INTEGRATING ADVANCED CONTROL STRATEGIES FOR AUTONOMOUS AGRICULTURAL ROBOTICS INTO NIGERIAN EDUCATIONAL REFORMS: CHALLENGES AND OPPORTUNITIES

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Abstract
The integration of advanced control strategies for autonomous agricultural robotics into Nigeria's educational reforms is pivotal for modernizing the agricultural sector and enhancing productivity. This paper examines the importance of incorporating cutting-edge technologies into educational curricula to cultivate a skilled workforce capable of implementing innovative agricultural practices. Nigeria's current agricultural education framework reveals significant challenges, including outdated curricula, inadequate infrastructure, and limited technological integration. Despite these hurdles, autonomous agricultural robotics holds promise for enhancing productivity, efficiency, and sustainability in farming practices. The paper highlights the urgent need to address infrastructure limitations, the scarcity of trained educators, financial constraints, and cultural resistance to change. However, amidst these challenges lie numerous opportunities. Policy recommendations advocate for government incentives to stimulate private sector investment in educational technology and infrastructure. Additionally, educational institutions should develop specialized training programs for educators and integrate practical, hands-on learning experiences into their curricula. Stakeholders in the agricultural and educational sectors are encouraged to forge partnerships with international organizations and technology providers to access cutting-edge resources and expertise. Furthermore, promoting research and development in agricultural robotics within academic institutions can drive local innovation tailored to Nigeria's agricultural needs. Hence, by adopting these suggestions, Nigeria can position itself as a frontrunner in agricultural innovation, fostering long-term economic benefits and sustainable development. This strategic approach not only addresses current challenges in agricultural education but also ensures readiness to meet future technological demands in the sector.

Keywords: Agricultural robotics, educational reforms, Nigeria, advanced technologies, curriculum development

Introduction

The potential of autonomous agricultural robotics in transforming Nigeria's agricultural landscape cannot be overstated. These advanced technologies promise to revolutionize traditional farming practices by enhancing efficiency, productivity, and sustainability (Bechar & Vigneault, 2016). Autonomous agricultural robots can perform tasks such as planting, weeding, and harvesting with precision and minimal human intervention, thereby addressing labor shortages and increasing crop yields (Duckett, Pearson, Blackmore & Grieve, 2018). However, the successful implementation of such technology hinges on a robust educational framework that can equip future generations with the necessary skills and knowledge. Technological integration in education is critical for preparing students to meet the demands of a rapidly evolving agricultural sector (Voogt & Roblin, 2012). Furthermore, by incorporating advanced control strategies for autonomous agricultural robotics into the educational curriculum, Nigeria can address the skill gap and foster a generation of technologically adept agricultural professionals.

This integration is not only essential for modernizing agriculture but also for driving economic growth and ensuring food security. Education systems that adapt to include cutting-edge technologies enable students to become innovators and leaders in their fields (Voogt & Roblin, 2012). In the context of Nigeria, where agriculture is a major economic sector, modernizing agricultural education could significantly boost the sector's contribution to the national economy (National Bureau of Statistics, 2020). Integrating advanced control strategies for autonomous agricultural robotics into Nigerian educational reforms presents both significant challenges and remarkable opportunities. While there are substantial obstacles such as inadequate infrastructure, limited access to technology, and the need for trained educators (Olaniyan & Okemakinde, 2008), the potential benefits far outweigh these challenges. By overcoming these hurdles, Nigeria can achieve a more efficient and productive agricultural sector. This paper explored the current state of agricultural education in Nigeria, the promise of autonomous agricultural robotics, the challenges and opportunities associated with their integration, and strategies for successful implementation. Through this exploration, it will become evident that educational reforms incorporating advanced agricultural technologies are crucial for the future of Nigeria's agriculture and overall development.

