An Introduction to Agricultural and Bioresources/Biosystems Engineering (ABE)

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An Introduction to Agricultural and Bioresources/Biosystems Engineering (ABE)

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1. **Evolution of ABE**

The Malthusian thesis (proposed by Thomas Malthus in1798) states that as human population tends to increase, human wellbeing demands a similar increase in food production. In this vein, the US Department of Agriculture stated (USDA, 1967):

> "*Under all is the land. Land is what we live on. It is the foundation of the environment that shapes our lives. Our ability to adapt to our environment determines the level of civilization we attain. When we have food to eat, clothes to wear, houses to live in, and health to enjoy, it is because we have made good use of the land. Only then – when we are fed, clothed, housed, and healthy – do we have the time and energy for tasks that will raise our standard of living and create from our environment a higher civilization. Luxuries are possible only after the necessities of life have been assured. Civilization is based on the productivity of the land. Productivity, however, depends not only on the rich natural endowment of land but also on the wisdom, skill, and technology with which men use it."*

Agricultural engineering as a discipline of study was created at the Iowa State University which granted the first BSc degree in the discipline in 1910. Ever since then agricultural engineering has evolved into a world-wide recognized member of the Engineering family, accreditable for professional engineering practice.

By definition, engineering combines creativity and practicality on a scientific basis. When the scientific basis borders on living things, their byproducts and/or their natural resource base, the engineering discipline is variously called **Agricultural, Biological, Biosystems, Bioresources,** and/or **Bio-environmental** engineering. Currently, the world population is approaching 8 billion with most of the growth occurring in developing countries such as Nigeria. By the Malthusian principle, expanding agricultural and bioresources production in a sustainable manner will be crucial in responding to the challenges. Problems ranging from development of sustainable systems for the production of food, feed, fibre and renewable energy, to the scale-up of products of new discoveries in biology and biotechnology require solutions in the context of globalization and the prevailing role of ICT, while ensuring local relevance and protection of the environment.

2. **The Role of ABE**

Agricultural engineering role was initially the alleviation of human drudgery in farm work and primary processing of farm produce. Today, however, the roles of ABE include the productive management of whole watersheds and ecosystems which may be terrestrial (horticultural, agricultural, forestry) or aquatic/aquacultural. ABE is involved in ensuring the sustainable production of biological materials such as food, fish, feed, fibre and timbre which may be utilized in their primary form, or as input to a wide range of industries. ABE is further involved in such industries, in roles such as value-addition, processing, packaging, preservation, biomass conversion as renewable energy, as well as in building and construction projects using timbre, fibre and their byproducts. To ensure sustainability in production of biomaterials, ABE engages in the management of their natural resources base, in soil and water resources development, and in environmental conservation, restoration, remediation and management.

3. **Position of ABE in the Engineering Family, Society and in Development**

ABE is dedicated to increasing agricultural and bioresources production through improved technology. In this regard, it applies relevant aspects of the other disciplines in the engineering family. In addition to courses of study which are common to all engineering disciplines in the first and second years of an undergraduate program, ABE applies courses in mechanical, civil, electrical, electronic/computer, and materials science and engineering. Hence, ABE is an integrative discipline in the engineering family at the undergraduate level, applying relevant aspects of other engineering disciplines to ensure appropriate and improved technology for increasing agricultural and bioresources production in a sustainable manner. Figure 12.1 illustrates the uniquely distinct nature of ABE in the engineering family.

