

DIGITAL TECHNOLOGY INNOVATIONS AND PRACTICES FOR IMPROVING LIVESTOCK AND FISH PRODUCTION IN NIGERIA

¹Akaa, C.W., ²Ogbuagu, K.P., ³Ibrahim, N.O., ⁴Emmanuel, V.S., ⁵Abubakar, B.A., ⁶Bello, M.N

¹Department of Agricultural Education, Joseph Sarwuan Tarkja University, Makurdi Nigeria

²Department of Animal Science, Federal University, Lafia, Nigeria

³College of Agricultural and Animal Science, Kaduna, Division of Agricultural Colleges, Ahmadu Bello University, Zaria, Nigeria

⁴Department of Biological Sciences, Federal University, Lokoja, Nigeria

⁵Department of Animal Science, Federal University, Kashere, Nigeria

⁶Hydrobiology and Fisheries Department, National Institute for Horticultural Research, Ibadan
(Corresponding Author :Akaa, C.W isaacakaa83@gmail.com)

Abstract

The review highlighted and discussed various digital and ICT technology innovations in use in different parts of Africa and outside Africa and stressed the need for their adoption for the improvement of fish and livestock production in Nigeria. Technology innovations such as digitalizing Senegals fishery sector, Tracking fish ponds, the wise intervention, interactive farming, monitoring livestock vitals with machine learning and mobile management were reviewed. It was concluded that the use of digital and Information Communication Technology devices will help to revolutionize fish and livestock production, and that the case studies discussed can be applied easily in other locations. More farmers should embrace the use of digital and ICT technologies for seamless and enhanced fish and livestock production. Training of livestock and fish farmers on the use of Digital and ICT technologies to boost production. Government and the relevant stake holders should make efforts to subsidize the high cost of data. The problems of weak, poor and epileptic network should be looked into with a view to providing strong and steady network.

Keywords: Digital Technologies, Fish Production, Innovations, Improving, Livestock Production

Introduction

Livestock farmers in developing countries are faced with various challenges that lead to considerable fall in the production of certain livestock species like goats, cattle, swine and poultry, which further leads to protein shortage. This is due to high cost of production that originates from increase in prices of conventional feed ingredients and livestock species. (Shettima *et al.*, 2024) The problem of animal protein scarcity in Nigeria and other developing nations has attained a deplorable status which calls for urgent remedy to avert the imminent protein malnutrition (Adekunmi *et.al.*, 2017) Fish is one of the main sources of food for humans, especially in developing nations, and provides a significant portion of protein, fats, and fat-

soluble vitamins (Fashagba *et al.*, 2020). It is also a good source of valuable medicinal, feeding, and technical products. As global populations grow and environmental challenges intensify, the need for sustainable and efficient agricultural practices becomes increasingly urgent. Digital, and information communication Technology are essential for modern agricultural development. In general and livestock and fish production in particular. These concepts work synergistically to address challenges such as food insecurity, climate change, and resource scarcity. By leveraging these tools and approaches, stakeholders can create a more sustainable and resilient agricultural sector. Digital agriculture involves the use of digital tools and platforms to collect, analyze, and share agricultural data. This includes mobile apps, satellite imagery, and digital marketplaces. Digital agriculture leverages data-driven insights to optimize farming practices, improve decision-making, and enhance market access for farmers.

Digital tools empower farmers with real-time information on weather, market prices, and best practices. (Mittal & Mehar, 2016). As the world continues to face unprecedented challenges, the role of these interconnected concepts in driving agricultural transformation cannot be overstated. Policymakers, researchers, and practitioners must work together to promote the adoption of innovative technologies, strengthen extension services, and harness the power of ICT to ensure a food-secure future for all.

This review is aimed at highlighting the importance of the use of digital and ICT in improving livestock and fish production using case studies from out side Nigeria

Literature Review

Review of Concepts

Agricultural Technology

Agricultural technology includes tools, machinery, and techniques used to enhance farming efficiency and productivity. Examples include precision farming equipment, irrigation systems, and biotechnology.

Technological advancements have revolutionized agriculture by enabling farmers to monitor and manage their operations with greater precision and efficiency.

Technology adoption has transformed agriculture by enabling farmers to produce more with fewer resources. For example, the use of drip irrigation systems in India has reduced water usage while increasing crop yields (Narayanamoorthy, 2005). This technology is particularly beneficial in arid and semi-arid regions where water scarcity is a major constraint. Similarly, the adoption of mechanized farming equipment, such as tractors, harvesters, milking machines has reduced labor requirements and increased productivity, particularly in large-scale farming systems. Biotechnology, including genetically modified crops, has also played a significant role in enhancing crop resilience and nutritional value, contributing to global food security.