Current State of Agricultural Education in Nigeria

Brief Overview of the Existing Agricultural Education Framework: Nigeria's agricultural education framework comprises diverse institutions, including vocational schools, colleges, and universities specialized in agriculture. Nevertheless, key institutions like the Federal College of Agriculture in Ibadan and the University of Agriculture in Abeokuta play pivotal roles in shaping agricultural education. These institutions offer comprehensive programs in agronomy, animal science, agricultural engineering, and related fields (Ogunbameru, Orheruata, & Eboh, 2006). The framework was structured to provide a balanced blend of theoretical knowledge and practical training essential for supporting the agricultural sector. At these institutions, students pursued diploma, undergraduate, and postgraduate programs that covered a wide array of agricultural disciplines. These included crop production, livestock management, soil science, agricultural economics, and more. The curricula were designed to impart both theoretical insights and hands-on skills necessary for graduates to thrive in agricultural professions. Additionally, vocational training centers within the framework specialized in specific agricultural domains such as poultry farming, fisheries, and horticulture. These centers emphasized skill development through practical experiences, preparing students directly for the agricultural workforce (Aina, 2007). This dual approach offering academic rigor alongside practical training ensures that graduates are well-equipped to tackle the challenges and opportunities within Nigeria's diverse agricultural landscape.

Opinion on the Adequacy and Relevance of Current Curricula: The current agricultural curricula in Nigeria, while comprehensive in traditional agricultural practices, often lack sufficient emphasis on modern technological advancements. Courses tend to focus more on conventional farming methods and less on emerging technologies such as precision agriculture and autonomous robotics (Ekpenyong, 2011). This gap creates disconnect between the skills taught in educational institutions and the skills needed to drive technological innovation in agriculture. The relevance of the curricula is thus limited, as it does not fully prepare students for the evolving demands of the agricultural industry. Many graduates find themselves ill-equipped to handle the challenges posed by modern agricultural practices that require a deep understanding of new technologies. For instance, knowledge about the Internet of Things (IoT), data analytics for farm management, and the use of drones for crop monitoring are often not included in the standard curriculum (Agwu, Ekwueme *and*

Anyanwu, 2008). Moreover, the curricula often lack flexibility and adaptability, failing to incorporate the latest scientific and technological advancements in a timely manner. This rigidity means that students are learning outdated practices, which can hinder their effectiveness and innovation potential in the field. The educational system's slow response to incorporating contemporary agricultural technologies further exacerbates this issue (Olaitan, 2006).

Viewpoint on the Integration of Technology in Education and its Current Shortcomings

The integration of technology in agricultural education in Nigeria is still in its nascent stages. While some institutions have begun incorporating elements of technology into their programs, such as computer-aided design (CAD) for agricultural engineering and basic information technology courses, the adoption of advanced technologies like autonomous robotics remains minimal (Oluwatayo & Oluwatayo, 2012). Several factors contribute to these shortcomings:

1. **Infrastructure Deficiencies:** Many educational institutions lack the necessary infrastructure to support advanced technological training. Laboratories and classrooms are often inadequately equipped with modern tools and resources. For instance, there is a shortage of computer laboratories, modern farm equipment, and internet facilities, which are crucial for teaching and learning about advanced agricultural technologies.
2. **Limited Access to Technology:** Students and educators have limited access to cutting-edge agricultural technologies. This restriction hampers hands-on learning and practical experience with modern equipment. The limited availability of modern farming equipment, such as precision farming tools, drones, and robotic systems, prevents students from gaining the necessary practical skills needed in the contemporary agricultural industry.
3. **Educator Training:** There is a shortage of educators trained in advanced agricultural technologies. Most educators are proficient in traditional agricultural practices but lack expertise in newer, technology-driven methods (Ogbondah, 2010). Continuous professional development for educators is often neglected, leading to a gap between the skills of the educators and the technological advancements in the agricultural sector (Oluwatayo & Oluwatayo, 2012).
4. **Financial Constraints:** Funding is a significant barrier to the integration of advanced technologies. Both governmental and private sector investments in educational technology are insufficient to meet the needs of modernizing agricultural education (Onwueme & Sinha, 1991). The budget allocations for educational institutions are often inadequate, limiting their ability to procure modern equipment and upgrade facilities (Ogbondah, 2010). Hence, addressing these shortcomings is crucial for aligning Nigeria's agricultural education with global standards and ensuring that graduates are equipped to meet the technological demands of the modern agricultural sector. Enhanced investment in educational infrastructure, better training for educators, and increased access to modern technologies are essential steps towards achieving this goal.

