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Success Factors of Electronic (E) Agriculture in Ghana: Lessons from MoFA and Cowtribe

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ABSTRACT

The productive potential of digital technologies has been articulated in various sectors of the economy and found expression in electronic agricultural extension, otherwise known as e-extension. E-extension has been described s holding the promise of resolving communication and extension challenges confronting the agricultural sector. The government of Ghana, through the Ministry of Food and Agriculture, the World Bank, and the Food and Agriculture Organization (FOA), have all recommended and supported initiatives on e-extension in Ghana. The World Summit Information Society (WSIS) *2010 plan of action includes e-agriculture as an application of ICTs in enhancing agricultural productivity. The emerging discourses around ICT and agriculture are also against a backdrop of research evidence that radio remains Ghana's farmers' most used means of accessing agriculture information. Therefore, this study focuses on Ghana's experience with e-agriculture to investigate the opportunities and challenges of applying the concept. The paper examines principles defining success factors of Ghana's e-extension initiative using Cowtribe, a private sector initiative, and government e-extension. Using the case study approach with key informant interviews, the results show that while MoFA's e-extension initiatives have had challenges in reaching farmers efficiently, Cowtribe represents the progress and success story of e-agricultural extension in Ghana by providing essential and timely information on livestock management and agricultural market data services, respectively, to farmers and other value chain actors. The study results are expected to contribute theoretical insights into the opportunities and challenges of using ICT in agricultural extension.*

Key Words: *Electronic (e) agriculture, communication, ICTs, MoFA, Cowtribe, agricultural extension, digital space.*

INTRODUCTION

The potential and significance of Information and Communications Technology (ICT) in developing countries often need to be revised, considering the integration of challenges of local economies with the digitised global market and scientific world. According to McGrew (2014), globalisation is an equally pervasive phenomenon with our individual and collective sense of identity and security linked in an uncertain world. Due to globalisation and digitalisation, the world is increasingly becoming connected daily for economic activities. Hay (2014) argues that globalisation produces a deadly crisis for man. Others argue that the world is intrinsically linked in trade, communication, technology, science, agriculture, and other social services. What is now essential is the digitisation process of the globalised world. It has speeded up the linkages and made it closer than it was without digitisation. Castells (2005)) contended that globalisation and digitalisation have led to price transmission signals of agricultural products across space. Most developing countries have had difficulties integrating well into global economies due to weaker and more challenged digital technology. Castells (2005) tried to define the digital electronic state as,

> a social structure based on networks operated by information and communication technologies based on microelectronics and digital computer networks that generate processes and distribute information based on the knowledge accumulated at the nodes of the networks.

According to Castells (2005), information and data transfer can only be achieved with the knitting process of the social, microelectronics, and digital computer networks aspects. The functioning of people without microelectronics and digital computer networks now makes it imperative that the E-Systems have come to stay.

According to D4Dhub[1], in most African countries, the effort around digitalising their economies through service provision has seen jumps to make development more accessible to the people. This is improving because of the increasing access and penetration levels to the global internet. The African Union (AU) policy on digitised Africa iterated several of its target indicators through its strategy dubbed 'The Digital Transformation Strategy for Africa (2020-2030) Agenda[2]' and streamlined very key milestones for the continent by 2030, including;

- Digital Single Market in Africa by 2030
- Six (6) mb/s of internet access
- Harmonise policies, legislations and regulations to accelerate Digitalisation.
- Enforcing Cyber Security and Personal Data Protection across the continent
- Advancing standards and interoperability for the cross-border trust framework
- Promoting the management and the use of specific country codes in top-level domains

[1] https://d4dhub.eu/news/digital-services-in-africa
Digital services in Africa: Three takeaways from #egov2022

[2] African Union Digital Transformation Strategy for Africa (2020-2030). chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf

- Online e-skills development
- Agenda 2063 flagship Pan-African digital society with everything "E."
- 99.9% of people have a legal digital identity in Africa and
- Strong digitalised agriculture, health, and education.

THE RESEARCH PROBLEM

E-agriculture is innovative and novel, considering the needs and potentials of the agricultural ecosystem. This is because it has the potential to propel, in wider forms, information on technologies and new knowledge to all stakeholders and actors within the agricultural ecosystem. Even though the technology and approach have been in Ghana since 2004, many of the operations and rollouts to farmers appeared weak and challenging. Considering the low literacy rate of the total population in Ghana, such interventions will indeed experience setbacks with the adoption levels. Another issue that can be linked to this problem is the weaker state of the country's telecom and general ICT infrastructure.

