

# KeSEBAE NEWS

NEWSLETTER OF THE KENYA SOCIETY OF ENVIRONMENTAL, BIOLOGICAL  
AND AGRICULTURAL ENGINEERS

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## Engineering For Environmental, Biological And Agricultural Systems In Kenya Lawrence O. Gumbe

### 1.0. Introduction

*Engineering for Life* is the engineering profession as applied to the environment, biological systems and biology-based production and processing industries. These biology based production and processing industries are largely in agriculture, fisheries and forestry.

The profession has its origins, about 100 years ago, in *Engineering for Agriculture* which was called *Agricultural Engineering* in America and *Rural Engineering, Génie Rurale*, in Europe.

President Uhuru Kenyatta in his address to Kenyans during the 54th Jamhuri Day celebrations on 12 December 2017, unveiled what he termed as **The Big Four**, the agenda that will define the Government's priorities and development path for the 2018–2022 planning cycle

The Big Four Agenda is aimed at accelerating economic growth focuses on:

- a. Manufacturing
- b. Food security and nutrition
- c. Universal health coverage
- d. Affordable Housing.

As a start, the Big Four Agenda sits in very well within the global, continental and national development contexts. At the global level, the Big Four Agenda is effectively aligned to the 2030 Agenda for Sustainable Development, upon which the seventeen Sustainable Development Goals (SDGs) are anchored.

At the continental level, the Big Four Agenda aligns well with Africa's Agenda 2063 themed "The Africa We Want". This agenda sets out Africa's aspirations for development by 2063 and is founded on the desire for shared prosperity and well-being,

for unity and aspiration, for inclusive growth and people-driven sustainable development.

In the national context, the Big Four are rightly pegged on the Kenya Vision 2030 and well-mainstreamed in the third-Medium Term Plan (2018-2022) of the Vision, due for launch soon. The Big Four Agenda is also a major step in the realisation of the country's Constitutional obligations.

The five-year process of implementing the Big Four Agenda requires holistic approaches that recognise the collaborative roles of both levels of Governments. Furthermore, the integrated nature of the Big Four Agenda calls for inclusive and integrated approaches to its implementation and reporting.

Whereas the National Government still retains the policy function in agriculture, housing, energy, health and national public works, it is noteworthy that devolution of agriculture, health services, county planning and housing, and energy regulation, place counties at the center in the implementation of the Big Four Agenda.

Agricultural Engineering as a profession was developed in the USA over 100 years ago. Its functions in Europe were effected through a profession called *Genie Rurale* (Literally Rural Engineering). The professional societies in USA and Europe were known respectively as American Society of Agricultural Engineers and *Congre Internationale de Genie Rurale* (CIGR). Both professions were concerned with problems in agriculture and rural development including agricultural production machinery, irrigation, water supply, agricultural processing, rural structures and infrastructure and soil and water conservation.

Over the last 60 years the above professions developed to become engineering for the

environment, agriculture, forestry, marine, amenity and biology-based production and processing industries. Our role now includes engineering in:

- i. Environment and Climate Change
- ii. Energy and Machinery
- iii. Food and Process Engineering
- iv. Irrigation, Drainage and Water
- v. Infrastructure and Structures

Big 4 Agenda as outlined above is a strategy within Kenya's Vision 2030 and the African Unions Agenda 2063. The vision is about creating industrialized societies which imply that a country's capacity to produce secondary goods and services, which as it were, will ensure the conversion to an order in which industry is dominant.

It is therefore, not merely, the construction of plants and factories, but rather the integrated and holistic government-wide policy interventions that together secure the enabler environment and putting in place governance and regulatory framework that gives incentives for growth in all sectors of the economy. We want to industrialize so that:

- We can transform and boost both the agriculture and service sectors as well as provide high quality jobs for the large number of jobless Kenyans
- We can produce high value of goods for both domestic and export markets
- We have a unique scope for learning, improvement and transformation especially in science technology and innovation
- We have access to productive resources by expanding our capabilities through education, skills development and socio-cultural changes

The role of engineers in the environment and biological systems in enabling the Big Four Agenda, Vision and Agenda 20063 is

discussed by sector in the following sections.