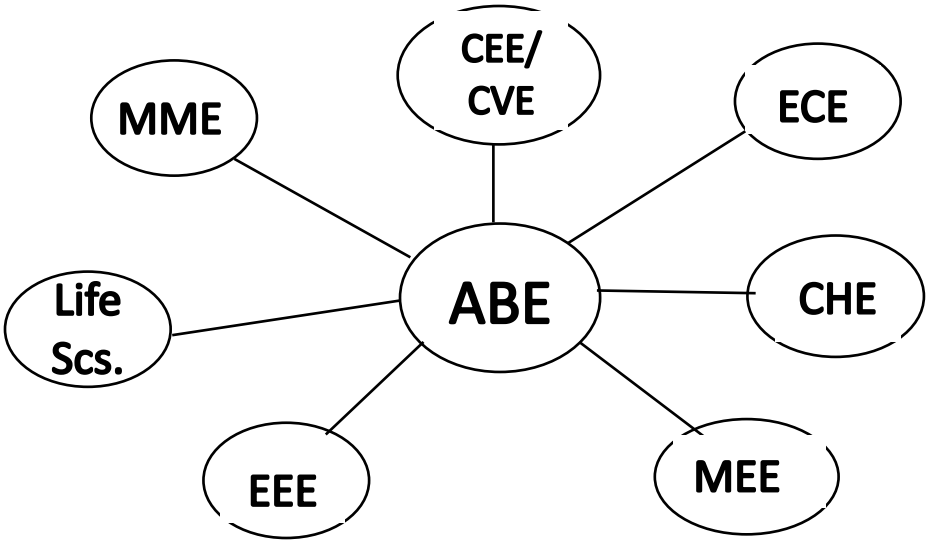

Fig.12.1: ABE integrates aspects of other engineering disciplines with the life sciences (agricultural and biological) while remaining uniquely distinct as an engineering discipline in its own rights (Mbajiorgu, 2023)

In the society, ABE presents a very practical and down-to-earth approach to problem solving. Be it a garden in a family home, an urban or a rural farm, a subsistence or a commercial large-scale agricultural, horticultural, forest or aquacultural enterprise, ABE provides appropriate technology for each case adaptatively, thereby enhancing the development of society. In this way ABE is a catalyst to development, by providing for the basic human needs and thereby enabling the society to engage higher endeavors.

4. **ABE Specialty Areas**

Traditionally, areas of specialization in ABE are as follow:

a) **Power and Machinery** – Tractors, machinery, mechanisms and devices for planting, growing, harvesting and transportation of food and biomaterials. This specialty area involves tillage practices, machinery development and management, forage harvesting, chemicals application, soil dynamics, tractors, tractive and transport efficiency, fruits and vegetables harvesting, grain/crop harvesting, forest engineering, small-scale lawn and garden tractors and implements, nursery and greenhouse mechanization, human factors or ergonomics, materials handling, etc.

b) **Soil and Water** - Structures, equipment and resources for irrigation, drainage, soil erosion and flood control. This specialty area involves groundwater development and utilization, rainwater harvesting and runoff control, evapotranspiration and the water cycle, hydrological systems and their modelling, irrigation and drainage systems development, erosion control, soil and water conservation, flood control, watershed management, and integrated land-use and water resources development/management.

c) **Structures and Environment** – Agricultural buildings and environmental control for livestock production, plant growth and stored products. This specialty area involves development of structures, family housing, livestock housing and silos, environmental sanitation, waste management and utilization, and environmental control in greenhouses, livestock buildings, product and grain storage facilities and silos.

d) **Processing, Storage and Food Engineering** – On-farm processing systems for agricultural products, off-farm equipment for processing, storage, packaging, handling and physical distribution of food products. This specialty area involves biomaterials handling, physical properties, crop and feed processing and storage, food processing and value-addition, packaging and containerization for transportation and distribution, electrical power controls and utilization in food processing and storage.