Despite this, some significant levels of massive rollout and adoption of the e-approach of agriculture due to the penetration of teledensity of 79.94% (NCA, 2017) and the number of owned and used mobile phones in Ghana being 37,445,048 representing 130.91% (NCA, 2017) of the 28,833,629 million people in this country. Mobile phones are now being used daily to transfer money, buy, and sell goods and services, and communicate information, including test results, stock levels, and prices of agricultural commodities throughout the country. Added to these indications, the ratio of extension officers to farmers being 1: 1500 with a freeze or restricted engagement of agricultural college graduates who qualify as extension officers by the government, the compelling potential of e-extension and agriculture would have been ideal and cost-cutting for the government to pursue vigorously. These statistics should have been used as the conduit to amplify the electronic initiative to benefit from the immense promise of the e-agriculture concept. However, the perils of the e-concept appeared weighty and non-striking in the current agricultural drive of the country.

The Ghanaian government's effort at extension has yet to yield the desired results as the AEA-farmer ratio continues to be minimal. Accessing farmers, persuading them, and getting them to adopt good agronomic practices have been the focus. But as the government's extension bureaucracy continues to cite an inadequate number of staff, low level of resources, and other constraining factors, some private sector-led organisations such as COWTRIBE and ESOKO have successfully rolled out and have achieved an average adoption and usage of the electronic or mobile technology to disseminate agricultural knowledge. Significant progress is made through digitalization or electronic services (health, utilities, agriculture, education, economy etc.) led initiatives implemented by both the public and the private sectors (Kpessa-White and Dzisah, 2022; World Bank, 2017), albeit in slow forms. What lessons can be learnt from these innovative technologies to do e-extension work for smallholder farmers in the public sector? What are these institutions or organisations doing right, and with what processes and principles do they roll out their innovations? As the focus of this article, we asked these critical questions to understand and provide perspectives on the realities and supposed plans of e-agriculture in Ghana with the cases of COWTRIBE and the E-Extension Project.

THE ELECTRONIC (E) CONCEPTS

The Electronic (E) Services in Ghana

E-services reveal three main components: service providers, service receivers, and

service delivery channels. The coming to light of these three components requires that the electronic/digital policy formulation, the infrastructural development, and platforms and utilisation be developed (Alhassan, 2004). Ghana has developed critical electronic platforms for service-targeting development for different sectors, including e-services, e-health, e-government, and e-extension.

In the service sector, e-banking has become the fastest way to serve customers. E-banking permits customers to find information and carry out most banking services, such as account balance inquiries, bill payments, and inter-account transfers through the Internet (Addai, 2015). Electronic banking is the automated transfer of new and traditional banking products and services directly to customers through electronic and interactive communication channels (Woldie et al., 2008). According to (Gurau, 2002), this electronic approach has significantly impacted the efficiency and effective operations of the banking sector. Kim *et al*. (2010) have contended that many countries are developing contrivances to upkeep the growth of broadband access and use as broadband, which deals with high-speed data transmission, allows multimedia communication, improves access to information, and supports high-quality Internet connectivity. This development again makes the adoption of e-services imperative in Ghana's quest to maximise the potential of digital technologies.

In governance, Ghana's government (GoG) implemented the e-government service for development as part of the e-Ghana project as an effective national electronic way of distributing information and knowledge. According to the Ministry of Communication through the NCA (2014), ICT for Accelerated Development (ICT4AD) is to engineer an ICT-led socio-economic development process to transform Ghana into a middle-income, information-rich, knowledge-based, and technology-driven economy. On this, Mensah (2015) revealed that e-government was one of the fourteen (14) pillars of the ICT4 policies captured as an attempt to make the governance process participatory and inclusive. Its main goal is for the government to interact with its citizens through the Government-to-Citizen (G2C), Government-to-Business (G2B), and Government-to-Government (G2G) modules. This policy initiative appeared relevant because of some significant levels of internet penetration in the country. The World Bank revealed that the percentage of internet users in Ghana was 19.56% in 2014, which increased to 35%, according to the World Digital Agency, in 2018. The increase indicates that any service rolled out through an e-platform will largely thrive and propel development.

