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Innovation Centric Extension Services and Information Communication Technologies Benevolence: Implications for Local Innovation Generation and Agripreneurial Promotion for Sustainable Food Systems

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Abstract

Innovation generation is central and requisite path to any developmental efforts, in agriculture it is prime and so recognized, but its generation were traditionally expert driven. Extension's role then, was mainly to transfer technology through a linear model, this is amidst robust facilities, established institutions and experienced farmers that can co-create innovation and thus smoothen adoption. Amidst increasing demand for food systems and need to be resilient the need for more innovations is apparent. Recently, a more robust approach that is participatory, flexible and inclusive is gaining ground and holds great potentials, the Agricultural Knowledge and Innovation System (AKIS). Regarded both as a facilitator of innovation generation and a precursor for sustainable food systems through expansion of opportunities across Agricultural Value Chains (AVCs). This paper espouses the need for an innovation centric advisory service towards stimulating local innovation generation and utilizing ICTs'. A structured review of relevant literature led to these conclusions. First; connectivity and interactive e-platforms can serve as innovation platforms for stakeholders towards enhancing local innovation generation across AVCs. Second, an innovation centric extension service will aid the generation of local innovation. Thirdly, a need for regulated e-agricultural advisory service is apparent and thus some sort of certification for advisory service facilitators is required.

Keywords: local innovation, innovation platforms, agricultural knowledge and Innovation System, ICTs and E-innovation Platforms

Introduction

Global food systems are expected to sustainably feed more than 10 billion people by the year 2050 and therefore supplies must be doubled to meet this demand. The Food and Agriculture Organization (FAO, 2017) posited that the food demand will rise by the year 2050 and the need to cater for the increased population is a necessity. However, this heightened demand is coming amidst myriad challenges threatening the sector, thus making such demand seemingly daunting task. Nonetheless, a respite is suggested within literature which revealed that through concerted, deliberate and strategic efforts of stakeholders within the food supply chain, this demand is deemed a reasonable and achievable. Through innovative efforts and resulting resilient agricultural livelihood systems, the food supply can withstand all environmental and social pressure (Cooper & Wheeler, 2015; FAO,

2016) towards a sustainable supply of food and fibre. In this regard, the services of frontline agricultural advisory service providers are deemed as lone route of information provision and linkages towards repositioning the food supply system. But, yet another challenge exist, the shrinking extension-farmer ratio within the sector and thus poor coverage of the clienteles. The benevolence of Information Communication Technologies (ICTs) is suggested as a capable and bridging tool for addressing such gap (Huber et al., 2017; Muktar et al., 2018; Ortiz-Crespo et al., 2021; Tokurah, 2021) and is even alluded to unveil a new surge of agricultural information outlets especially to youth who are the heavy users of ICTs and thus their desirable enchantment to the sector (Bafana, 2021; Muktar et al., 2015, 2020; Tokurah, 2021).

The fact that youth are an agile and audacious population, they are considered highly necessary catalyst and thus important players in the food and innovation system. Furthermore, literatures have alluded to the fact that the new trend of innovation generation is etched to machine and connectivity (Luque et al., 2017; Zhuhadar et al., 2017), this makes the youth central. Being that youth are recognized *techies* with a natural affinity to machines, their utilization is seen as having huge potential of spurring new innovations and implementation. Perhaps, the lingering problem of youth disenchantment and poor attitude to agriculture may be solved if ICTs are harnessed properly through their innovative use. Ultimately, if this happens it will open up new opportunities across various nodes of the Agricultural Value Chains (AVCs), yielding new budding enterprising ideas, spring of agriprenuers and increased job opportunities.

From this viewpoint we argued that stimulation of inclusive local innovation generation and dissemination as the key essence of innovation centric extesnion service and is the only way to address the challenges facing food supply system as well as captivating the youth towards the vocation of agriculture. This is achievable through a user centric and participatory approach to problem analysis and proffering solutions. We write to contribute to the application of Agricultural Innovation Systems (AIS) principles to innovation platforms and argued that interactive electronic spaces like WhatsApp, Facebook and other e-applications can facilitate and spur up local agricultural innovation. Thus, this paper is set out espouse the importance of innovation centric advisory service that is aided by ICTs as a panacea to sustainable food system. It is structured into three sections. The 1st section situates the discourse of extension and need for innovation generation and ICTs intermediation in a participatory approach, second section promotes the innovation system thinking and catalytic role of youth and e-innovation platforms and thirdly, the AIS as a framework that anchors collective innovation generation is suggested.