However, in more modern and advanced programs of study and professional work, ABE has developed new and emergent technical areas of specialization, viz:

e) **Biomass and Renewable Energy Engineering**, involving the specialized processing of biomaterials into biofuels, pharmaceuticals and cosmetics, solar thermal engineering, solar

photovoltaics, wind and geothermal energy harvesting, and small hydropower development.

f) **Forest Engineering**, involving power requirements and development of specialized equipment and machinery for forest establishment and maintenance, tree felling, log processing, timber transportation, special logging techniques, ergonomics and safety issues.
g) **Aquacultural Engineering**, involving development of systems and facilities for small, medium and large-scale aquacultural production; equipment and controls for aquacultural operations, and environmental and waste management.
h) **Ecological Engineering**, involving catchment and ecosystems management; use of wetlands for environmental quality management; climate change impacts and enhancement of ecosystems adaptation mechanisms, environmental pollution assessment and control; restoration of impaired watersheds and bioremediation engineering.

5. **Climate Change Impacts and Issues in ABE**

Climate change arises as a direct or indirect consequence of human activities which alter the composition of the global atmosphere, and is in addition to natural variability of the climate, leading to an increasing global warming trend over comparable time periods in the past. Mitigation of impacts of climate change on agricultural and bioresources production in Nigeria is considered in the context of adaptation to such impacts, rather than the reduction of GHG (Greenhouse Gas) emission to the atmosphere or the reversal of change trends in climate variables. The impacts on agricultural and bioresources production can be identified as: reduced product nutrient levels, increased competition by weeds, shifts in spatial boundaries of crop potential areas, and change in spatial distribution of productive land areas. Other impacts are: changes in water availability, increased temperature and evapotranspiration hence intensification of the hydrological cycle, occurrence and spread of crop and livestock pests and diseases, and more frequent incidents of precipitation extremes, leading to droughts and floods which affect land-use patterns, productivity and yield. For instance, in Southeast Nigeria, the production of yam, maize and cassava crops have shown decreasing trends over a study period of 30 years, from 1984 to 2014, due to climate change (Chikezie *et al.,* 2015). There is, therefore, a need to sensitize farmers and producers on the use of climate forecasts as a mitigation tool.

The Nigeria Meteorological Agency's (NiMet) Seasonal Climate Prediction (SCP) is readily available at the beginning of each year, providing forecasts on rainfall onset and cessation dates, rainfall amounts, length of crop growing season, temperature, and occurrence of dry spells across various land-uses and areas of the country. With the predictions of rainfall characteristics during the farming season, farmers and producers are guided to take advantage of favorable rainfall to optimize crop yield and minimize crop failure. Adjustment of cropping practices to suit climate predictions and adoption of ***Smart Agriculture***, which includes Soil and Water Best Management and Conservation Tillage Practices, are necessary mitigation measures.

6. **ABE Careers**

Careers in ABE range from basic research to managing production facilities which can be as diverse as equipment manufacturing, food processing, and large-scale commercial farms. Other careers opportunities are in federal and state ministries and agencies, and private consultancies and entrepreneurs in the food, feed, fibre and renewable energy production and delivery systems.

Graduates in ABE can find employment in the following institutions, companies and industries in Nigeria:

(a) Government - federal and state ministries/departments of Agriculture, Fisheries, Environment, Energy, Mines, Natural Resources (Land and Water), Rural Development, Science and Technology, town/LGA engineering divisions;
(b) Engineering consulting firms;
(c) Companies - food processing, irrigation and drainage design and component manufacturing, farm machinery engineering component sales, chemical/fertilizer/feed, tyre manufacturers;
(d) Educational - teaching/lecturing/research – universities, polytechnics, colleges of science/technology/agriculture, research and training institutes and centers;
(e) Financial institutions – Banks and Agricultural credit institutions;
(f) Industries - fisheries, surface/subsurface survey, biotechnology firms, greenhouse and horticultural, solar energy technology and other renewable energy industries; goods manufacturing for water pollution control, air pollution control, solid waste management, measuring and monitoring instrumentation, scientific/research/laboratory equipment and chemicals;
(g) Services provision sector - waste handling and environmental facility operation, environmental pollution/impact assessment, laboratory and related field services, facilities design for natural resources conservation and protection, and for aquacultural and forest production.

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