uncertainty, risk analysis, petroleum dependence, niche business opportunities, and global food production and distribution systems.

(3) New developments in science and technology are being driven by changes in bio-security, the expanding global population, health concerns, shrinking natural resources, and climate

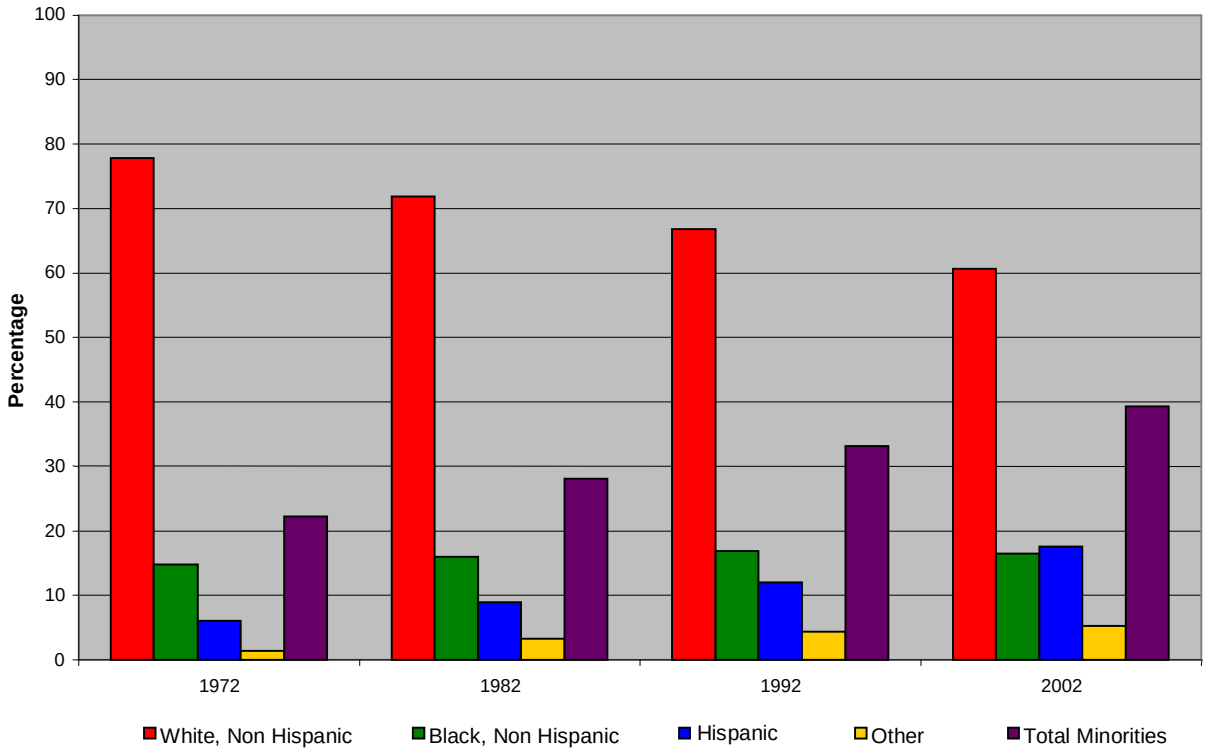
change. Emerging biotechnologies and nanotechnologies are powerful tools to increase food system efficiency. Other scientific developments will help us maintain our renewable natural resources. All of these require graduates with basic science skills and the ability to solve problems with scientific applications.

(4) Public policy choices and accountability will affect the market for graduates who can provide public services, including education, natural resource utilization, food assistance, recreation, and financial support. Public concerns regarding diet and health, food safety, and the environment dictate the number and kinds of graduates needed to manage regulatory programs and provide services to assist producers and others working in the food and natural resource system.

Important Factors Affecting Future Agricultural and Natural Resources Graduates

Many factors are impacting higher education institutions as they offer academic programs to prepare future graduates in the agricultural and natural resources sciences. The factors that are especially important include the racial and ethnic characteristics of k-12 students, student and family misconceptions about agriculture careers, and the changing skill sets employers seek. These factors are discussed below.

Figure 6 - Racial/Ethnic Distribution of Public Schools, Grades K-12, United States, 1972-2002



SOURCE: US Department of Commerce, Census Bureau, Current Population Survey 1972-2004.

Figure 6 indicates the demographic trends in the racial and ethnic composition of students in U.S. public schools. A steady increase in the percentage of minority students over the last 30 years is shown (22 percent in 1972 compared to 39 percent in 2002) with the percentage of Hispanic students increasing from 6 percent to 18 percent over the same time period. While agricultural and natural resources higher education programs have been working to attract more minority students, there have only been very small increases in minority baccalaureate degree recipients from 1995 to 2004. Diversity continues to be a major opportunity and challenge to colleges of agriculture and natural resources.

In 2005, academic program administrators in colleges of agriculture and natural resources evaluated the factors affecting student choice to seek admission and matriculate. Results of the survey are presented in Table 2.