Innovation centric advisory services for local innovation: stimulus role of ICTs

Globally, the agricultural sector had never been so much challenged by socio-environmental factors and yet insatiable expectations to perform its duty of supplying food and fibre. The decimating effect of climate change, its related extreme events, an aging farming population and even agriculturally impassive youth are in recent time identified as major issues impeding food supply systems' efficiency (FAO, 2015; Nyasimi et al., 2017). Individually, all these problems require unique, specific and deliberate efforts to solve. Usually, the stakeholders within the system which include research outfits, government agencies and strong policy are instruments of addressing such issues, with extension agents serving as conduits or facilitator to

and from the institutions. However, while the generation of innovation is going on, the dissemination of these new innovation is a growing challenge in recent times, especially within African nations. The problem of shrinking number of extension workers population and thus widening extension-farmers ratio is increasingly expanding the recommended ratio of service providers to farmers in the world. For example, in African countries like Kenya there were reported ratio of 1:1000 extension worker to farmer (Speranza et al., 2009), and in Nigeria there was reported ratio of 1:75,000 (Oge, 2019). These are revealing a huge gap that will certainly affect not only their delivery and performance but also the supply of food supply system eventually. Efforts to stem these problems led to the promotion of various approaches by various regimes of governments across nations but most of which are considered to be expert centric or top down. Yielding to generation of innovation that were observed to be hatched in isolation of the end users and thus may not solve their felt need. This usually makes such programs to fail or perform below expectations of the planners.

Thus, the need for a renewed approach to extension service towards bolstering morale and promoting the generation of local innovation and even entrepreneurial activities across the value chain is acknowledged as the way to go (Etela & Onoja, 2017; Fielke et al., 2020; Steinke et al., 2021). Recently, there has been a noticeable deluge of innovations and utilization of ICTs as enablers to generating new ideas and agriprenuerial support, where they are utilized to promote economic activities in addition to the social benefit they provide. It has now been accepted that the ICTs are a platform that are facilitating business ideas, link up customers as well as aid uptake of goods and services. Several researchers have investigated the ICTs role in promoting idea generation (Duncombe, 2007; Hall, 2007; Lusk, 2010; Sarker, 2015), marketing promotion and linkages (Ifeanyi et al., 2018; Zhang et al., 2016) and even disseminating knowledge and extension services (Muktar et al., 2018; Mwombe et al., 2014; Siraj et al., 2012; Williams & Agbo, 2013). The enabling role of ICTs, their extension of wealth of information as well as facilitation of innovativeness is mentioned as capable of serving the food system to innovate towards sustainable development. Appendix 1 projects some case scenarios that showcase how the ICTs innovation provides jobs and economic activities among youth and the general agricultural sector towards serving the food system. It also reveals how advisory services are rendered through linkages provision and even core peddling of agricultural knowledge, now this is yet another issue of great concern to practitioners.

System thinking and e-innovation Platform, a solution to paradox of participation in Agricultural Value Chains

System thinking and or innovation system within agriculture simply means the linkages and feedbacks within FVCs with all actors and elements involved and partaking actively in the process of demand, generation and effective utilization of innovation away from the scientism of knowledge creation by experts in the linear system. (Borman et al., 2022; Pound & Conroy, 2017). The innovation system thinking is contrasting the hitherto, expert centric linear model of innovation generation and dissemination for adoption but rather accepts a convergence of perspectives, experiences and expertise towards issues in the food system. Hubart et al (2000) in (Koutsouris, 2012) stressed that the innovation system offers potent

alternative to the dominant linear paradigm of agricultural innovation which has lost its appeal.