Digital

Digital agriculture involves the use of digital tools and platforms to collect, analyze, and share agricultural data. This includes mobile apps, satellite imagery, and digital marketplaces. Digital agriculture leverages data-driven insights to optimize farming practices, improve decision-making, and enhance market access for farmers.

Digital tools empower farmers with real-time information on weather, market prices, and best practices. For example, the *e-Choupal* initiative in India provides farmers with digital access to market information, enabling them to negotiate better prices for their produce (Mittal & Mehar, 2016). By connecting farmers directly to buyers, this platform eliminates intermediaries, ensuring fairer prices and higher incomes for farmers. Additionally, digital platforms such as weather forecasting apps and soil health monitoring tools enable farmers to make informed decisions, reducing risks and improving productivity. The integration of digital technologies into agriculture also facilitates traceability and transparency in supply chains, enhancing consumer trust and marketability of agricultural products.

Methodology

Literature on basic concepts such as digital, innovations, information Communications Technology were assembled from journals conference papers bulletins and from the internet, case studies of use of digital and ICT innovation technologies in fish and livestock production from from other parts of Africa and out side Africa were reviewed

Review of Case Studies of use of Digital Technologies

Review of Case Studies in Fish Production

Digitalizing Senegal's Fishery Sector

In Senegal, where the majority of fish processors are women, an innovative mobile app is enhancing the competitive advantage of the entire fisheries sector.

The 'Wireless Solution for Fisheries in Senegal' (WISE) project has designed an app with multiple functions to be used by different market players in the fishery value chain. The app provides women processors with access to video on good hygiene practice and other best practice for fish processing, to improve product quality and generate better prices. Among women beneficiaries is Anta Diouf, a fish processor in Mballing, in Senegal's Thies region, and one of the 5,000 people who use the app "Wise helps us communicate with fisherman while they are still at sea." She says. "their fish prices are sent to a server that transmit them to us in real time. This enable us to negotiate in advance and, thus, be more efficient and productive." The app also helps users to secure microcredit loans at low interest rate (3-5%), which is often a challenge to women agribusiness owner.

Wise also seeks coordination by non-profit organization FHI 360, the telecom operator Tigo, and the NGO Inter-Mondes, with the support of the Senegalese government. According to FHI 360, since the programme launch in 2014, most processors have more than doubled their income by boosting their monthly output from 100kg to 1000, kg of processed fish.

Wise also seeks to improve the safety of Senegalese fishermen, 90% of whom are small-scale. In recent years, many fisherman have been lost to sea without being able to report their location. Others have been killed by the coastguards, WISE has therefore developed a navigation tool that uses the GPS receiver in a smartphone to find authorized fishing ground. "an alarm sounds on the phone if fishers get too close to the borders," explains Berhane Gabru, Wise director at FHI 360. An SOS feature enables fisherman lost at sea to quickly send their contact details to sea rescue services. In addition, the application provides meteorological data, such as wave height, visibility, wind speed and direction at different times of the day. As a result of using app, fishers have indicated that they have increased their catches by 50%.

Tracking fishponds

A KENYAN TECH company is using a mobile app, Samaki (Swahili for fish ponds) to monitor fish ponds, and the conditions of their fish ponds, and collecting data for daily records keeping and sampling, all of which is then relayed to farmers phone in real time. The company, upande, specializes in internet of things (IoT) based sensors and special cameras that monitor key conditions in a fish pond including the level and temperature, of water, and pH, oxygen and nitrate levels. Thresholds are set for each sensor, which automatically alert a farmer by email or SMS when there is a change in condition. The data also enables farmers to analyse fish growth and monitor the efficiency of their farms to ensure they are making a profit.

In St Lucia, a local aquaponics facility is being touted by agricultural ministers in Antigua and Barbuda as a

model for the rest of region to replicate, due to its high efficient use of space for economic food production. Green Havens Fresh Farm- an organic farm which specializes in integrated vegetable, tilapia and shrimp cultivation has 1- vertical vegetable beds and four fish tanks built above each other and is supported by an 80,000 gallon solar-powered rainwater harvesting system. Lights on automatic timers and circulatory fans are also used to control the growing area and maximise production. The organic Aquaponic system, which was established in 2016, produces 1.8 t of lettuce each month and 7.25 t of tilapia annually.

