



## Operationalizing Agricultural Education Innovations for Sustainable Development in Sub- Saharan Africa



Agricultural Education is a program and a process designed for equipping learners with knowledge, skills and attitude in teaching and technical areas of agriculture to enable them impart same to students in Schools and Colleges (Amadi & Nnodim, 2018, Tsojon 2020). As a programme, it is designed to develop a particular knowledge and skills associated with various farming designs (Tata & McNamara, 2018). Agricultural Education as a course of study is offered in tertiary institutions (Universities, Polytechnics, Colleges and similar institutions) which are involved in teaching and learning processes that provide academic credits and competencies that lead to certificates, diplomas and degrees (Suskie, 2018; Oladunjoye, 2018). Tertiary education institutions offering agriculture program perform the roles of teaching, research and service to the growth of citizens (Ryan et al., 2018).



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### Operationalization of agricultural education innovations

Operationalizing is mostly used in research design, especially in studies on psychology, social sciences, life sciences and physics. Operationalization is a process of defining the measurement of a phenomenon that is not directly measurable, though its existence is inferred by other phenomena. This means that despite the impressive gains or benefits in agriculture, the increasing population are still underfed. Therefore, although we cannot measure directly, agricultural impacts, it is necessary we bring it nearer through innovations in other to sustain developmental efforts by feeding the hungry mouths when innovations are adopted. This can be achieved through tertiary agricultural education. Tertiary education is meant to add to national development through appropriate manpower training in order to inculcate proper values for the positive growth of the individual and

society. Also, the institution is to develop the intellectual potential of individuals to understand and appreciate their environment; to assist individual acquire positive skills that will enable them to be self-reliant and productive members of the society. Agricultural education in tertiary institutions helps in attaining the 4th industrial revolution in which disruptive technologies and trends such as the Internet of Things (IoT), robotics, virtual reality (VR) and artificial intelligence (AI) are changing the way modern people live and work. The integration of these technologies into manufacturing practices is known as Industry 4.0. Innovative technology offers benefits such as maximizing production volume and minimizing the risk of failure (Cole, Stevenson & Aitken, 2019). The fourth industrial revolution which began in 2011 in Germany focused on computerization as an innovative production concept (Fowler, 2018). The fourth industrial revolution could not only suggest how to overcome the previous problems but also furnish the foundation for the production development adopting new forms in working applications frame for farming. Industry 4.0 brings the concept - “collective” and “value chain” (Mohamed, 2018) which involves the autonomous connection of computer-based algorithm for open field agriculture.

### Utilizing innovative agricultural technologies and practices for sustainable development

A survey report by Islam & Karim (2019) has shown that food demand is continuously growing, and there is the need to produce 70 percent more food grain by the next 30 years. Therefore, we should use new and advanced technology such as “Agriculture 4.0” also known as “digital farming” to grow more food. According to Xu, David & Kim (2018), the applications of agriculture 4.0 can change the business of farming. Digital farming, an innovative and smart agricultural technology is more productive and sustainable than the old farming method and therefore has no alternative. Considering the importance of Agriculture as a very good asset that enhances sustainable development especially in developing countries where majority of people earn their living in the sector, adopting innovative agricultural technologies and practices for sustainable development becomes imperative. Innovations simply mean new ideas, methods, practice or technologies developed through researches for better result.

### Innovative agricultural technologies and practices for sustainable development

Research has revealed that there are five innovative agricultural technologies and practices for sustainable development, namely: bees and drone, artificial intelligence or automations, blockchain technology, urban agriculture/vertical farming and genetic editing (Dowsett, 2020).

(i) **Bees and drones:** Bees and drones are necessary as climate change is continuously being

experienced. Climate change result to food scarcity and associated high prices. Bees play significant roles in pollinating plants thereby enhance consistent food production. Due to climate change, bees are disappearing or going into extinction. Drones are then developed to perform the function of bees. Drones are now being used in experimentation farms to supplement pollination efforts that remaining bees are completing (Dowsett, 2020). Drones are also used in automated crop harvesting, aerial drone photography and in delivery of products.

(ii) **Artificial intelligence:** Artificial intelligence or automations has been developed for use in different spheres of life but before, no one was thinking of driverless vehicles on farms. Recently, there is a driverless tractor technology in the form of “AutoCart” software. The software fully automate a grain cart tractor, providing farmers with a very welcomed assistance during busy harvesting season, thus, permitting them to automate their existing equipment too, to maximize its capacity and efficiency. The AutoCart software is actually a cloud-based platform, meaning that these automated agricultural vehicles will become part of the global internet of things (IoT). However, automated vehicles are only one small piece of IoT innovation and machine learning in agriculture. A new AI system that uses a combination of voice recognition, machine vision, and temperature sensors for example is now being trialled to keep track of the health, wellbeing and location of animals and disease detection in crops.

(iii) **Blockchain:** Although Blockchain is in cryptocurrency finance, the agricultural world is starting to incorporate this innovative new technology in a different way. Most of the earliest blockchain applications in agriculture were with regard to supply chains and traceability; the status of crops could be recorded and updated using blockchain, right from harvesting to delivery. The true benefit of this for larger operations in particular is a secure, highly accurate ledger where nothing ever goes missing in transit. All crops that belong to a specific farmer can be traced in real time. Blockchain can also be used for resource management, like tracking other sensors and equipment for example, or maintaining machinery records.

(iv) **Urban agriculture/Vertical farming:** Urban agriculture is another innovation that makes best use of very limited farm space which may be quite small, and could literally just be an outdoor traditional community garden. However they can still be very valuable, offering an environmentally controlled, self-contained pod. Sometimes they may even be stacked on top of each other which is known as vertical farming. Despite the relatively small size, yields from vertical farming can be around ten times more efficient than traditional agriculture. Traditional farmers could then learn a lot from vertical farmers in their design and building of structures, making the most of smart design to increase yield and reduce waste. As the world’s population continues to grow and take up more room, efficiencies in space management and farming practices will become all the more essential for

feeding the populace.

(v) **Genetic editing:** Innovations in the area of Genetic editing has propelled scientists to carry out genetic “surgeries” to help them identify and alter an organism’s genome by replacing or removing specific genetic sequencing on a strand of DNA. This means that genetic editing can be used to alter for example a cow’s gut microbes with the aim of controlling the animal’s size as well as reducing the amount of methane produced by these animals. Adjusting the microbiomes of cows in this way could produce more meat on less feed. This in turn leads to industry efficiency and increased profitability. Scientists have also begun to engineer crops that can thrive on less water and yield more food.

## Conclusion

Conclusively, the application of innovative agricultural technologies and practices is very necessary for sustainable agricultural production and development. Researchers in agricultural institutions should continue in their efforts to invent ideas, methods, practices and technologies that can bring food to the table for the increasing population. These innovations require disseminations for adoption among farmers. Tertiary institutions must therefore work in collaboration with extension agents to ensure that these innovations are adopted and utilized for sustainable development.

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