The Concept of Electronic Agriculture (e-agriculture)

The World Bank supported the Ghanaian government's e-agriculture program through the MoFA to strengthen and modernise agricultural production in Ghana. Agricultural extension in Ghana has been responsible for distributing new technology, interventions, and knowledge useful to farmers (MoFA, 2011). Extension efforts and service delivery are meant to ensure that information on agricultural technologies and interventions is made accessible to increase farmers' productivity and improve the role extension plays in national development. E-agriculture is seen first as a supplement to face-to-face extension. However, some technophiles will go further to look forward to a period when e-agriculture will replace direct and personal contract extensions.

Many individuals, academic institutions, professional bodies, and funding organisations widely use e-agriculture. E-agriculture offers the rich potential of supplementing the traditional delivery of services and channels of communication in

ways that extend the agriculture organisation's ability to meet the needs of its farmers. According to Meera & Jhamtani (2004), e-agriculture describes an emerging field focused on enhancing agricultural and rural development through improved information and communication processes. More specifically, e-agriculture involves conceptualising, designing, developing, evaluating, and applying innovative information and communication technologies (ICTs) in rural areas, primarily focusing on agriculture and the value chains.

The FAO coined a recent term to embrace all information communication technologies that support agriculture. Information source solutions and provisions for agricultural purposes are available with the current multiplicity of electronic devices such as mobile networks, computer networks, systems, and online platforms. FAO posits that most information communication technology applications concentrate on the production segment, especially in extension services and advisory services such as the farmer line in Ghana and Kenya. However, on climate change, e-agriculture innovation has brought climate change information and knowledge closer to the people on emergency issues, mitigation, and adaptation purposes than before.

According to MoFA (2011a), e-agriculture interventions have been developed and tested worldwide, with varying degrees of success in improving agricultural productivity and income and reducing risks. Enhancing the ability of smallholders to connect with the knowledge, networks, markets, and institutions necessary to improve their productivity, food security, and income and employment opportunities is a fundamental development challenge. The development of e-agriculture and the spread of mobile telephony and the Internet in rural areas allow farmers, entrepreneurs, and other actors in the agricultural value chain to gain access to information, services, and markets they could previously not benefit from and represent a transformational opportunity for rural populations, both as producers and consumers. Some countries that have adopted electronic agriculture are Bhutan, Sri Lanka, Papua, New Guinea, Philippines, Fiji and Vanuatu (FAO, 2015). These countries have adopted e-agriculture mainly for information to be transferred from one point to another through extension services deliveries.

The application of e-agriculture is still in its elementary stage, evolving around the immense multiplier impact capability that can significantly change the economic and social condition of the farmer, i.e., empowerment. This ensures the effective and efficient use of information and communication technologies for analyzing, designing, and implementing existing and innovative applications to help the agricultural sector. E-agriculture describes an emerging field that enhances agricultural and rural development through improved information and communication processes. FAO & ITU (2022) indicate that in agri-food, for example, 3D printing has been introduced in industrial product development, is currently poised to disturb worldwide manufacturing, and is gradually becoming more available to consumers. In a country like Spain e-agriculture machine, also known as the 'natural machine', leverages its innovation by stimulating healthy eating and reducing the consumption of processed foods that contain a high amount of sugar, fat, salt as well as preservatives through information provision and designs (FAO & ITU, 2022).

In Ghana, Esoko, Farm Radio International, and Cowtribe, as entities, emerged as very popular and successful promoters and champions of e-agriculture by providing a platform for smallholder farmers to receive a package of advisory services on market prices, bids and offers, whether forecasts, livestock information, vaccines, etc. with a direct connection to service providers.

Interestingly, the success of rural and agricultural growth programmes is argued to be hinged on decisions by rural actors on questions such as what to grow, where to sell, how to maintain soil fertility, and how to manage common resources (Rivera et al., 2002). Such decisions are currently aided by innovation and electronic services, where information is easily accessible and utilized. Electronic agriculture in Africa, the Caribbean, and the Pacific started in 2004, and TradeNet is offered in Ghana as the main essential source of market information for agricultural produce.

Prospects of E-Extension Services in Ghana

The potential contribution of e-extension to agriculture can be viewed through cost reduction, increased efficiency, and improved productivity. First, the information requirements of the farmers should be analysed and documented, and then adequate information systems (IS) should be developed. In developing the systems, the focus is on new challenges made by deregulation and globalisation of the agricultural sector (Samah *et al.,* 2009).