## 2.0 Enabling Big 4, Vision 2030 and agenda 2063

### 2.2. Food Security and Nutrition

Food security is realized when we have affordable food in adequate quantities and qualities for the population. This implies that requisite quantities of food are produced, processed, stored, transported and marketed effectively, efficiently and competitively internationally. Food is mainly produced in agriculture, fisheries and aquaculture.

#### 2.1.1. Agriculture and Bioproduction

The engineer has a great role to play in improved production in agriculture including land preparation, crop protection and harvesting. Agricultural production is a thermodynamic process which require adequate efficient energy input for it to be technically and economically effective. Agricultural mechanization is a strategy of achieving better production. A big challenge in Kenya is that the average age of the farmer is over 60 years. Agriculture needs to be made attractive to the young by making it pay more to farmers, reducing drudgery and making it sexy. Lack of proper agricultural mechanization is also a big challenge to agriculture in Kenya.

#### 2.1.2 Agricultural and Bioproduction Machines for Agenda Four

What kind of agricultural machinery will we need to develop for Big 4 Agenda? The answer lies in the kind of agriculture we want to create. Kaya Johnson in a recent article state:

“A technical revolution is underway in farming, as breakthroughs in sensing technologies and robotics are set to overhaul almost every aspect of one of the oldest industries in the world. Technological development has always steered the direction of farming, to create bigger yields and leading large-scale commercial farming to swiftly outstrip traditional small-scale models.

With the aid of robotics, however, it seems that small-scale farming may once again become an economically viable pursuit, whilst improving efficiency and sustainability across the agricultural sector. Testing is already underway to use automated systems for picking and employ

- Soft drink industries such as soda factories such as Coca Cola and Pepsi Cola

sensors to determine the progress of a crop’s growth. For those farming livestock, sensing technology can help monitor an animal’s health; while sensors to monitor and maintain soil quality can help reduce levels of disease and pestilence thereby reducing the need from harmful agrichemicals.”

Linus Opara, at the Pan African Society for Agricultural Engineering Conference organized by the KeSEBAE in March 2018 in Nairobi, stated that we must “BURN THE HOE”. A call for modernization of African Agriculture. The machines for modernizing Kenyan agriculture and bioproduction include:

- Smart tractors and combine harvesters
- Smart irrigation machinery
- Unmanned Aerial Vehicles
- Smart milking machines
- Smart crop driers
- Smart timber harvesting and transport machinery

The engineer will be key to design, manufacture, marketing and operations of the above machinery.

#### 2.1.3 Agricultural and Bioproduction Structures

Agricultural buildings and other structures will play important roles in the development of modern agriculture in Kenya. The engineer will design, construct and operate a variety of these including:

- Smart greenhouses
- Smart poultry production buildings
- Smart piggeries
- Smart milking parlous
- Smart aquacultural structures
- Urban Agriculture
- Crop and animal production in high-rise buildings with IoT controlled water, nutrient, feed, medicine and internal environment control. Figure 2.1a() and (b) shows the application of IoT in high-rise building.

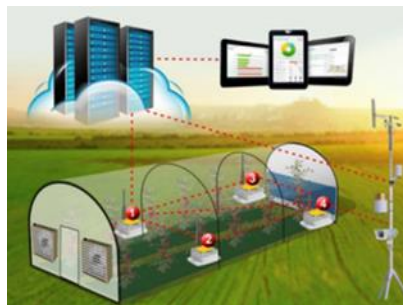


Figure 2.1(a): Application of IoT in Urban Agriculture

The engineer is required to design factories, supervise construction of the same, design production processes, operate machinery



Figure 2.1(b): Application of IoT in Urban Agriculture

### 2.3. Manufacturing

Manufacturing as related to agriculture, forestry, marine, amenity and biology-based processing industries can be described as Food and Bioprocess industries, Bioprocess Engineering is significant to this sector, activities include<sup>4</sup>:

- Primary processing- activities which are undertaken in or near the production are such as a farm or forest. These include threshing, cleaning, washing, drying, filtering, packaging, sorting, grading, grinding, bulking, transportation and baling.
- Storage in bulk or bags or containers at the production level or in a factory
- Secondary processing- these are secondary activities undertaken at factories including cooking, baking, jam production,
- Marketing- activities undertaken to ensure that products are sold including advertising, transport, wholesale and retail sale,

Significant Food and Bioprocess manufacturing activities currently or previously undertaken in Kenya include:

- Cotton and textile industry such as cotton ginneries Rivatex, Raymond and Kicomi textile mills
- Sugar industries such as Mumias, Chemelil, Ramisi, Soin, Sony and Kibos sugar factories
- Beer and alcoholic beverage industries such as Kenya and Keroche breweries
- Tobacco industries such as BAT and Mastermind factories
- Timber industries such as Timsales and Raiply
- Fruit and fruit juice factories such as Del Monte and Pick and Peel
- Dairy industries such as KCC and Brookside
- Meat industries such as Kenya Meat Commission and Farmers Choice
- Salt industries

and effect monitoring and evaluation of the above.

Future factories may will involve innovation in the food and agriculture sector may include:

- New types for raw material processing technology
- Innovative packaging of products
- New food additives
- Application of new solutions may reduce or prevent adverse changes caused microorganisms, oxidation of food ingredients, and enzymatic and nonenzymatic reactions
- Healthier and more nutritious food may be delivered as well as the food may taste better due to improvements in food composition, including organoleptic changes, and changes in the perception and pleasures from eating food.
- Crops may be improved in terms of reduced exposure to diseases and resistance to changing weather conditions
- New food technologies can also offer solutions malnutrition. According to the World Health Organization approximately 30% of the global population is malnourished.
- Food can be created with a 3D printing. In 2013 NASA declared that they are developing the type of food that can be printed. The main goal of the agency was to ensure that astronauts could print out food, instead of consuming it out of tubes. The conference SXSW demonstrated the first printed pizza.
- Processing and manufacture of timber and related plant fibre products for production of constructional materials, furniture and other products.
- Cotton lint and seed processing and manufacture of textiles, surgical cotton seed oil and animal gauze feed
- Manufacture of products from sisals, water hyacinth, farm residues and other plant fibre
- Manufacture of jam, margarine, honey, syrup and related products.

#### 2.4. Energy

Electricity consumption in Kenya is about 160 kWh/capita. The country's Vision 2030 wishes to transform it into a middle income economy by the year 2030. This implies that electricity consumption should rise to about 4,345 kWh/capita. Kenya currently generates electricity through hydropower, geothermal power, thermal power and renewable sources, mainly, solar and wind<sup>5</sup>.

- Use of internet of things in site engineering surveying and map production

The current generation capacity is 2,299MW. The projected Vision 2030 installed capacity is 60,531MW. Vision 2030 generation mix will include geothermal at 26%, nuclear at 19%, coal at 13 %, liquefied Natural Gas (LNG) at 11%, thermal at 9%, wind at 9%, hydropower at 5%, imports at 5 % and solar at 3%. The estimated cost to achieve this is US dollars 26,055,236,042.

The current transmission network lines are 59,459 km. This will increase to 73,355 km. This increase will cost about US dollars 3.8 billion. The current distribution network is 42,176 km. The figure is expected to be expanded to 45,876.6 km.by 2024. The expansion will cost an estimate of USD 331,269,348.

#### 2.5. Universal Health Coverage

Universal Health Coverage can only be achieved if there are adequately resourced health care infrastructure and adequate primary, public and environmental systems which reduce the need for disease outbreak and pressure on hospitals and dispensaries. The engineer has a great role to play in the above through Biomedical and Health Systems Engineering.

*Biomedical and Health Systems Engineering* is the application of the science and art of engineering to the planning, design and management of systems for health care in human and veterinary medicine. Biomedical and Health Systems engineering can also be defined as the application of engineering principles and techniques to medicine. It combines expertise in engineering with expertise in medicine and human biology to develop technologies and techniques for healthcare and patient care. As a field, it is very broad, with applications ranging from molecular imaging to the construction of artificial hearts. This is a crucial profession for the development of a nation.

#### 2.6. Affordable Housing

The engineer for the environment and biosystems has a big role to play in the development of modern housing for human habitation and animal production. The Big 4 Agenda emphasizes need for better urban and rural housing structures.

Rural buildings and structures in Kenya have been built either traditionally with few

- Use of automated systems in functional, structural and environmental design of houses

improvements, or in an inadequate and often overly expensive way, guided by people with insufficient knowledge of the special technical, biological and socio-economic problems involved<sup>7</sup>.