The cardinal milieu for innovation to occur and even flourish therefore is identified to be the innovation platforms, which in essence are nothing other than connectors of stakeholders, motivators and inspirational platforms towards a common goal. Importantly, the interaction, context and perspective of actors to issues and situation is believed vital and necessary input towards problem solving. Creating this environment that creates nexus between these stakeholders physically is proving difficult and was posited to be non-existent according to Nigerian Extension Service report (Huber et al., 2017) but a prevailing monopoly of knowledge by experts and prescriptive solutions to issues abound. The limited number of agents and resources in Nigeria are incapable of sustaining such interactions within physical innovation spaces or platforms as such the e-platforms are deemed as convenient and equally effective alternative. The ubiquity of ICTs and its increased penetration and utility is a window that can accommodate such interaction effectively. Similar to the online training and seminar being practiced globally, e-innovation platforms can thrive through the benevolence of ICTs with minimal cost of resources. Thus, e-innovation platforms are understood to be the next alternative to not only dissemination of innovation findings but a platform where ideas may be discussed, innovation initiated as well as popularized. Moreover, extension has for long regarded and utilized ICTs as veritable and enabling tools to solving its myriad problem solving activities (FAO and International Telecommunication Union, 2016; Ifeanyi et al., 2018) and have utilized them for dissemination from time immemorial. A more interactive and deeper use is deemed an immediate necessity, therefore e-innovation platforms if subscribed to and utilized will aid in the stimulation of local innovation. Conversely, considering their nature and appeal, tremendous potentials are foreseen where youth may be pulled as active actors and catalyst in the generation and dissemination agribusiness innovations. Certainly, consideration of technical skills may pose some hindrances but this can be surmounted through yet another innovative initiative of community viewing clubs that can be facilitated within communities. These are similar to the radio-listening clubs of the 80s as reported in FAO (2014). These were clubs were radio programs were facilitated to be listened to by extension agents within communities for the purpose of discussing and understanding messages listened to. Similarly, the e-innovation platforms can be given such approach for coaching and training by the little number of extension agents. Utilizing e-innovation platforms will tremendously promote the actual implementation of participatory extension through extension of opportunities, voices and actual involvement of stakeholders.

Agricultural innovation and e- platform Players: need for experts' regulation

The potentials of e-innovations are no longer imaginary but a stark reality that is on the palm of our hands. The 4th generation revolution has leapfrogged many sectors to another realm where possibilities knows no bounds. Applications of Internet of Things (IoTs), Artificial Intelligence (AI) and Big Data are opening up astounding technologies that aids and facilitate easy living and practices. Within agricultural sectors many technologies are developed along the value chains and various innovative applications of these technologies are developed and deployed into the sector. Although, most of these recent and disruptive technologies are targeted to

serve the downstream of the value chain through provision of marketing and financial linkages. They have opened up new streams of opportunities and employments for vast number of people along the chain. Applications like Farmcrowdy, hello tractor and Farminnovate are an opening to many benefits across the value chain. However, close observation reveals little of these innovations are coming from mainstream agriculture professionals, students and or even field workers.

Therefore, most developers are not with the requisite technical knowledge and thus innovations may lose the once touted expert and prescriptive connotation but rather maybe an abyss of misguidance, thus negatively serving the system. The fact that the knowledge requirement for developing such software is usually computer science and its allied courses based makes developers deploy applications they deemed the sector needs without input from the experts in agriculture. However, due to the unique nature of agricultural value chains products, it is a most to involve the experts to project their peculiarity and remediation techniques. If done this way, such applications may better serve the value chain more beautifully if and when experts are involved, at least in the content development aspect. Some sort of certification as having met the required standard to better serve the system should also be deployed. For example, some of these applications and software extends extension and advisory services and these are essential inputs that are supposed to emanates from informed sources. A simple perusal of the applications developed in the last decade will reveal applications developed as presented in the Table 1 below with no person with agricultural background as part of the team, this is a dangerous trend and may present an inhibitive effect to agriculture.

Table 1: Agritech innovations serving food value chains and educational background of CEOs

S/N	Name of Application or software	Country of Incoporation	CEOs And Educational Background
1.	Hello Tractor	**Nigeria**	*MSc Economics*
2.	FarmCrowdy	**Nigeria**	*BSc. Applied Information Technology*
3	Farmlogs	**USA**	*BSc Computer Information System*
4	Climate Field View	**USA**	
5	Agrivi		*Electrical and Electronic Engineering* *Economics* *Business and Computer Science*
6	Releaf.NG	**Nigeria**	*Bsc Computer*
7	Thriveagric	**Nigeria**	*Bsc. Biochemistry*

Source: Authors Compilation 2022

Innovations serving AVCs will better be positioned to perform if the principle of the AIS is followed where stakeholders are engaged and the innovation is generated, assessed and used in unison and agreement of all steps achieved. This will both make the innovation adopted and sustainable but also makes it further serve the food system sustainably.