E-agriculture services provide several benefits like increased productivity, increased quality of products, high income, increased efficiency, raised Profit, accessible knowledge gathering about the climatic condition, humidity, soil type, crop pattern, etc., and can speedily share agricultural Information. E-agriculture facilitates timely and accurate updates regarding current market price & market demand to farmers at lower cost and risk using ICT-enabled devices such as mobile phones, radio, and television and through internet services. Therefore, creating awareness among the rural masses regarding IT and ITC programs is vital in achieving rural development. If E-agriculture awareness had been created among the rural masses, that might lead to social and economic well-being. The desire for ICTs for extension is due to their characteristics that have the potential to influence extension systems positively. According to Colle and Roman (2003), ICTs hold the key to rural development as they can reach many people simultaneously, overcoming geographic boundaries, providing frequency and repetition of contact, storage of information on-demand access, capturing the reality of events by depicting them geographically and in real-time, and greater efficiency (lower costs) in sending and receiving information.

The overall development of rural areas is expanding in new directions as 'traditional societies are being transformed into 'knowledge societies worldwide (Meera et al., 2004). The link between development and the increased use of ICTs in development is based on two assumptions: that a new kind of economy is emerging – an information economy; and second, the main constraint to development is knowledge or information gaps (Bedi, 1999). Whether public or private, an agricultural extension cannot properly function without a continuous flow of appropriate innovations from various sources (local and foreign). The assertion that a knowledge gap is an important determinant of persistent poverty and that many developed countries already possess the knowledge required to ensure a universally adequate standard of living suggests the need for policies that encourage greater communication and information flows within and between countries (Rollings, 1997). ICTs have been applied in many development efforts to bridge the information gap. ICTs have been used as tools and a source to provide knowledge and information to service providers (extension professionals), reach a wider audience (farmers), and solve rural development problems (Ramírez, 1999). Moreover, ICTs have provided relevant information to farmers to improve their productivity, increase yields, and obtain better prices for their produce (Bhatnagar &

Schware, 2002). The most significant ICT applications are providing efficient access to useful information, securing adequate feedback for learning, providing tailor-made advice; exchanging similar experiences of people elsewhere; and providing inventory and evaluation of opinions (Leeuwis, 2003).

E- Agriculture is key to improving agricultural production and the value chain. Food traceability systems using ICTs have become important risk management tools that allow food business operators or authorities to contain food safety problems and promote consumer confidence. ICT-enabled marketing and market access play a major role, especially regarding market prices and demand information. ICT-enhanced marketing and certification strengthen the capacity of small-scale producers to increase revenue by improving their position in local and international markets. GIS and agro-meteorological technologies have been introduced into programmes for various purposes, including land-use planning, crop forecasting, and early warning systems. Space technology is also essential for monitoring threats from many natural disasters. In addition, the use of mobile phones has become more common for exchanging information, such as disease surveillance and pest tracking. ICT solutions are also growing for the later stages of the agricultural value chain (e.g., post-harvest, transport, storage).

Additional outcomes of e-Agriculture include the development and strengthening of innovative mechanisms and processes for information exchange and communication, including normative guidelines and tools; empowered networks for the exchange of new mechanisms and processes among key stakeholders; relevant content in the digital format being developed, filtered, mobilised, and exchanged; and other activities based on partnerships and collaborative lesson-learning.

THE THEORETICAL FRAMEWORK

Technology Acceptance Model Theory (TAMT)

This theory by Davis (1989) argued that for information communication technologies to be accepted by users, several dynamics need to be considered in the development and deployment process for decision-making on the technology in question as one of the popular theories in information technology adoption, factors or attributes include the behaviour patterns, the complexity and demonstrability of the technology, and the acceptable behaviour in various information systems. In the view of Legris *et al*. (2003), the theory further tries to notice how externalities influence internal beliefs, attitudes, and intentions on technology use, acceptance, and other decision-making processes.

The Technology Acceptance Model Theory (TAMT) fits into the e-agriculture concept because it concerns introducing new technology to bring about development. When farmers want to use e-service technology on their mobile phones to utilise agricultural knowledge for decision support, several factors come into play. A proponent of this theory argues that the acceptance and rejection of E-agriculture, for example, can be hinged on the technical agricultural content, the device carrier (support system), the audible and user-friendliness of the electronic content, the target group, barriers to the electronic service access, etc. Porter & Donthu (2006) remind us that age, education, income, ethnicity, and general environmental exposures contribute to technology usage and acceptance that developers need to, as a principle, consider in churning out innovation, dissemination, and adoption.