Review of Case Studies in Livestock production Interactive Farming

AN INTERACTIVE voice response (IVR) service is providing small holders with information for the prevention and control of disease in pigs in Uganda. Launched in May 2018 by the international livestock Research Institute, the IVR system offers 4- minute lessons delivered in the local language, to raise awareness of diseases like American swine fever among pig Farmers. The message can be updated and tailored to provide context – specific information. The system can also track which lessons the farmers has listened to and ask questions to gauge whether the information has been retained. The free IVR service is being piloted among 230 smallholders farmers in Masaka district and farmers can phone regardless of model of network provider

. Monitoring livestock Vitals with Machine Learning Technology

In Uganda, a new technology is embracing AI and machine Learning to detect livestock diseases 2 days before they manifest, connect farmers to veterinary officers and monitor animal movement to avert theft. The innovation, dubbed Jaguza Luganda, constitutes a chip with a sensor that is connected to a radio-frequency identification (RFID) reader, and to users' mobile phones or computers. Since 2016, 18,000 Jaguza chips have been installed.

The chips and sensor technology is attached to an animal's ear, and RFID reader is able to detect the sensor in the chip from up to 300m away, or even further is an antenna or radar is installed to bolster the frequency. The chips monitor vital information about the animal, including temperature variations, feedings patterns and reproductive stages through the smart sensor, and is able to detect diseases 48 hours before they manifest, allowing for timely medical attention. We use Jaguza to predict problems earlier, detecting cases like lameness or digestive disorder and provide recommendations to farmers on how to keep their cows healthy and improve the efficiency of their farms. Using these insight, we're already seeing a 35% increase in livestock production on our customer's farms" says Jaguza's founder Ronald Katamba. (Spore Magazine, 2000)

The technology can also track livestock movement and alert farmers, through mobile

messages, in the event that animals wander beyond farm boundaries. "Jaguza learns patterns about a cows movement from the sensor. We use this data to develop machine learning models and sensor flow algorithms." Explains Katamba. The technology has also been effective in reducing cases of theft that are rampant in Uganda's livestock rearing regions Charles Walugembe, who keeps 180 Cows began to trail Jaguza in 2018. He chipped 50 of his exotic cows that were bringing him the highest returns for their meat and milk. "for the longest time, we have been hiring armed guards to watch our cows. We have been spending almost half of what we earn from our livestock to pay these guards and other protection methods like fencing, but somehow we still manage to loose them. Since using Jaguza, I am able to track movement no matter where I am and we haven't had any cases of missing livestock, he says.

Mobile Management

The Jaguza Livestock mobile application, which has 85 Veterinarians signed up and on standby to respond to farmers inquiries, compliment the sensor device. Using GPS, the app maps out the farmers proximity to a veterinary officer, and provides information on the vets specialization and availability. Information on good livestock management practices, including feeding and disease detection is also provided on the app, which is available on both android and IOS mobile not connected to the internet, the technology is accessible offline through a USSD code. Over 1,250 users have downloaded the app to access livestock information, and both the sensor device and app have attracted farmers beyond Uganda – in fiji, Mozambique and Namibia.

In a bid to streamline Livestock keeping the app also has a provision for record keeping, allowing farmers to records expenses and earning. Dan Kitsitu has been rearing cattle in Uganda for the last 15 years and signed up with Jaguza in 2017 to monitor his 40 cows. Besides managing to tackle common diseases like foot and mouth disease, rinderpest and East Coast Fever, he used to spend a lot of money on veterinary services and medicine, especially due to frequent disease outbreaks from which I lost a number of cows. Beyond getting alerts on any health issues of my cows before they escalate, I have managed to bring down expenses like feed and supplement by up to 50% using the electronic records keeping that allows me to identify where I am over spending." Says kitsitu. "I have also been able to access information on good Farm management practices for feeding, vaccination and production, in place where extension services are no longer readily available due to the scarcity of government officers," he adds.

Scaling out with drone sensors.

to cater to large farmers, Katamba is using drones fitted with high definition camera and thermal sensing technology. The drones, which are connected to the farmers' phones through a cloud based system, track the animals body temperature and alerts the

farmers in the case of sickness. Where it might usually take up to a whole day to count each cows reared by large scale farmers, the drones take on average 15 minutes to do a headcount. "our drone tech uses "smart cameras" that are powered by AI and facial recognition to identify individuals animals in real-time. The camera monitor the animals" presence on the farm and send real-time information's to the farmers' mobile and computers there are two signs, a red one which indicates that the cow is fine," he explains.