Rural buildings and structures have become an important part of integrated rural housing and development programmes. As a large proportion of the food grain produced in Africa is stored on-farm, it is very important to develop effective storage methods and structures, especially for the modern, high-yielding grain varieties being adopted by farmers, which are more susceptible to pests than traditional types. Improved management and breeding programmes to increase livestock production have also created a need for more appropriate animal housing<sup>7</sup>.

Engineers produced by this department, and sister departments in other universities, have a thorough knowledge of farming systems, crop and livestock production systems and climate factors, as well as a genuine understanding of rural life and the farmer's social and economic situation.

They are also be familiar with the full range of building materials and types of construction, from traditional indigenous to industrially produced, as they apply to rural structures.

They are able to select appropriate installations and equipment for rural buildings.

This knowledge will enable them to produce specifications, in cooperation with the farmer, for functional building designs that provide a good environment and durable construction, thereby contributing to efficient and economically sound agricultural operations.

Further important tasks for specialists in rural structures and services are interpreting and explaining the drawings and technical documentation to farmers, as well as supervising the construction workers<sup>7</sup>.

The engineer can effectively design, supervise construction, operate and maintain mass development of modern mass housing systems through:

- Mass manufacture of structural elements and other components at factories for use in prefabricated development of houses

- Use of 3D printing in the construction of houses
- Use of the IoT in the operation and maintenance of housing systems

#### 2.7. Transport and Access.

The need for improved roads and railways should be outlined as essential for supply of

inputs, marketing of products and movement of workers in agriculture and manufacture.

## KeSEBAE ANNUAL CONFERENCE 2019

**Theme:** Engineering the Big 4 Agenda  
**Venue:** University of Nairobi Towers  
**Date:** Thursday 14 – Friday 15 November 2019

### Background

The Government of Kenya has initiated an ambitious development programme known as the “Big 4 Agenda” that prioritizes the following key areas: food security, affordable housing, manufacturing, and affordable healthcare for all. The Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE) recognizes the important role Engineers can play towards the achievement of these Agenda.

In this year’s KeSEBAE Annual Conference, nine (9) sub-themes have been identified as vital to the success of this programme. :

#### Sub-themes

1. Engineering for Food Security
2. Engineering for climate change
3. Engineering the environment
4. Engineering our irrigation
5. Energy for the Big 4 Agenda
6. Engineering our infrastructure
7. Engineering our water and sanitation systems
8. Engineering and technical education
9. Socioeconomics of the Big 4 Agenda

The Society wishes to invite researchers with complete works on any relevant topics under the above sub-themes. Authors are invited to submit abstracts of their research papers to:

Eng. (Dr.) Duncan Mbuge  
 Email: [info@kesebae.or.ke](mailto:info@kesebae.or.ke)

### Conference Structure

Key note speeches, platform presentations, plenary discussions, poster presentations and exhibitions

### Registration

The participants are required to register by paying a conference fee of KES. 10,000 (regular participants) and KES. 2,000 (students) through the payment information below

Conference materials to be submitted as follows:

- Abstracts – October 31, 2019
- PowerPoint and poster presentation – November 8, 2019
- Full papers for publication – November 10, 2019

**MPESA:** PAYBILL: 303030  
 Account no.: 2038150696

**BANK:**  
 Kenya Society of Env. Bio. & Agric. Engineers

Barclays Bank of Kenya  
University Branch  
Account no.: 2038150696

Please, submit evidence of payment to 0726305273

## KeSEBAE Upcoming Activities

The Editor

The KeSEBAE Annual Conference and Series of lectures for this year are as tabled. **All lectures to be held at the University of Nairobi Towers from 5.00pm.**

Date	Theme
November 2019	KeSEBAE Annual Conference
December 2019	Water and Irrigation Projects Operations, Maintenance and Management
January 2020	Operation, Maintenance and Management in Food and Agroindustry Plants
February 2020	Renewable Energy and Electrification for Rural Kenya
March 2020	Environmental and Social Impact Assessment For County and National Projects: The Engineering Perspective
April 2020	Planning, Construction and Maintenance of County Roads



### Call for membership

The Kenya Society of Environmental, Biological and Agricultural Engineers invite interested individuals to register as members of the society.

#### EDITORIAL

*The KeSEBAE NEWS is a Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers*

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