The TAMT theory will confirm or reject the hypothetical position in the operations and deployment of the e-service by MoFA and Cowtribe to farmers and other agricultural chain actors on the functionality of the technology (Davis, 1989). The theory will

also help assess the influence of users' attributes, exposures, and complexity of technology on the choice and acceptance of e-agriculture (Legris *et al.,* 2003).

THE METHODOLOGICAL APPROACH TO THIS RESEARCH

Research Design

The philosophy underpinning this study is the interpretive paradigm. This paradigm is associated with qualitative research to understand the realities from an individual perspective. People, issues, and situations cannot be studied using models developed for the physical sciences because humans are qualitatively different from natural events (Carballo, 2003: Creswell, 2013). Interpretive researchers identify with the constructs of what participants are researching with an interpretation of the world around them. The epistemological position for this paradigm is linked to knowledge co-creation and sharing, as well as creating relationships amongst the proponents of the e-innovation acceptance of the technology and the mobile novelty.

Data Collection

Every research is based and premised on beliefs and approaches based, either quantitative or qualitative (Creswell, 2013). The beliefs and principles determine the categories and forms of knowledge to be generated and the procedure involved. As qualitative research, we are viewing it from the naturalistic inquiry form, which is developed from within the social and human sciences and refers to theories on interpretation (hermeneutics) and human experience (phenomenology) (Mumuni, 2018). Yin added that qualitative study uses the realist approach where events and scenarios are captured based on their occurrences (Yin, 2011), such as addressing and capturing farmers' concerns in their languages for easy use and application. The naturalistic inquiry form took the dimension of what MoFA and Cowtribe did and are doing through the electronic system to help improve farmers' livelihoods. This is case study research with the interview as the main medium for generating data. In doing this, we focused on how these institutions used their e-platforms with content to distribute to farmers in a detailed form—the how and why assisted us in exploring, illustrating, and describing the e-agricultural phenomenon in Ghana.

The in-depth interview guide (semi-structured) was developed for both participants of Cowtribe and MoFA to elucidate information on their e-agricultural concepts, approaches, principles, operations, and challenges. In each case under study, the participants interacted with were:

- Chief Operations Officer-Cowtribe
- Northern Zonal Coordinator- E-Agriculture Project, MoFA

Interactions with these participants took the form of detailed conversations with the guide of the semi-structured questions, recorded using an audio device with participants' consent to examine their perspectives on the subject in question, an idea, initiative, or subject as espoused by Creswell (2013) in qualitative data collection processes and types.

Data Analysis

The data collected were transcribed and coded into categories, themes, and sub-themes (Strauss & Corbin, 1998) to make an informed interpretation and meaning from the participants' perspectives. The themes and sub-themes were then interpreted using the holistic coding procedures (Creswell, 2013; Bernard & Bernard, 2012) for inference. The holistic approach we adopted analyses all the data as unabridged and tries to tie in relevant and strongly held conclusions based on the data (Creswell, 2013; Bernard & Bernard, 2012). With the coding procedures approach, we were allowed to further break down the information from the participants into smaller forms of actions and attributes.

Discussions were then made on the identified themes and sub-themes through the clarity of the obscure approach of data posited by Neuman (2006), guided by the interpretive paradigm view that meanings can be attributed to texts from the perspectives of the researchers' worldview and experiences.

RESULTS AND DISCUSSIONS

A. MoFA's E-Extension Approach

The Ghana government's electronic agriculture program through the Ministry of Food and Agriculture was supported by The World Bank to strengthen and modernise agricultural production in Ghana as part of achieving some of the then Millennium Development Goals[3] (MDGs), Goal 8 (with the support of the private sector, to benefit from the new information and communication technologies). This goal, called e-Agriculture, which is an area of application of Information and Communication Technologies (ICTs), was a significant focus during the 'World Summit Information Society (WSIS) Plan of Action being facilitated by the Food and Agriculture Organization (FAO) of the United Nations (UN).

The logistics provided to these offices were primarily satellite systems, Global Positioning Systems (GPS), computer labs, flyers, and other electronic systems to improve the quantity and quality of production. MoFA's plan of action was the establishment of the e-extension project to propel the initiative of the general concept of agriculture under the West African Productivity Project (WAPP) of disseminating information through technical support and content, information, capacity building, education, and input information at the Northern and Southern Offices.

