

The Impact of embracing Information and communication Technology in the Agriculture Sector

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ABSTRACT

Developing countries in Africa have been battling with the challenge of providing quality healthcare by arresting the food insecurity predicament through advocating for adoption of better Agricultural practices that can boost the yields, though the main impediment is lack or limited access to information on many aspects of agricultural research and development to the important stakeholders. This paper examines the various ICT platforms and technologies used in the Agricultural sector, statistics of their usage index and eventually ascertain whether they have any impacts on Agriculture and are also handy in addressing the looming food insecurity in Africa.

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I. INTRODUCTION

Information and Communication Technologies (ICTs) is a convergence of telecommunication and computing technologies towards the acquisition, retrieval and dissemination of information. These platforms include: Advisory Services on Farmer Information Services, Market Linkages, Supply Chain management, Financial access and Macro Agricultural Intelligence, while the technologies are: The internet of things (IoT), Big data, Machine learning and Blockchain. The duo facilitate for information acquisition, processing, storage, sharing and dissemination across respondents over a network of digital devices across the globe yet food security is critical for the survival of individuals, households and ultimately nations. According to World Bank (2010), 73% of the African people live in rural areas surviving on less than a dollar a day and

poor farmers have largely remained poor. Agricultural sector has been faced with a myriad of challenges such as insufficient investment in rural areas, inadequate advanced appropriate technologies and inputs including improved varieties as well as inadequate access to markets and unbalanced market conditions, among other things.

II. METHODS AND MATERIAL

The researcher applied integrated Literature survey in identifying relevant research articles and ICT technologies embraced by stake holders in the Agricultural Sector. Then a critical analysis on scholar articles and reports was done to assess the impact of these technologies on the food security in Africa as well as the statistics of the user index in the future.

3. ICT Platforms and Technologies that are used in the Agricultural Sector

Digitalisation for Agriculture (D4Ag) is the use of digital technologies, data and business model innovations to transform practices across the agricultural value chain and address bottlenecks, and enhance, agricultural productivity, postharvest activities, market access, finance and supply chain management in order to realize greater incomes for small scale farmers, enhance agriculture value chain economics for agribusinesses both large and small, expand the economic span of youth and women, address food and nutrition security and build climate resilience, while mitigating the potential negative environmental effects of agriculture according to the digitalisation of African Agriculture Report (2019).

a) ICT Platforms Used in Agriculture in Africa

i. Advisory Services (Farmer Information Services): Farmer information services provide relatively general agricultural information and advice on agronomic best practices (e.g., planting, harvesting, pest and disease management), farming inputs, the weather, and market information (e.g., prices for key inputs and commodities), typically via SMS, USSD, and IVR, and occasionally with call center support. Recommendations are not traditionally tailored beyond national levels or general crop types. According to GSMA, (2016), Farmers access the advice and information directly, as is the case for most advisory service solutions tracked in this report, or via agents such as government extension officers, NGO staff, agribusinesses agents, financial service provider agents, and lead farmers. In such intermediary models, agents make use of digital advisory tools and information repositories to provide support to individual small scale farmers. They include enterprises like Esoko in Ghana (in its earlier stages), Grameen Foundation's Community Knowledge Worker (CKW) solution in Uganda, many early donor-funded 'e-extension' agriculture projects from NGOs

like Catholic Relief Services (CRS), and most of the initial MNO-linked agriculture value-added service (mAgri VAS) solutions like Tigo Kilimo in Tanzania and M-Kilimo in Kenya as depicted by Van Campenhout, (2016).

Weather/Climate and Pest & Disease Solutions

Plantect™: Is a service comprising of hardware for measuring the environment inside a greenhouse and software for predicting disease occurrence based on the measurement data. The hardware includes sensors for measuring temperature, humidity, sunlight, and carbon dioxide. These are installed inside a greenhouse and the measurement data is sent to a cloud. Users can access the data in the cloud via a web-based app using various devices, such as smart phones or PCs. This enables them to check the inside environment in the greenhouse in real time, or browse past data, at any time and from any location. Besides monitoring, Plantect™ also plays an important role in the prediction of the occurrence of disease. Using the data sent to the cloud by the monitoring function, Bosch's proprietary algorithm analyses elements related to disease occurrence, such as leaf wetness, links the analysis with weather forecasts, and displays plant disease infection risk notifications on the app. Plantect™ uses a long range wireless communication protocol due to low energy consumption. Furthermore, since it is battery-powered, initial installation requires no wiring such as electrical power sockets or communication cables. It can be easily installed in any position within the greenhouse. It uses readily available alkali batteries, which can last for up to one year.

Trapview System

It is an automated pest monitoring system that monitors all kinds of insects, which can be lured into insect traps. It works in any area covered by the GPRS or 3G network. TRAPVIEW system consists of three fully integrated, automated and easy to use tools. The energy independent and weather resistant pheromone

traps send pictures of lured pests. All pictures from the traps are gathered, processed and securely archived. The pests that are spotted are automatically marked. An application with powerful analytical tools allows you to efficiently keep an eye over and successfully respond to the condition in the field.