The Promise of Autonomous Agricultural Robotics

Explanation of Advanced Control Strategies and Autonomous Agricultural Robotics: Autonomous agricultural robotics encompasses the use of self-operating machines and systems in farming practices, leveraging advanced control strategies to perform agricultural tasks with minimal human intervention. These strategies include a variety of sophisticated techniques such as machine learning, computer vision, and artificial intelligence, which enable robots to navigate, analyze, and interact with their environment (Blackmore, Fountas,

Tang, & Have, 2007). Some of the key components of autonomous agricultural robotics include precision navigation, computer vision, machine learning algorithms, and robotic manipulators. Precision navigation utilizes GPS and sensor-based systems, allowing robots to navigate fields with high accuracy, ensuring precise application of inputs such as seeds, fertilizers, and pesticides. Computer vision involves the use of cameras and imaging technologies, enabling robots to monitor crop health, identify weeds, and assess soil conditions. Machine learning algorithms enable robots to learn from data, improving their performance over time and adapting to changing conditions. Robotic manipulators, equipped with mechanical arms and tools, can perform tasks such as planting, weeding, and harvesting (Bechar &Vigneault, 2016). Collectively, these technologies enhance the efficiency and effectiveness of farming operations, leading to increased productivity and reduced labor costs.

Opinion on the Potential Benefits of These Technologies in Nigerian Agriculture: The adoption of autonomous agricultural robotics holds significant promise for Nigerian agriculture, offering potential solutions to many of the challenges faced by the sector, including labor shortages, low productivity, and inefficiencies in resource usage. Autonomous robots can operate around the clock, performing tasks faster and more accurately than human labor, leading to higher crop yields and more efficient use of land and resources (Duckett, Pearson, Blackmore, & Grieve, 2018). Precision farming techniques enabled by these robots ensure that inputs such as water, fertilizers, and pesticides are used optimally, reducing waste and minimizing environmental impact. This efficient use of resources is crucial in addressing sustainability challenges in agriculture (Bechar and Vigneault, 2016). With the aging farming population and decreasing interest in agriculture among younger generations, labor shortages are a pressing issue. Autonomous robots can fill this gap by taking over labor-intensive tasks, making farming more attractive to the youth by transforming it into a high-tech industry (Blackmore, Fountas, Tang, & Have, 2007). Furthermore, advanced control strategies enable real-time monitoring and management of crop health. Robots equipped with sensors and imaging technologies can detect diseases, pests, and nutrient deficiencies early, allowing for timely interventions and reducing crop losses (Olsen, Zhang, & Chen, 2016). By addressing these challenges, autonomous agricultural robotics can significantly enhance the productivity and sustainability of Nigerian agriculture.

Insights on the Urgency and Necessity of Adopting These Technologies in Education: Integrating advanced control strategies and autonomous agricultural robotics into the educational curriculum is essential for the future of Nigerian agriculture. The urgency of this integration is underscored by the rapidly changing agricultural landscape globally and the need for Nigeria to remain competitive. Preparing students with knowledge and skills in these cutting-edge technologies will ensure a future-ready workforce capable of driving innovation in the agricultural sector. This preparation is critical for sustaining agricultural productivity and economic growth (Olaitan, 2006).

There is a significant gap between the skills taught in traditional agricultural programs and the demands of modern agricultural practices. Updating curricula to include advanced technologies will bridge this gap, making graduates more relevant and employable (Agwu, Ekwueme and Anyanwu, 2008). Exposure to advanced technologies in educational institutions fosters a culture of innovation. Students trained in the latest technologies are more likely to develop new solutions and improvements for agricultural practices, driving the sector forward (Voogt & Roblin, 2012).