MoFA's argument and principle on e-agriculture are to provide prompt and efficient agricultural services delivery using ICTs, which serve as a mediation social tool between the people and the platform. The institution believes this is anchored on five (5) key components or thematic areas; e-farm information (interactive voice response systems), 24-hour call centre, e-learning and resource, resource centres, use of the web portal, and e-field extension service delivery approaches. Interactive Voice Response Systems (IVR), according to MoFA, are delivered in farmers' language throughout the country to respond to their critical information needs. With the provision of satellite systems, Global Positioning Systems (GPS), computer labs, flyers, and other electronic systems to improve content quantity and quality, e-agriculture issues are argued to be a high-hanging fruit initiative.

Observations at the Northern Zone offices revealed an equipped office set-up with computers and flyers on the supposed content of agricultural information for farmers. The centre exists to train extension officers on digital agricultural knowledge innovations for extension advisory services to farmers. It is also open to selected key and contact farmers who are early and better adopters of technologies and can teach their colleague farmers. As noted by the Northern Zonal Coordinator (NZC) of the E-agriculture project,

> "…farmers who are educated, serious, focused on farming as a business and always relied on the extension services are highly likely to adopt faster and better than others who farm to feed. Their interest in the extension services is low from our experience with them …." (NZC, 7th August 2020).

[3] The MDGs expired in 2015 and were replaced by Sustainable Development Goals (SDGs) to run from 2015-2030.

This position of the NZC affirms Rogers's (1995) constructs that early and fast adopters of technologies and innovations, such as the e-agriculture innovation, are quicker in doing farmer-to-farmer approach dissemination than late adopters. It also affirms the Davies (1989) model of TAM theory level of education or exposure of beneficiaries of knowledge/technology is a pre-requisite to accepting a new intervention or technology. They are the first point of contact for farmers with extension officers who can be relied upon. Extension officers do not require leaflets and other information manuals to convince them (Mumuni, 2016).

It was revealed further that the project started very well with a consolidated database of farmers who utilised the call centre through subject matter specialists who helped to address their concerns online through IVR.

Interactions with the Northern Zone Coordinator (NZC) of the E-agriculture project further revealed that;

> "The national database of this innovation reached 17,330 new farmers and other agricultural-based actors with over 551,804 IVR through a free short code number 30037 to reach e-capacity personnel and subject matter specialist on crops, livestock, agribusiness, and mechanisation". …. (NZC, 7th, August 2020).

The approach posits linking these farmers directly to professional extension and technical advisory services at no or less cost through the mobile phone. This is progress and a success story towards providing technical and innovative information to farmers in Ghana by the Ministry. The NZC noted further that,

> "The system again provides mobile phones to extension officers for e-extension and fertiliser subsidy management deliveries with farmers biodata and farm geos staff to locate and provide appropriate services to them on-demand" (NZC, 7th, August 2020).

Beyond the IVR services through the mobile phone system, the MoFA e-platform further claims to provide online content by populating web pages/ portals with relevant agricultural information and innovations with other essential data from all agricultural stakeholders. Officers constantly monitored farmers' fields and district offices to ascertain the level of application and use of the knowledge shared on their platform.

However, it became clear that MoFA needed more funding to scale up and strengthen these in-rolls made due to funding challenges and content on the platforms for dissemination. The project ended quite early when they struggled to achieve the five key components of the e-agriculture initiatives. The NZC explained that,

> "We have problems filling the platform with digital content that addresses all the farmers' issues. We will still have to do more to attract such capacities for continued support to farmers. It's all about funding to help create more digital content, including text, graphics, and audio for farmers. We hope to get the project's second phase where we can scale up and mainstream into MoFAs routine activities..." (NZC, 7 August 2020).

Another challenging issue that the study revealed was farmers' difficulty moving from conventional extension to e-platforms, which is new and complex. This position of farmers' challenges of using or switching to the innovation links much to the Technology Acceptance Model Theory of Davis (1989). He argues that changing and accepting such technologies depends on users' exposures, beliefs, education, and the functionality of such devices.

Outreach, dissemination, publicity, and advocacy are important to adopting and using technology to promote and ensure better and wider coverage. The coordinator intimated that the margin of publicity of the e-agriculture technology to farmers and other stakeholders needed to be more compared to the bigger mandate expected of the project. The NZC explained that,

> "We needed more media publicity to discuss the need to change and adapt, and stakeholders like agricultural NGOs, the media, and other donors to partner with us. For some of us in the project, our advocacy and implementation of the concept were insufficient to cover the entire country and all farmers in our database. We could have better outcomes than we achieved if we received such support." (NZC, 7th, August 2020).

