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Agricultural and Biological Engineers

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Work Classification Based Related D.O.T. Occupations:
- Biologists
- Chemists
- Conservation Scientists
- Farm Managers
- Foresters
- Landscape Architects

Interests Based Related G.O.E. Occupations:
- Chemical-Engineering Technicians
- Customer-Equipment Engineers
- Fiber Technologists
- Mechanical Engineers
- Project Engineers
- Soils Engineers

Skills Based Related O*NET Occupations:
- Chemical Engineers
- Foresters
- Geologists
- Industrial Safety and Health Engineers
- Landscape Architects
- Product Safety Engineers

Noteworthy Quote:

"I found biological and agricultural engineering to be a challenging field of study and very different from the typical engineering fields. I have the chance to work in an industry that affects everyone in the world. Other university departments are so big and impersonal, but my faculty took time to get to know me and help me grow, personally as well as academically. There is a real sense of community in this major. My studies prepared me for the job market by exposing me to many different experiences and scenarios that come across in work."

–Dolores Landeck, Public Affairs Manager, American Society of Agricultural and Biological Engineers, St. Joseph, Michigan

Agricultural and biological engineers (ag-ri`cul-tur-al`and` bi-o-log-i-cal en-gi`neers) apply biological science and engineering principles to problems relating to both the use and conservation of soil, water, and land resources, particularly as those tasks relate to providing food, feed, fiber, timber, and renewable energy resources.

Working with farmers, agribusinesses, and conservation organizations, agricultural and biological engineers use their knowledge and skills to develop systems, equipment, and technologies to improve crop and livestock production, improve food processing techniques, or extend the storage-life of perishable items, while conserving natural resources, preventing environmental pollution, and protecting the people involved.

Agricultural and biological engineering combines the principles of engineering science with biological and agricultural sciences. On the one hand, agricultural and biological engineers design agricultural machinery and facilities such as tractors, implements, animal housing, storage and handling facilities, and irrigation and drainage systems. And they also develop systems for natural resources management, new products from agricultural wastes, and methods for improving food and fiber (such as cotton and wool) production.

Work Performed

Agricultural and biological engineers apply engineering and biological principles to promote conservation and the wise use of water, land, and air. Protecting natural resources from the effects of weather, soil erosion, and pollution is important because greater agricultural production places more demands on a limited amount of land and water. However, advancements in soil and water conservation, machine systems, and biological research can provide both practical food and fiber production and a cleaner, better-managed environment.

As part of their work, some agricultural and biological engineers plan and supervise the construction of farm buildings such as silos and other facilities for the storage and processing of grain, hay, feed, and silage, or for fruits and vegetables. They may design shelters or habitats for livestock, poultry, or plants such as greenhouses and nurseries. In planning shelters, they take into account environmental requirements, insulation, heat transfer, and ventilation. Other projects may include the design and production of structures and systems for the processing and recycling of waste matter. Comfortable and affordable housing for people is another field of interest.

They also devise power and machinery systems for harvesting, handling and processing feed, liquids, grain, food products, or livestock. These specialists may develop systems that size, sort, and grade fruits and vegetables, for instance. They may devise new ways of growing and harvesting crops like apples, tomatoes, corn, cut flowers, and fish.

Agricultural and biological engineers also design and develop computer-controlled systems that process, harvest, produce, or manufacture agricultural goods. They may design an automated flour mill, cereal plant, oil extraction plant, or other systems. They may design process control systems that, for instance, dry and store hay and grain or food products. They also plan computer-controlled equipment that performs tasks such as feeding cows.

Regarding natural resources, these engineers work in many nonagricultural applications including flood control, urban run off, and solid waste disposal. Preserving

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water quality is a primary concern. Agricultural and biological engineers plan, supervise and manage the building of irrigation, drainage, flood and water control systems. They may design systems to reclaim water and land in order to serve agricultural, industrial, or town and city needs. With regard to soil erosion and sediment control, agricultural and biological engineers may design irrigation or drainage systems to channel water on or off the land without taking the soil with it. They may build canals and ponds or reshape or resurface fields.

In waste management, agricultural and biological engineers look for methods to use wastes such as food processing scraps or animal wastes in ways that help rather than harm the environment. Some wastes are useful as crop fertilizers or animal food ingredients. Others can be a source of biomass energy fuel.

Agricultural and biological engineers also conduct research to reduce risks associated with the use of pesticides. They may work with government agencies setting regulations on the use and methods of applying herbicides, fertilizers, pesticides, or alternative methods of pest and disease control.