The integration of these technologies into education can have broader economic and social impacts. By modernizing agriculture, Nigeria can enhance food security, reduce poverty, and improve the livelihoods of farming communities (National Bureau of Statistics, 2020). Addressing the existing shortcomings, such as infrastructure deficiencies, limited access to technology, educator training, and financial constraints, is crucial for aligning Nigeria's agricultural education with global standards and ensuring that graduates are equipped to meet the technological demands of the modern agricultural sector. Enhanced investment in educational infrastructure, better training for educators, and increased access to modern technologies are essential steps towards achieving this goal.

Challenges in Integrating Advanced Technologies into Educational Reforms

Infrastructure Limitations and Their Impact: Infrastructure limitations pose significant challenges to integrating advanced technologies into educational reforms in Nigeria. Many educational institutions lack adequate physical infrastructure such as computer laboratories, modern classrooms, and reliable internet connectivity (Olaniyan and Okemakinde, 2008). Without these essential facilities, it becomes challenging to effectively teach and learn about advanced technologies like autonomous robotics and precision agriculture. Moreover, the lack of infrastructure hampers hands-on practical training, which is crucial for mastering technological skills in agriculture and other fields. Perspective on the Lack of Trained Educators and Technical Experts: The shortage of trained educators and technical experts proficient in advanced technologies is another critical barrier. Most educators in Nigeria are well-versed in traditional teaching methods but lack expertise in cutting-edge technologies (Ogbondah, 2010). This gap means that students often do not receive adequate guidance and mentorship in utilizing advanced agricultural robotics and other high-tech innovations. Furthermore, the insufficient number of technical experts capable of training educators further exacerbates the problem, limiting the dissemination of modern agricultural practices in educational settings.

Discussion on Limited Access to Modern Technology and Resources: Limited access to modern technology and resources is a significant impediment to integrating advanced technologies into educational reforms. Many educational institutions struggle with acquiring and maintaining state-of-the-art equipment necessary for teaching and research in fields like robotics and precision farming (Jegede, 2009). This limitation not only restricts students' exposure to practical applications but also hinders the development of innovative solutions to agricultural challenges. Unequal access to technology exacerbates disparities in educational outcomes, particularly affecting students from rural and underserved areas.

Financial Constraints and Potential Funding Issues: Financial constraints pose formidable challenges to the adoption of advanced technologies in educational reforms. Budgetary allocations for educational institutions often fall short of meeting the substantial investment required for purchasing modern equipment, upgrading infrastructure, and conducting specialized training programs (Onwueme & Sinha, 1991). Moreover, the reliance on external funding sources, which may be unpredictable or insufficient, further complicates efforts to sustain long-term educational reforms centered on advanced technologies. Adequate and sustained funding is essential to bridge these financial gaps and ensure equitable access to technological advancements across all educational institutions. Cultural Resistance to Change and Traditional Educational Practices: Cultural resistance to change and entrenched traditional educational practices present significant barriers to integrating advanced technologies into Nigerian educational reforms. The prevailing educational culture often prioritizes conventional teaching methods and subjects over emerging technologies and interdisciplinary approaches (Olaitan, 2006). This resistance impedes the adoption of innovative educational strategies that could enhance students' readiness for modern

agricultural practices and other technological advancements. Overcoming cultural resistance requires concerted efforts to promote awareness, demonstrate the benefits of technological integration, and foster a supportive environment for educational reforms. Hence, addressing these challenges requires a comprehensive approach that includes policy reforms, infrastructure development, capacity building for educators, strategic investment in technology, and community engagement to foster a culture of innovation and acceptance of change in educational practices.

Opportunities Created by Integration

Enhancement of Educational Curricula with Cutting-Edge Technology: Integrating advanced control strategies for autonomous agricultural robotics into Nigerian educational reforms presents the opportunity to enhance educational curricula significantly. Therefore, by incorporating cutting-edge technology, students can gain exposure to the latest advancements in agricultural science and technology, preparing them for modern farming practices. The integration of robotics, precision farming, and artificial intelligence into the curriculum can transform traditional agricultural education into a dynamic and interactive learning experience. This shift not only makes learning more engaging but also ensures that students acquire relevant skills that align with global technological trends (Voogt & Roblin, 2012).