Considering the facilities and resources (human, financial and logistics) offered, a simple e-extension model to be disseminated to farmers online or offline in text, graphics, or audio could have produced a better and more complete database of farmers as beneficiaries who are using technology with the right and available content.

B. The Cowtribe Experience

Cowtribe E-Approach/Technology

Over 13 million small farmers live in Ghana's rural and peri-urban areas. In these areas, over 75% of rural people and 25% of peri-urban people depend on livestock for their livelihoods. Cowtribe technology-based company with its head office in Tamale, tries to contribute to these issues by addressing some challenges through its mobile technology. With 11 different active languages, they record audio voices for farmers and serve over 90,000 farmers in 2021, hoping to reach one million by 2025 (DRK Foundation (2022).

As a tech company operating with a peculiar principle like the UBER technology, they use a mobile application called the Shepheard App, available on the play store with security features. The application allows livestock farmers to access veterinary doctors (30), over 200 technicians, and several other veterinary pharmacies. The service aims to reduce livestock mortality and increase productivity and income for rural farmers and livestock keepers.

On why the use of the mobile phone to address farmers' extension needs, the respondent explained;

> "So we thought of how we could leverage mobile technology to ensure that we provide them with preventive access to veterinary services instead of emergency calls, and so this is where we thought of leveraging mobile phones because now we have a high penetration of mobile phones and even the poorest farmer now has access to a mobile phone, even if he does not have, the son, the wife, or a neighbour will have one." (COO, Cowtribe, 13 July 2020).

> "We also developed the Zhulia application platform. Zhulia is a simple enterprise resource planning system built for rural agro-vet stakeholders. Zhulia comes in two modules; a POS application that can be installed on any smartphone to support in-shop sales. The second part is the Retail Manager App, which allows shop owners to manage inventory, sales, and finance and order medications, feed, and other supplies directly from distributors and manufacturers with just a button" (COO, Cowtribe, Sept 2020).

A scale-up on just given messages was done using an application with several components. The platform allows the moderators to aggregate community demands and connects them to veterinary supplies. This conforms with the TAMT theory, which argues that the simplicities and affordability of technologies make the adoption process easy and effective. The services offered by the platform created include;

- Access to technical specialists
- Reporting of diseases and animal health conditions
- Request for treatments
- Purchase and use of vaccines
- Audio voice messages that address critical questions and issues of farmers in their language

These approaches make it easy to utilise as most Ghanaian farmers need help reading and writing. There are 8.3 million households in Ghana (GSS, 2021), with 44.1 percent having no formal education. Therefore, they cannot read and write. Affirming such views, Surabhi and Gaurav (2009) revealed that farmers who subscribed to mobile phone extension services in a study in India largely preferred audio to text messages because of literacy concerns. Addressing the challenges and health needs of the livestock sector with such all-encompassing technology and low-hanging fruit interventions is a diatribe of solving the country's food security needs. Again, with the widening gap of the farmer and extension officer's ratio (1500:1), an innovative platform such as the e-platform called the "Zhulia and Shepherd App" links farmers to a pool of veterinary extensionists who hitherto would not have been available for extension advisory services to them.

Principles and Data Credibility

The agric-led tech company revealed that seeing the smiles and outputs from farmers at the end of the day drives their zeal and commitment. "A healthy animal means a gain for us all". They achieve this by addressing all livestock farmer's concerns with a simple mobile phone at the offline level. They argued for their data credibility and reliability with emphasis as a technology company, they have signed up to the data protection act 2012, which forbids them from doing otherwise. The respondent explained that,

> "We are here to serve farmers. Support their needs, and we do it with passion and dedication with our little resources. It is deceptive for us to forge data because if we forge data, it does not translate into cash from farmers" (COO, Cowtribe.13th, July 2020).

> "Government people and development partners can trust our data because we are a signatory to the data protection law. We do not forge information, and anything fed into the system is what you see; it gives you raw data that you can trace and analyse, kind of a dashboard that you can see." (COO, Cowtribe.13th, July 2020).