Entrenching Bottom-up Model to advisory Service for local Innovation generation: The Agricultural Knowledge and Innovation System Model

Agricultural sector may arguably be the first sector where innovation generation started where man begin to invent simple tools and acts of farming for food and fibre necessary for survival. The value addition of mostly agricultural produce also necessitates the generation of other innovations like clothing etc. The sector still thrives and depends on innovation like many other and thus the need for continuous innovation generation to serve its purpose. Although innovations are continuously generated and sent into the farming communities through recognized and accepted model of innovation adoption by (Lai, 2017) most of the hitherto culture of generating innovations was expert driven where the research outfits are looked upon to solve all problems emanating from farmers and other actors. Current, realities in line with the participatory approach of extension revealed that stimulating the local solution to local problems is not only apt at this time but has the potentials of bringing sustainability.

Therefore, credence is now accorded the social dimensions of simple yet revolutionary ideas and methods of simplifying operations and value addition from any actor within the agricultural value chain. This means rather than looking into the linear model of innovation generation, a more liberal approach is encouraged where the community and all stakeholders are viewed as potential generators of innovation. Interestingly, this is capable of making the idea and or generated innovation transcend all phases of innovation adoption stages and leap frog to final stages of trial in the adoption system. The virtue of this system is people are involved or are the generators of the innovation and are therefore ever ready to practice that without any apprehension or reservation. This was as asserted by Juma, (2011) where they reported that no-till innovation generated and disseminated across more than 60 countries, adoption *en-masse* was only achieved where diverse actors formed innovation networks to develop technical innovation that is locally suited. This clearly shows the changing demand to extension services from the push system to the pull system (FAO, 2017; Knierim et al., 2017; Alex Koutsouris, 2012). this is to say rather than pushing people to adopt an innovation extension service provider now are to act as real catalyst in the system and are needed to stimulate the process of generation of local innovation not only adoption. Although research centres and ivory towers retain their rights and expertise with the technical knowhow in generating more advanced and more technically based innovations, yet local innovations that may solve immediate issues and add value may be better generated in this manner and its adoption simplified and assured through this process which gives everyone due recognition and roles. The Agricultural Knowledge and innovation System provide the framework for such innovation generation where it recognizes all stakeholders as equal and partners in the generation of innovation (Aerni et al., 2015; World Bank, 2012). But then there is need for a regulation and validation framework for such innovation even though these instruments and check may be restrictive and a source of scuttling blooming innovations. Yet, a framework like AKIS provides ready frame to utilize with in the time being.

Potentials of interactive ICTs as Innovation Platforms for local generation

The potentials of ICTs to serve the agricultural centre is so enormous that it is viewed as a potent enabler towards revolutionizing the sector. Recent disruptive

technologies are great pointers and the fact that these ICTs are so ubiquitous that the last mile farmers are so familiar with them that utilization is no longer an issue (Muktar et al., 2015). ICTs therefore are seen as having great potentials in facilitating farmer to extension interaction within populations and because the interaction will involve many stakeholders including the experts that will be able to pick up some innovative potentials as well as ideas for further assessment and validation is high. The table below listed some ICTs platforms and how they can be utilized as e-innovation platforms as possible enablers of local innovation generation. In response to the criticism of the marginalised people may not access services on the e-platform thus, the whole e-revolution is looked at with suspicion and accused of deliberate side-lining of disadvantaged citizens. (Steinke et al., 2021) argued that when these set of people are deliberately targeted and put at the centre of user centric design process, such involvements may lead to solving their needs and conditions. Meaning that they can be made to access these services if the programs are tweaked to serve them. Similarly, the voice interactive platforms like that in the WhatsApp where a recorded message can be sent and received, it allows for people with less literacy access such services.

Conclusion and Recommendation

The review clearly shows the applicability of e-innovation platforms in todays quest for local solutions to local problem through promoting innovation centric advisory services. A detour of the literature promotes different examples of innovative initiatives by young enterprising individuals that are generating socio-economic benefits for the populations. Although, these initiatives are observed to have some positive impact to advisory services but of concern is the entry of untrained people into provision of services to the agricultural sector. Being a sector that requires special treatment to issues and requirements this came across as a source of concern. Thus, the promotion of facilitation for local innovation around applications of ICTs for agritechs as well as regulation of actors and new entrants into the sector service provision is recommended.