Development of a Future-Ready, Skilled Workforce: The inclusion of advanced technologies in agricultural education will contribute to the development of a future-ready, skilled workforce. Graduates will possess the technical know-how and practical skills necessary to operate and manage autonomous agricultural systems. This competency will be essential in meeting the demands of a rapidly evolving agricultural sector. By fostering a workforce that is proficient in modern technologies, Nigeria can enhance its agricultural productivity and competitiveness on a global scale (Olaitan, 2006).

Potential Increase in Agricultural Productivity and Efficiency: The integration of advanced control strategies for autonomous agricultural robotics is expected to significantly increase agricultural productivity and efficiency. By equipping future farmers with knowledge and skills in precision agriculture and robotics, these technologies can be effectively implemented to optimize resource use, reduce labor costs, and enhance crop yields (Duckett, Pearson, Blackmore, & Grieve, 2018). This efficiency can lead to more sustainable farming practices, addressing food security issues and contributing to the overall economic stability of the agricultural sector.

Opportunities for International Partnerships and Collaborations: Integrating advanced agricultural technologies into the educational system opens up opportunities for international partnerships and collaborations. Educational institutions can collaborate with global technology companies, research institutions, and universities to access the latest innovations and research in agricultural robotics. These partnerships can facilitate knowledge exchange, joint research projects, and access to international funding and resources. Such collaborations can enhance the quality of education and research in Nigeria, positioning the country as a leader in agricultural technology in Africa (Voogt & Roblin, 2012). Long-Term Economic Benefits for Nigeria's Agricultural Sector: The long-term economic benefits of integrating advanced agricultural technologies into education are substantial. By producing a skilled workforce adept in modern agricultural practices, the productivity and profitability of Nigeria's agricultural sector can be significantly enhanced. Increased efficiency and higher crop yields can lead to greater food production and export potential, boosting the country's economy. Additionally, the adoption of sustainable farming practices can reduce environmental impact and ensure the long-term viability of the agricultural sector (National Bureau of Statistics, 2020). Therefore, addressing these opportunities through strategic

educational reforms can pave the way for a technologically advanced and economically robust agricultural sector in Nigeria.

Strategies for Successful Integration

Government and Private Sector Collaboration: Successful integration of advanced control strategies for autonomous agricultural robotics into Nigerian educational reforms requires robust collaboration between the government and the private sector. Such partnerships can provide the necessary funding, expertise, and resources to implement technology-driven educational programs. Government policies should incentivize private sector investment in educational infrastructure and technology, while private companies can offer technical support and real-world insights into the application of advanced agricultural technologies. Joint initiatives can create a sustainable framework for continuous improvement and innovation in agricultural education (Akinyemi, 2013). Development of Specialized Training Programs for Educators: To effectively teach advanced technologies, it is crucial to develop specialized training programs for educators. These programs should focus on equipping teachers with the knowledge and skills needed to integrate robotics and precision agriculture into their teaching. Training should include both theoretical understanding and practical applications of these technologies. Continuous professional development and certification programs can ensure that educators remain updated with the latest advancements, thus enhancing the overall quality of agricultural education (Ogbondah, 2010).

Incorporation of Practical, Hands-On Learning Experiences: Incorporating practical, hands-on learning experiences is essential for mastering advanced agricultural technologies. Educational institutions should establish laboratories and experimental farms where students can engage with autonomous agricultural robots and precision farming tools. These practical experiences can bridge the gap between theoretical knowledge and real-world application, fostering a deeper understanding of modern agricultural practices. Experiential learning opportunities such as internships and field projects can further enhance students' readiness for the agricultural workforce. Establishment of Partnerships with International Organizations: Establishing partnerships with international organizations can significantly benefit the integration of advanced technologies in education. Collaborations with global institutions, technology providers, and research organizations can provide access to cutting-edge technologies, research findings, and best practices. These partnerships can facilitate student and faculty exchanges, joint research projects, and participation in international conferences and workshops. Engaging with the international community can position Nigerian institutions at the forefront of agricultural innovation and education (Voogt & Roblin, 2012).