Table 2 - Main Problems or Concerns Affecting US High School Students in Selecting Agricultural Sciences as a Career Major

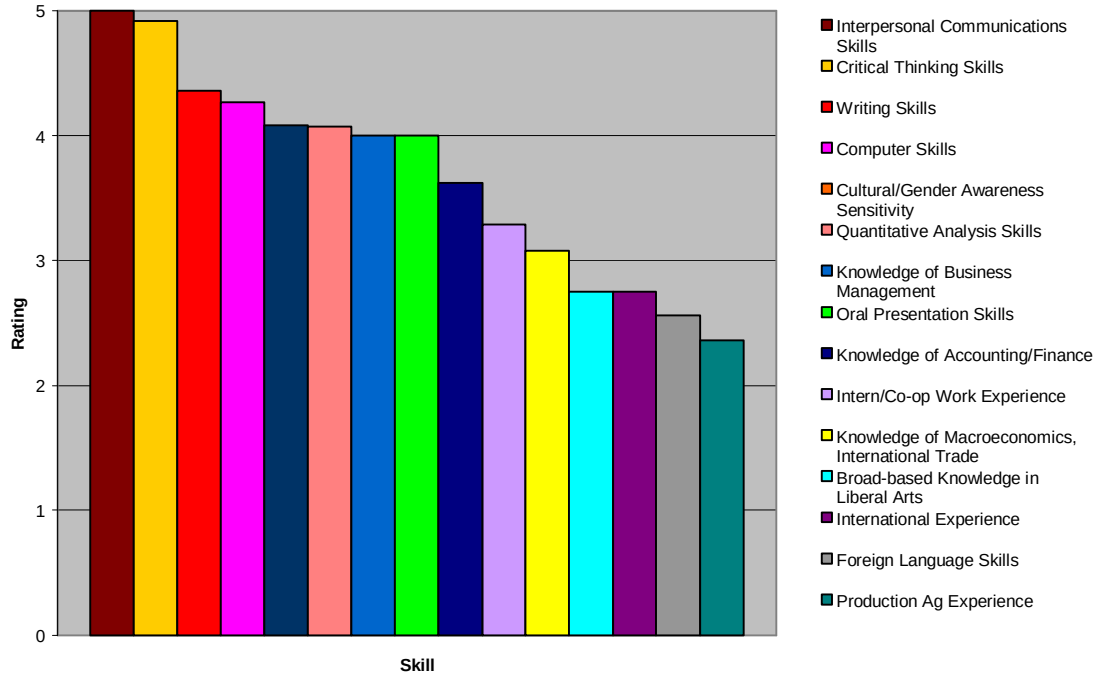
Misconception or Image About Agricultural Sciences	41%
Lack of Knowledge About Employment Opportunities	33%
Lack of Knowledge About Fields of Study	22%
Perceived Relevance/Importance To Future Career	22%
Students Lack Fundamental Knowledge in Mathematics and Sciences	11%
Peer Pressure/Family Against Agricultural Sciences Studies	7%

Source: "Agricultural Programs: Are They Able to Adapt for the Future?" August 2006. Jorge A. Gonzalez.

These data suggest that colleges of agriculture and natural resources continue to be challenged in helping potential students better understand the academic and career opportunities in these fields. In addition, there appears to be continuing reason for concern regarding the public's perception of the images associated with agricultural and natural resources programs of study.

Figure 7 presents the skills that agri-business employers have identified as the ones most important for new college graduates. Colleges of agriculture and natural resources must continually update courses and curricula to meet changing expectations in the employment arena. Portfolios of faculty and academic resources may or may not be positioned to offer academic programs capable of generating graduates with the high priority skills and preparation that employers seek.

Figure 7 - Skill Sets and Abilities that Agribusiness Employers Seek in New College Graduates



SOURCE: AAEA Presentation: Response to Recommendations of the National Food and Agribusiness Management Commission, July 2006, Franklin E. Boteler.

Evolving Higher Education Programs in Agricultural and Natural Resources

Agricultural and natural resources colleges have responded to these concerns by consolidating and realigning their offerings with other programs, and by changing their names and structure. For example, at the 58 traditional 1862 Land-Grant institutions, 49 have an agricultural college. Of these, 12 are named the "College of Agriculture" while 37 have names encompassing agriculture along with something else, most commonly natural resources, life sciences, environmental sciences, food sciences, biological sciences, or family and consumer sciences. These changes are reflected at non-land-grant institutions as well. Names are trending toward the life sciences, and as a consequence, the public image of "agriculture" is broadening.

Along with the name changes for colleges of agriculture, departments within the colleges also are shifting. The traditional food, agricultural sciences, and natural resources disciplines now also include biology, rangeland, statistics, communications, fisheries, parks and recreation, human development, and landscape architecture. Associate Deans for academic programs at the 1862 Land-Grant institutions have recently projected the following majors as having the most growth potential: pre-veterinary science, equine/companion animal science, agricultural biotechnology, food science/food safety/nutrition, turf/landscape/urban horticulture, natural resources/environmental science, agribusiness, and families/communities/consumer sciences.

In contrast to the above fields of study, other traditional majors are projected to decline, including soil and crop science, entomology, animal science (meat animal), and plant pathology.

Closing Thoughts

What can we expect for the future? One recent study solicited responses to this very question. Results from that study suggest that agriculture's future will be filled with a host of new and emerging disciplines, including: genomics; genetics; molecular biology; computational biology; biological engineering/manufacturing; bio-security; wellness; food/health interaction; human/animal interaction; animal behavior/wellbeing; renewable energy/resources; bio-based products; biosensors; bio-renewable engineering; climate change; spatial sciences; water conservation, management, and policy; sustainable agriculture; land-use planning/policy; landscape restoration and design; human/environmental interaction; international/intercultural (agriculture/business); entrepreneurship; food production policy; health/science information and decision making; production/management/ecology of GMOs; and science/risk communication.

These emerging fields clearly reflect several societal changes – from producer to consumer, rural to suburban, and uninformed to educated. It appears, more and more, that "agriculture" is being defined as an area of basic sciences applied to wellness and sustainability. Is this our future? Will the Land-Grant institutions still be positioned to provide for a "practical education in agriculture and the mechanical arts for the common man?" Or, is this mission obsolete? We must not just "wait and see" but, rather, we must define and engineer the future we need and desire. Hopefully, the National Academy of Sciences Leadership Summit will do just that.

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