Despite the success of the technology, which has seen Katamba invited Texas to promote Jaguza to livestock farmers in the area, he note that regulations for flying drones in Uganda are not yet in the place and poor internet connectivity has stood in the way of project implementation. "Drones are still banned in Uganda despite the numerous benefits they deliver to ordinary people. We are in constant communication with the government to have a policy shift in recognizing these emerging technologies while investing in increasing internet connectivity to allow easier adoption of the innovations," says Katamba. Who obtained a license to operate only after receiving a letter from the chief of Defense Forces and the Uganda Civil Aviation Authority.

Jaguza is a member of the CTA AgriHack network, which supports young digital agripreneurs with capacity building opportunities, and was among the 2016 finalist of the pitch Agrihack competition. The company won first prize as a mature start-up in the 2019 competition at the African Green Revolution Forum in Accra, Ghana. (Spore Magazine, 2000)

Discussion

The technologies reviewed above can be adopted in Nigeria if the enabling environment is put in place, such as encouraging and training of farmers on the use of digital and ICT tools, subsidizing costs of data, provision of strong and steady networks, agricultural extension services needs to be overhauled.

The use of digital tools in fish and livestock production and indeed agriculture in general will endear more youths to agriculture, especially those who want to make money from agriculture without getting their hands dirty, this was alluded to by Dr Akinwunmi Adeshina, Then Managing Director of the African Development Bank. **As reported by Spore Magazine, 2019** Technology adoption has transformed agriculture by enabling farmers to produce more with fewer resources, thus helping to attain food security which is a front burner on the policies and programme priority list of governments of many countries. The use of climate smart technologies have helped farmers mitigate the effects of climate change which is one of the emerging global challenges.. The use of digital and ICT technologies in curbing criminal activities and insecurity is apt, and should be the way to go by government, since Ayinoko *et al*, 2024 reported a drop in agricultural and agribusiness practices in Nigeria, due to banditry,

insurgency and other criminal activities which they say has serious food security implications.

Conclusion and Recommendations

Conclusion

The use of digital and Information Communication Technology devices will help to revolutionize fish and livestock production,

The case studies discussed can be applied easily in other locations

Recommendations.

More farmers should embrace the use of digital and ICT technologies for seamless and enhanced fish and livestock production

Training of livestock and fish farmers on the use of Digital and ICT technologies to boost production.

Government and the relevant stake holders should make efforts to subsidize the high cost of data.

The problems of weak, poor and epileptic network should be looked into, with a view to providing strong and steady network

References

- Adekunmi A.O., Ayinde J.O & Ajala, A.O (2017). An assessment of animal protein consumption patterns among rural dwellers in Osun state, Nigeria. *Ife journal of Agriculture*. 29:1
- Aker, J. C. (2011). Dial "A" for Agriculture: A Review of Information and Communication Technologies for Agricultural Extension in Developing Countries. **Agricultural Economics*, 42(60): 631-647.
- Fashagba, S.T., Akinbode, B.A. and Babalola, S.O. (2020). The Effects of Garlic Extract on the Proximate Composition and Microbial Load of Hot and ColdSmoked *Clupea harangus* (Atlantic Herring Fish). *International Journal of Biochemistry Research & Review* 29(9): 32-39
- FAO. (2017). **The Future of Food and Agriculture: Trends and Challenges**. Rome: Food and Agriculture Organization.9
- Huang, J., Rozelle, S., & Pray, C. (2002). Enhancing the Crops to Feed the Poor. **Nature*, 418*(6898), 678-684. Kassie, M., Shiferaw, B., & Muricho, G. (2015). Agricultural Technology, Crop Income, and Poverty Alleviation in Uganda. **World Development*, 39*(10), 1784-1795.
- Mittal, S., & Mehar, M. (2016). Socio-economic Factors Affecting Adoption of Modern Information and Communication Technology by Farmers in India: Analysis Using Multivariate Probit Model. *Journal of Agricultural Education and Extension*, 22*(2), 199-212
- Narayanamoorthy, A. (2005). Economics of Drip Irrigation in Sugarcane Cultivation: Case

Study of a Farmer from Tamil Nadu. *Indian Journal of Agricultural Economics, 60*(2), 235-248.

Woyche, S., & Steinfield, 9C.
(2016). Why Don't Farmers
Use Cell Phones to Access
Market Prices?
Technology Affordances
and Barriers to Market
Information Services
Adoption in Rural Kenya.
*Information Technology for
Development*, 22(2), 320-
333.

**Shettima, I., Rekwot, P. I., Ayo, J.
O. and Nwannenna, A. I.
(2024).** Effects of *Carica
papaya* peel meal- based
diets on rabbit bucks'
spermiogram and reaction
time.
*Tropical Animal Health
and Production*, **56(2)**: 83-
94.

Spore Magazine March to May, 2019

Spore Magazine. December, 2018 to February, 2019