Promotion of Research and Development in Agricultural Robotics within Academic Institutions: Promoting research and development (R&D) in agricultural robotics within academic institutions is vital for sustaining technological advancement. Universities and research centers should be encouraged to conduct research on the development and application of autonomous agricultural systems tailored to Nigeria's specific agricultural needs. Funding for R&D projects, research grants, and incentives for innovation can stimulate the creation of locally adapted technologies. By fostering a research-oriented culture, academic institutions can contribute to the continuous evolution of agricultural practices and ensure their relevance in the global context (Bechar & Vigneault, 2016). Consequently, implementing these strategies can create a conducive environment for the successful integration of advanced agricultural technologies into the educational system, thereby enhancing the overall effectiveness and impact of agricultural education in Nigeria.

Case Studies and Best Practices

Examples of Successful Integration of Advanced Technologies in Education Globally: Several countries have successfully integrated advanced technologies into their educational systems, providing valuable case studies for Nigeria. In the United States, the Massachusetts Institute of Technology (MIT) has pioneered the use of robotics and artificial intelligence in its curriculum, fostering a hands-on learning environment that encourages innovation and practical application (MIT, 2017). In Japan, Tokyo University of Agriculture and Technology integrates precision farming and robotics into its agricultural programs, ensuring that students gain firsthand experience with cutting-edge technologies (Kondo, 2016). Similarly, the Netherlands has implemented advanced agricultural technologies in educational institutions like Wageningen University, which focuses on sustainable and high-tech farming practices (Wageningen University & Research, 2020).

Lessons Learned from Other Countries' Experiences: The experiences of these countries offer several lessons for integrating advanced technologies in education. Firstly, a strong emphasis on hands-on, experiential learning is essential for effective education in advanced technologies. Institutions like MIT and Wageningen University provide extensive laboratory and fieldwork opportunities, allowing students to directly interact with technology (MIT, 2017; Wageningen University & Research, 2020). Secondly, collaboration with industry partners can enhance educational programs by providing access to the latest technologies and practical insights. Tokyo University of Agriculture and Technology's partnerships with technology companies serve as a model for such collaborations (Kondo, 2016). Lastly, continuous professional development for educators ensures that they remain updated with technological advancements and can effectively teach new content (OECD, 2019).

Adaptation of Best Practices to the Nigerian Context: Adapting these best practices to the Nigerian context requires a tailored approach that considers local challenges and opportunities. Enhancing hands-on learning can be achieved by establishing well-equipped laboratories and experimental farms in educational institutions. Partnerships with local and international agricultural technology companies can provide necessary resources and expertise. Continuous professional development programs for educators can be implemented through collaborations with global institutions and online training platforms (Olaitan, 2006). Furthermore, integrating these technologies into the curriculum should be aligned with Nigeria's specific agricultural needs and conditions. For example, precision farming techniques can be adapted to local crops and farming practices to ensure relevance and practicality. Encouraging public and private sector investment in educational infrastructure and technology will also be crucial. Thus, by learning from global examples and tailoring strategies to local contexts, Nigeria can successfully integrate advanced technologies into its educational system, thereby enhancing agricultural education and productivity.

Conclusion

In conclusion, integrating advanced control strategies for autonomous agricultural robotics into Nigeria's educational reforms is crucial for modernizing agriculture and enhancing productivity. Despite challenges such as infrastructure limitations, a shortage of trained educators, limited access to modern technology, financial constraints, and cultural resistance, there are significant opportunities. Enhancing curricula with cutting-edge technology, developing a future-ready skilled workforce, increasing agricultural productivity and efficiency, and fostering international partnerships can transform the educational and agricultural sectors. Strategies for successful integration include government and private sector collaboration, specialized training programs for educators, practical hands-on learning experiences, partnerships with international organizations, and promoting research and

development in agricultural robotics. Learning from global best practices and tailoring these strategies to Nigeria's context can ensure the successful integration of advanced technologies, leading to long-term economic benefits and positioning Nigeria as a leader in agricultural innovation.