References

Aerni, P., Nichterlein, K., Rudgard, S., & Sonnino, A. (2015). Making agricultural innovation systems (AIS) work for development in tropical countries. *Sustainability (Switzerland)*, *7*(1), 831–850. https://doi.org/10.3390/su7010831

Bafana, B. (2021). *Creating Opportunities to Nurture Agripreneurship among Africa ' s Youth Staying power Research evidence for policy development*. Food and Agriculture.

Borman, G. D., de Boef, W. S., Dirks, F., Gonzalez, Y. S., Subedi, A., Thijssen, M. H., Jacobs, J., Schrader, T., Boyd, S., ten Hove, H. J., van der Maden, E., Koomen, I., Assibey-Yeboah, S., Moussa, C., Uzamukunda, A., Daburon, A., Ndambi, A., van Vugt, S., Guijt, J., … van Berkum, S. (2022). Putting food systems thinking into practice: Integrating agricultural sectors into a multi-level analytical framework. *Global Food Security*, *32*(October 2021), 100591. https://doi.org/10.1016/j.gfs.2021.100591

Duncombe, R. (2007). Using the Livelihoods Framework to Analyze ICT Applications for Poverty Reduction through Microenterprise. *Information*

Technologies and International Development, *3*(3), 81–100. https://doi.org/10.1162/itid.2007.3.3.81

Etela, I., & Onoja, A. O. (2017). Incentivizing e-Agriculture and Agribusiness Incubators for Youth Employment in Nigeria. *Nigerian Agricultural Policy Research Journal.*, *2*(1), 42–54.

Food and Agricultural Organization FAO. (2014). *Communication for Rural Develoment: Guideline for Planning and Project Formulation*.

Food and Agricultural Organization FAO. (2015). Food wastage footprint & Climate Change. *Food Wastage Footprint & Climate Change*, *1*, 1–4. http://www.fao.org/3/a-bb144e.pdf

Food and Agricultural Organization FAO. (2017). *Inclusive and coordinated approaches for sustainable food value chains*.

Food and Agricultural Organization FAO and International Telecommunication Union. (2016). *E-Agriculture Strategy Guide Piloted in Asia-Pacific countries*.

Fielke, S., Taylor, B., & Jakku, E. (2020). Digitalisation of agricultural knowledge and advice networks : A state-of-the- art review. *Agricultural Systems*, *180*(October 2019), 102763. https://doi.org/10.1016/j.agsy.2019.102763

Hall, A. (2007). Challenges to Strengthening Agricultural Innovation Systems: Where Do We Go From Here? *UNUMERIT Working Paper*, *38*(31). http://www.merit.unu.edu/publications/wppdf/2007/wp2007-038.pdf

Huber, S., Davis, K., & Lion, K. (2017). *Nigeria: In-depth Assessment of Extension and Advisory Services* (Issue March). https://www.digitalgreen.org/wp-content/uploads/2017/09/Nigeria-In-Depth-Assessment.pdf

Ifeanyi, N. O., Irene, I. C., Chiebonam, A., & Virginus, N. U. (2018). Use of Information and Communication Technologies for Agricultural Teaching and Research in Universities in Enugu State , Nigeria. *Journal of Agricultural & Food Infromation*, *6505*. https://doi.org/10.1080/10496505.2018.1437444

Knierim, A., Labarthe, P., Laurent, C., Prager, K., Kania, J., Madureira, L., & Ndah, T. H. (2017). Pluralism of agricultural advisory service providers – Facts and insights from Europe. In *Journal of Rural Studies*. Elsevier Ltd. https://doi.org/10.1016/j.jrurstud.2017.07.018

Koutsouris, A. (2012). Facilitating Agricultural Innovation Systems: A critical realist approach. *Studies in Agricultural Economics*, *114*(2), 64–70. https://doi.org/10.7896/j.1210

Koutsouris, Alex. (2012). Facilitating agricultural innovation systems: A critical realist approach. *Studies in Agricultural Economics*, *114*(2), 64–70. https://doi.org/10.7896/j.1210

Lai, P. (2017). the Literature Review of Technology Adoption Models and Theories for the Novelty Technology. *Journal of Information Systems and Technology Management*, *14*(1), 21–38. https://doi.org/10.4301/S1807-17752017000100002

Luque, A., Peralta, M. E., de las Heras, A., & Córdoba, A. (2017). State of the Industry 4.0 in the Andalusian food sector. *Procedia Manufacturing*, *13*, 1199–1205. https://doi.org/10.1016/j.promfg.2017.09.195

Lusk, B. (2010). Digital Natives and Social Media Behaviors. *Journal of Education and Practice*, *17*(6), 1.