Tracking Devices, Voice, and Text message techniques

Another dimension to the e-argument saw using RUMEN BOLUS as an electronic device shot into the animals to monitor their health status, location and welfare. This allows them to forecast, plan and advise farmers on the growth and health needs of the animals. With RUMEN BOLUS inside an animal, animal stealing, animal migration, and mixed-up issues are addressed. This is a success story of animal safety and health surveillance for livestock managers with the GPS principle aided. The price tag during purchase by butchers is argued to be higher than other animals who do not benefit from extension advisory

services. The technology also helps trace the meat quality and helps determine the infection status of such animals. Jason (2010) states that the tracking and tagging system helps 'herds' to be managed more effectively and efficiently, giving even small farmers additional incentives.

The innovative plus and success story of this e- extension strategy is using the audio content in the farmer's language at the right time with the right solution. Audio content makes adoption faster and easier for farmers due to convenience and ease of use (Heike, 2017). The respondent noted that,

> "We have a recording studio, where we record the voice in the 11 languages so far and put it in the computer, and it is mounted on the platform addressing the critical issues raised by the farmers. We focus on preventive services first." (COO, Cowtribe, 13 July 2020).
>
> Our digital platforms allow us to provide all services and needs of livestock farmers on everything about animal husbandry. (COO, Cowtribe, 13 July 2020).

These languages are recorded in a studio designed to help push such interventions where the connection to farmers is pivotal to their services alongside the services of the community service agents based in the communities with them. For those who can read, the organisation can share text messages (locations of veterinary stores, vaccines and staff locations, health, weather issues and warnings, and markets, among other things) with all their registered livestock farmers on their platforms to read and make informed decisions.

The Lessons

Reaching several hundreds and thousands of smallholder farmers through a 24hr call centre, interactive voice response systems and consistent messages and audio ad alerts to farmers remains the most significant impact and story of these electronic initiatives. By virtue of MoFAs nationwide presence, its initiatives would have broadly reached out to the over 2 million smallholder farmers in Ghana. However, as revealed by the findings of this paper, actors within the ministry could not sustain the five-point component of the e-extension strategy of MoFA (2022) due to funding, staffing, expertise, and the commitment to managing the 24hr call centre with technical content to respond to farmers' needs. As argued by Davies (1989) on the assumptive effectiveness of technology acceptance theory, beneficiaries will adopt technologies that are consistently provided, simple and effective to use depending on the user's education, economic and other demographic considerations. Cowtribe reach of smaller smallholder farmers with the uber-tailored model appeared to affect adoption and general access to information on animal husbandry and other agricultural practices. The consistency of service provision, even on token base systems, tended to assure farmers of available and accessible agricultural knowledge irrespective of their location.

CONCLUSIONS

While these initiatives are ongoing at both the private sector (Cowtribe) and the government level (MoFA), the reality is that most of the farmers (13,366,340) at the household level in Ghana here are left unattended to, by extension, advisory services. According to the Ghana Statistical Service (GSS), of these 13,366,340 farmers, about 40.5% (5,346,536) farmers are into livestock are supported by only 30 veterinary doctors nationwide, and only 2000 veterinary technicians indicate the veracity of the country's agricultural challenges. Again, whilst the electronic (e) and digital space provides an enormous potential to help address the challenges of

the agricultural sector, not much has been done throughout the country and government to utilise and scale up these opportunities for agricultural development. The perils of not utilising e-technology well in the most optimum form while in the technology age exposes farmers and the country vulnerable.

Cowtribe, on the other hand from this paper, shows consistent innovation through the deployment of the audio-encrypted and text messaging system in the language of the local farmers, which takes away the literacy barriers and bigger electronic gadgets for technology access. More so, the consistency of data and content always provided to the farmers and all stakeholders on their platform (Zhulia and Shepherd App) is in line with the AU agenda on digital transformation, as opposed to MoFA, where the 24hr data centre established suffered from content provision challenges on farmers request.

From these discussions, an agricultural was established to support information access to MoFA for deployment to farmers nationwide. MoFA urgently needs to recruit key skilled agricultural personnel, including veterinary personnel, extension officers, and other subject matter specialists, to mount the e-extension centres for farmers' access. Paid extension services must be encouraged with strong partnerships from the private sector to support the electronic policy. Mainstreaming the e-agricultural concept in all district's agricultural centres with the requisite logistics support services is highly recommended to reach out to most farmers and other value chain actors within the agricultural circles. The government and agro-led technology companies should encourage the focus on voice messaging in the language of farmers to deepen farmers' use of the interventions.

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