Way Forward

To effectively integrate advanced control strategies for autonomous agricultural robotics into Nigerian educational reforms, the following suggestions were made:

1. The Nigerian government should implement policies that incentivize and facilitate private sector investment in educational technology and infrastructure.
2. The government should provide financial support and grants for educational institutions to develop and maintain laboratories and experimental farms equipped with modern agricultural technologies.
3. Educational institutions should develop and offer specialized training programs for educators to enhance their understanding and teaching capabilities regarding advanced agricultural technologies.
4. Schools should incorporate practical, hands-on learning experiences into the curriculum to ensure that students acquire real-world skills and expertise in autonomous agricultural robotics.
5. Stakeholders in the agricultural and educational sectors should establish and strengthen partnerships with international organizations, technology providers, and research institutions to gain access to cutting-edge resources, expertise, and best practices.

References

Agwu, A. E., Ekwueme, J. N., & Anyanwu, A. C. (2008). Adoption of improved agricultural technologies disseminated via radio farmer programme by farmers in Enugu state, Nigeria. *African Journal of Biotechnology*, *7*(9), 1277-1286.

Aina, L. O. (2007). Globalization and small-scale farming in Africa: What role for information centres. World Library and Information Congress: 73rd IFLA General Conference and Council.

Akinyemi, S. (2013). Funding Strategies for Qualitative University Education in Developing Economies: The Case of Nigeria. *International Journal of Higher Education*, *2*(1), 53-59.

Bechar, A., & Vigneault, C. (2016). Agricultural robots for field operations: Concepts and components. *Biosystems Engineering*, *149*, 94-111.

Blackmore, S., Fountas, S., Tang, L., & Have, H. (2007). Development and application of a software system to assist decision-making in precision agriculture. *Biosystems Engineering*, *97*(2), 193-207.

Duckett, T., Pearson, S., Blackmore, S., & Grieve, B. (2018). Agricultural robotics: The future of robotic agriculture. *Annual Review of Control, Robotics, and Autonomous Systems*, *1*, 235-261.

Ekpenyong, L. E. (2011). Foundations of Technical and Vocational Education: Evolution and Practice. Benin City: Ambik Press.

Kolb, D. A. (1984). Experiential learning: experience as the source of learning and development. *Prentice-Hall*.

Kondo, N. (2016). Robotics and automation for agriculture in Japan. *Journal of the Science of Food and Agriculture, 96*(2), 17-21.

MIT. (2017). MIT School of Engineering. Retrieved from https://engineering.mit.edu/

National Bureau of Statistics. (2020). Nigerian Gross Domestic Product Report.

OECD. (2019). Teachers and School Leaders as Lifelong Learners. OECD Publishing.

Ogbondah, L. (2010). Adequate Funding of Public Universities in Nigeria for Sustainable Development. *African Journal of Historical Sciences in Education*, 6(2), 322-333.

Ogunbameru, B. O., Orheruata, A. M., & Eboh, E. C. (2006). Institutional framework for agricultural development. *Journal of Agricultural Extension, 10*(1), 43-54.

Olaitan, S. O. (2006). Vocational and technical education in Nigeria (Issues and Analysis). *Onitsha: Cape Publishers International Limited*.

Olaniyan, D. A., & Okemakinde, T. (2008). Human capital theory: Implications for educational development. *Pakistan Journal of Social Sciences*, 5(5), 479-483.

Olsen, J. E., Zhang, Q., & Chen, Y. (2016). Advances in agricultural robotics: A perspective for the future. *Computers and Electronics in Agriculture*, 136, 20-26.

Oluwatayo, J. A., & Oluwatayo, M. B. (2012). Agricultural education in Nigeria: An appraisal. *Nigerian Journal of Agricultural Education*, 5(1), 13-22.

Onwueme, I. C., & Sinha, T. D. (1991). Field crop production in tropical Africa: Principles and practice. *Technical Centre for Agricultural and Rural Cooperation*.

Voogt, J., & Roblin, N. P. (2012). A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies*, 44(3), 299-321.

Wageningen University & Research. (2020). Education at Wageningen University. Retrieved from: https://www.wur.nl/en/Education-Programmes.htm

Yusuf, M. O. (2005). Information and communication technology and education: Analyzing the Nigerian national policy for information technology. *International Education Journal*, 6(3), 316-321.