Muktar, B. G., Man, N., & Orifah, M. O. (2020). Agricultural Information Systems and Sustainable Food Value Chain Development : Strategies Towards Innovative Application of ICTs. In *Opportunities and Strategic Use of*

Agribusiness Information Systems (pp. 93–95). https://doi.org/10.4018/978-1-7998-4849-3.ch006

Muktar, B. G., Man, N., Saleh, J. M., & Daneji, M. I. (2018). Evaluation of ICTs access, use and preferences for livelihood resilience: results from a survey of Malaysian fisher folks. *Journal of Agricultural Education and Extension*, *24*(4), 377–388. https://doi.org/10.1080/1389224X.2018.1479279

Muktar, B. G., Mukhtar, U., & Ahungwa, G. T. (2015). Harvesting Youth for Agro-entrepreneurship : Stimulus Role of Social Media in Nigeria. *International Journal of Applied Research and Technology*, *4*(11), 94–100.

Mwombe, S. O. L., Mugivane, F. I., Adolwa, I. S., & Nderitu, J. H. (2014). Evaluation of Information and Communication Technology Utilization by Small Holder Banana Farmers in Gatanga District, Kenya. *Journal of Agricultural Education and Extension*, *20*(2), 247–261. https://doi.org/10.1080/1389224X.2013.788454

Nyasimi, M., Kimeli, P., Sayula, G., Radeny, M., Kinyangi, J., & Mungai, C. (2017). Adoption and Dissemination Pathways for Climate-Smart Agriculture Technologies and Practices for Climate-Resilient Livelihoods in Lushoto, Northeast Tanzania. *Climate*, *5*(3), 63. https://doi.org/10.3390/cli5030063

Ortiz-Crespo, B., Steinke, J., Quirós, C. F., van de Gevel, J., Daudi, H., Gaspar Mgimiloko, M., & van Etten, J. (2021). User-centred design of a digital advisory service: enhancing public agricultural extension for sustainable intensification in Tanzania. *International Journal of Agricultural Sustainability*, *19*(5–6), 566–582. https://doi.org/10.1080/14735903.2020.1720474

Pound, B., & Conroy, C. (2017). The Innovation Systems Approach to Agricultural Research and Development. In *Agricultural Systems: Agroecology and Rural Innovation for Development* (pp. 371–406). Elsevier Inc. https://doi.org/10.1016/B978-0-12-802070-8.00011-6

Sarker, M. G. R. (2015). Impact of Whatsapp messenger on the university level students: A sociological study. *International Journal of Natural and Social Sciences*, *2*(24), 118–125. http://ijnss.org/wp-content/uploads/2015/05/IJNSS-V2I4-16-pp-118-125.pdf

Siraj, M., Ejiofor, T., Ahmad, A., Nor Azan, M. Z., Noraidah, S., Abu-Dalbouh, H. M., Tey, Y. S., Mad Nasir, S., Zainalabidin, M., Jinap, S., Abdul Gariff, R. A., Harga, A., Kasus, S., Jaya, D., Sidoarjo, T., S, K. S. D., Suryani, E., W, R. P., Hashim, J., … Wanigasundera, B. A. D. S. and W. A. D. P. (2012). Information Communication Technologies in Agricultural Extension Delivery of Agricultural Transformation Agenda. *Journal of Educational Psychology*, *4*(1), 2012. https://doi.org/10.5897/AJBM10.1398

Steinke, J., van Etten, J., Müller, A., Ortiz-Crespo, B., van de Gevel, J., Silvestri, S., & Priebe, J. (2021). Tapping the full potential of the digital revolution for agricultural extension: an emerging innovation agenda. *International Journal of Agricultural Sustainability*, *19*(5–6), 549–565. https://doi.org/10.1080/14735903.2020.1738754

Tokurah, O. (2021). *Youth to solve agricultural problems in Nigeria using ICTs*. Jóvenes Profesionales Destacados.

Williams, E. E., & Agbo, I. S. (2013). Evaluation of the Use of Ict in Agricultural Technology Delivery to Farmers in Ebonyi State , Nigeria . *Journal of Information Engineering and Applications*, *3*(10), 18–27.