Agricultural and biological engineers develop strategies for natural pest control and treatment of hazardous wastes, for composting, and for enzyme processing of biomass, food, feed, and wastes. They understand the biological nature of organisms and use it to develop biosensors, bioinstrumentation, plant-based pharmaceuticals, and nutraceuticals.

Agricultural and biological engineers in food processing plants develop new processes, plan the layout of processing lines, and direct the workers who install them. They may work with refrigeration, sterilization, evaporation, mixing, mechanical separation, and storage of food products. They may work in packaging technology to insure that consumers get safe, nutritious food products.

Agricultural and biological engineers in research develop and initiate new ideas, designs, and processes with an eye toward the future. They may work with other agricultural scientists on research with plant species leading to the production of new hybrids that can survive in hostile environments or provide enhanced nutritional value. They design new equipment and technologies to handle new hybrids.

Agricultural and biological engineers conduct research into aquacultural food production, or work with hydroponics, the cultivation and production of foodstuffs without soil. They concentrate on sources of power to conserve energy. They also design systems that operate on wind and solar energy. Some are involved in aerospace projects developing closed environment life support systems to provide food on manned space ships for long term voyages away from Earth.

Agricultural and biological engineers in bioprocess engineering develop new techniques for processing nutritious new foods and biological products. They may work with plant scientists to help devise genetic models for hybrid crops with desired characteristics. They design methods and tools to control biological processes such as those in bioreactors used by the drug industry.

Agricultural and biological engineers also offer advice in many specialties. They may advise chief engineers in a plant that makes agricultural equipment. Agricultural and biological engineers may advise light and power companies, food processors, software producers, or composting and waste treatment plants. They perform environmental impact assessments, preparing and presenting reports that are based on research and study conducted on farms, in forests and at research stations.

Agricultural and biological engineers identify and develop viable renewable energy sources such as biomass, methane, and vegetable oil to make these and other systems cleaner and more efficient. These specialists develop energy conservation strategies to reduce costs and protect the environment. They also design traditional and alternative energy systems to meet the needs of agricultural operations.

Working Conditions

Agricultural and biological engineers work indoors or outdoors, in a forest, laboratory or design office, or on a farm or research station. They work outdoors when they field-test or study equipment or processes, or investigate an environmental issue.

They may work in a food processing or pharmaceutical plant to direct the installation and start-up of processes.

While some work in small communities in regions where farming is an important part of the economy, agricultural and biological engineers may also travel extensively, going anywhere from urban industrial parks where food is processed, to remote wilderness areas. Those employed by government and educational institutions are increasingly working overseas in remote parts of Africa and other continents to study and teach agricultural and biological engineering processes.

Hours and Earnings

The hours of agricultural and biological engineers may vary with the kind of work they do. Those in research may work extended hours when a project reaches a critical point. Independent consultants may work whatever hours are required to complete a project.

According to the Bureau of Labor Statistics, in 2003 agricultural and biological engineers earned an average of $52,340 a year. Earnings ranged from a high of more than $89,910 a year to a low of less than $37,120 a year. According to a 2003 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in agricultural and biological engineering received starting offers averaging $42,987 a year, and master's degree candidates were offered an average of $54,000 a year. The earnings of agricultural engineers depend on geographic location, level of education, experience, and skills.

Most agricultural and biological engineers receive benefits including health and life insurance, paid vacation, sick and personal days, and retirement plans. Most traveling expenses are paid by the employer.

Education and Training

A bachelor's degree in engineering from an accredited engineering program is usually required for beginning agricultural and biological engineer positions. Some agricultural and biological engineers have degrees in agricultural engineering, biological engineering, biosystems engineering, etc., while others have degrees in chemical, civil, electrical, or mechanical engineering instead. An engineering program can last from four to six years. A master's degree may take one and a half or two years more.

To begin preparing for a career in agricultural and biological engineering, helpful high school courses are mathematics, English, computer science, physical sciences, and, most especially, biological sciences. It also helps to get involved in activities that offer experience in communicating, leading groups, solving problems, analyzing situations, and resolving conflicting views.

University programs have many names, not only agricultural and biological engineering, but also biological systems engineering, bioresource engineering, environmental engineering, forest engineering, or food and process engineering. Whatever the title, the typical curriculum begins with courses in writing, social sciences, and economics, along with mathematics, chemistry, physics, and biology.

The first two years of college consist of basic sciences such as physics, chemistry, calculus, and higher mathematics. Basic engineering courses include engineering mechanics, thermodynamics, hydraulics, heat transfer, and energy systems and utilization. An agricultural and biological engineering curriculum also includes appropriate biological and agricultural science courses. Other studies cover written and oral communications, social science, and the humanities. Students are also expected to take courses in computer science and engineering design.