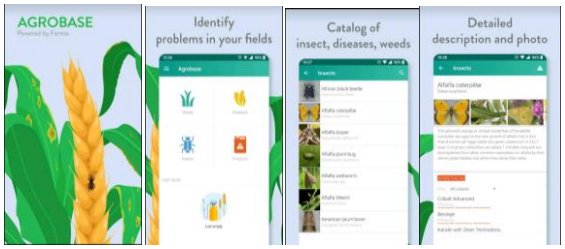
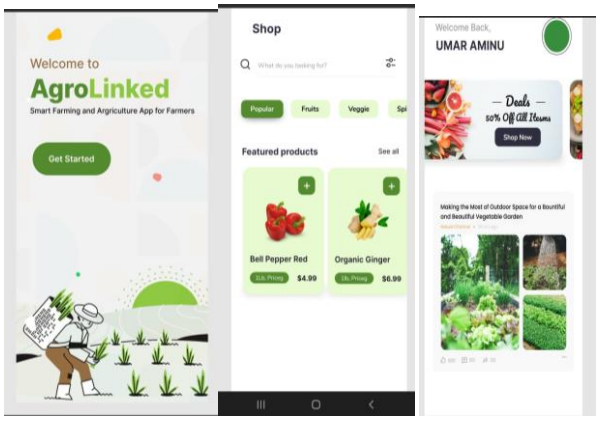
World Bank. (2012). Agricultural Innovation Systems: An Investment Sourcebook. In *The World Bank*. https://doi.org/10.1596/978-0-8213-8684-2

Zhang, Y., Wang, L., & Duan, Y. (2016). Agricultural information dissemination using ICTs : A review and analysis of information dissemination models in China. *Information Processing in Agriculture*, *3*(1), 17–29. https://doi.org/10.1016/j.inpa.2015.11.002

Zhuhadar, L., Thrasher, E., Marklin, S., & de Pablos, P. O. (2017). The next wave of innovation—Review of smart cities intelligent operation systems. *Computers in Human Behavior*, *66*, 273–281. https://doi.org/10.1016/j.chb.2016.09.030

Appendix 1*:* Examples of e-extension platforms on ICTs in Nigeria

S/N	Case Study	Online Application outlooks
1	***Case 1: Nigeria*** ***Kowazon Application*** It is a platform that is designed to serve the food Value Chain. It is developed to utilize the ICTs benevolence of blockchain platform. Uses: it aims to link up all actors within the Food Value Chain through, it therefore collates vendors and farmers information about products and link them to their end users as well as consumers. Kowazon also provides a delivery system where goods and or food ordered can be delivered to doorsteps. It also has a window where the customers are availed information of where an input for their services are and facilitate the transaction between the two linked actors.	 https://kowazon.com/?page_id=461/#Story
2.	**Case 2 AgrisetU: India** AgriSetu™ app connects farmers to their various needs – Seeds, Fertilizers, Equipment, Crop & Agricultural advisory along with Market linkage through a wide network researchers and industry experts. This agricultural App offers end to end agriculture services to Indian farmers that aims to enhance their lives and produce efficiencies within the agriculture supply chain. Through provision of daily updates or notifications that consist of modern agriculture such as – Weather Forecast, Market Demands, Prices, Information about Seeds, Fertilizers, Soil Quality Check and Various crop options, Government schemes, e-Magazine, agriculture e-Market, agriculture forum etc	 https://agrisetu.org/
3.	**Case Study 3 Agropartnership: Nigeria** Agropartnerships is a simple and secure	

	collaborative platform that enables you engage in profitable agribusiness opportunities from the comfort of your home. You can invest in Farms, trade in commodities and count your profits in no time We play across the value chain of every crop or commodity type we choose, cutting out middlemen by providing end to end solutions. Low minimum investment required per unit, you can start a farm or execute a trade with as low as N90,000	 https://agropartnerships.co/
4.	**Case Study 3: Agrobase Nigeria** An app or farmers and agronomists. Agro Knowledge database with pests, weeds, diseases catalog and all registered pesticides in country. Identifies weeds, diseases or pests in your field and will help you solve farming problems and to grow good yield with less investment	 Application on playstore
5.	**Agrilinked** This application is being designed by a group of undergraduate students in the Faculty of Computing and supported by Centre for Agricultural Research and Extension Services CARES in the Federal University Dutse. The application promised to link producers to inputs, markets as well as other areas of demand for their products. It is currently in its prototyping stage and it promises to avail so much to both farmers as well as consumers of produce within the state of Jigawa and beyond.	 Application to be deployed in the playstore

Source: Authors' Compilation 2022