In the final two or three years of college, students apply engineering principles and biological science to the engineering design of agricultural and biological systems. Many engineers obtain a master's degree to broaden their concentration or specialty, and to enhance promotion opportunities. Candidates for an advanced degree in agricultural engineering are usually required to write a thesis on their specialty and to do fieldwork and laboratory research, along with classroom studies. A Ph.D. is essential for university faculty positions in engineering.

About fifty colleges offer programs of study in agricultural and biological engineering. Many of these degree programs are offered at land grant universities under different program names including agricultural and biological engineering, bioprocess engineering, or biological systems engineering.

Licensing, Certification, Unions and Professional Societies

Engineers whose work may affect life, health, or property must be licensed. Requirements for licensing include a degree from an engineering program accredited by the Accredication Board for Engineering and Technology (ABET), four years of experience, and the passing of two engineering examinations. The first exam involves the fundamentals of engineering for those in training. The second exam involves principles and practice of engineering for those with four years of experience. Those who are licensed, about one third of all engineers, are called registered professional engineers.

Most agricultural engineers are members of the American Society of Agricultural Engineers (ASAE). This group has about 9,000 members in more than 100 countries. It conducts technical meetings and special interest conferences, publishes technical papers, and provides career information.

Personal Qualifications

Agricultural and biological engineers enjoy solving problems. They understand physical and chemical principles well enough to use them in their work, but they also rely on their own creativity to envision new designs or solutions. Because they often conduct research individually, they possess the ability to work without supervision and accept responsibility, yet they must also be able to work in a team environment, communicating effectively both orally and in writing. An aptitude for computing and design is also necessary.

Occupations can be adapted for workers with disabilities. Persons should contact their school or employment counselors, their state office of vocational rehabilitation, or their state department of labor to explore fully their individual needs and requirements as well as the requirements of the occupation.

Where Employed

According to the Bureau of Labor Statistics, there were about 2,780 agricultural and biological engineers employed throughout the United States in 2003. However, many professions hire agricultural and biological engineers with slightly different job titles such as "water resource engineer", "process engineer", or "design engineer". These engineers are hired by a wide range of private companies ranging from manufacturing to environmental consulting firms to government agencies. The larger employers include agricultural machinery companies, irrigation and drainage system manufacturers, manufacturers of control systems and measuring devices, consulting firms, power utilities, and alternative fuel producers.

For example, agricultural and biological engineers may work for major equipment manufacturers and serve as project test engineers. Those who work for food processing firms may serve as production managers or plant engineers or process and project engineers. Agricultural and biological engineers in environmental research may head the construction of waste treatment plants or water resources projects, maintain and control environmental systems for greenhouses, or oversee the construction of composting installations, or other bioprocess operations.

Agricultural and biological engineers also work for the U.S. Department of Agriculture and the U.S. Department of the Interior. Forestry engineers develop equipment for planting and harvesting timber. They also help design forest management systems. Others fill engineering positions in pharmaceutical, medical, and emerging technology and biotechnology companies.

Employment Outlook

The overall field of agricultural and biological engineering has moderately good to strong prospects because of the increasingly high-tech requirements of modern agribusiness industries. In the coming years, agricultural and biological engineers will be in demand to design biosystems that will adapt the products of biotechnology laboratories to plant and animal production. They will be occupied in designing systems for growing and processing food, feed, fiber, fuels, and chemicals from renewable biomass, and processing waste into useful by-products.

Environmental issues and the need for advanced technology to cope with them will create an urgent need for agricultural and biological engineers skilled in environmental and biological science and technology. Increasing industrialization among developing countries translates into a growing need for agricultural and biological engineers worldwide.

Entry Methods

Industries often send recruiters to campuses to interview and hire students for internships and cooperative education positions. Networking among associates or firms with whom students may have had internships during their college years may yield job leads. Graduating seniors can send resumes to food processing plants, manufacturers of agricultural machinery, electric utility companies, and so on.

New engineers can also become active in professional associations and use the contacts they make for job referrals and introduction. Agricultural and biological engineers who want to work for the government can write or call the state or federal agency in which they are interested.

Advancement

Agricultural and biological engineers with experience and ability may advance to supervisor of a staff or team of engineers and technicians. Some may eventually become engineering managers. Agricultural and biological engineers with a master's or doctoral degree may teach in college. They may also conduct research for the government or for private firms.

For Further Research

Accreditation Board for Engineering and Technology, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202. Web site: www.abet.org

American Society of Agricultural and Biological Engineers, 2950 Niles Road, St. Joseph, MI 49085. Web site: www.asae.org

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Dolores Landeck, Public Affairs Manager, American Society of Agricultural and Biological Engineers, 2950 Niles Road, St. Joseph, MI 49085.

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