Remote Sensing/Satellite

SatSure: Satellites give the users detailed geographical and climate records of any place in the world, from the 1990s up to today, this is made possible through collection and analysis of this data as well as combining it with other relevant information like commodity prices and news coverage. The information is therefore processed into clear risk-measurements so that one can make smart decisions based on the better view of the risks. The smart decisions include: response to developing risks with advanced warnings and decision insights, improvement of field operations with strategic information from satellites, sensors, and markets and finally monitor the health of large areas remotely and predict crop yields accurately

Drones/UAV surveillance

The ThirdEye project supports farmers in Mozambique and Kenya by setting up a network of flying sensors operators. These operators are furnished with flying sensors and tools to examine the obtained imagery. This innovation is a major transformation with regards to farmers' decision making in view of the application of limited resources such as water, seeds, fertilizer and labor. The flying sensor information helps farmers in making decisions regarding when and where they should apply their limited resources. The information from flying sensors enable farmers to manage their inputs as well as maximize yields, and simultaneously reduce unnecessary waste of resources according Okafor E., (2019).

Field Sensors

In the year 2019, Sunculture, a revolutionary solar pump startup from Kenya had a new idea to expand

their business. In addition to selling IoT-enabled solar pumps, Sunculture has integrated their hardware with sensors and an AI companion app, hence opening up the possibility of agriculture advisory and digital marketplace with BNPL (Buy Now Pay Later) financing options. The goal was to increase farmers' yield and growth, all within Sunculture's business ecosystem.

Plant health and soil portable diagnostics

AgroCares :Healthy agricultural fields are vital for every farmer. But farmers often lack important knowledge about the precious soil in which they want their crops to grow. The AgroCares scanner empowers smallholder farmers to make informed decisions about soil fertility management and fertilizer use, and this helps the farmers increase their yields.

Integrated precision advisory platforms

TATA: Technology intervention in agriculture evolves continuously and small scale farmers can find technology overwhelming. TCS Digital Farming Initiative (DFI) personalizes its solution to suite both small and large scale farmer by integrating their skills with the cloud through the unique intersection of advanced remote sensing and IoT technologies. DFI's platform uses intuitive interfaces with voice and local language, this makes adoption easier. The pillar of DFI platform is a distinct protocol-centric, market driven production tactic that controls cyclic optimization of extensive field data gathered from the agro value chain as well as predictive analytics of the data collected, which is processed and gives a guide on-field operations.

Farmer information services

Ratin: Facilitates farmers through provision of knowledge regarding the amount of water, quantity of fertilizer, or mineral to be applied where and when. Farmers can also get information about weather and can take measures to save crops. The app also provides farmers with the information about the new varieties

of crops, resource conserving cultivation practices as well as farm machinery and its implementation and this eventually helps in increasing returns to farmers.

Farm management software

Cropio: Is a satellite crop health management and vegetation control platform that expedites remote monitoring of agricultural land and helps its users to proficiently plan and execute the agricultural operations. Cropio offers real-time updates on current field and crop conditions, determines vegetation levels and pinpoints problem areas, delivers precise weather forecasts and an actual overview of the commodity market.

Participatory advisory

DigitalGreen: The majority of households are headed by men and decision-making patterns show that women make fewer household decisions compared to men, who make major decisions. Women have more diverse income sources compared to men, but men have the upper hand in determining the household budget allocation. Women do not embrace agricultural technologies and practices as quickly as men, this is attributed to the fact that they need to receive approval of their husbands before proceeding. Development Agent provides extension support to the women's heavier workloads hence they have less time to participate in extension activities. The extension support includes: Support women to interact with the digital technologies, ascertain that agriculture advisory services align with the schedules of the women, provide access to inputs to enhance agricultural production, introduce technologies that ease women's workload, conduct training that considers women's role in agriculture and society, create an enabling environment for women to develop and own assets and provide assertiveness training for women in male headed households to boost their participation in household decision-making.

ii. **Market Linkages:** These are digitally-enabled solutions that link smallholder farmers to high-quality farm inputs (e.g., seeds, fertilisers, herbicides/pesticides), production and post-harvest machinery and mechanisation services (e.g., irrigation, tractors, cold storage), or off-take markets, including agro-dealers, wholesalers, retailers, or even to end-consumers. Digital market linkage solutions help the smallholder farmers to lower their costs of production via access to lower-cost and/or higher-quality inputs, reduce the costs and risks of finding and transacting with buyers and ultimately increase their yields and incomes as depicted by IFC, (2018). The African start-up enterprises that fall into this category include: Farmers Pride in Kenya, CowTribe in Ghana, myAgro in Mali and Senegal, and Agrics iProcure in Kenya and Tanzania.

Digitally-enabled value chain integrators (Input integrators)

Emsika, based in Zambia is a platform specialized in wholesale and retail trade in agricultural inputs ranging from farm equipment, agro-chemicals to seedlings. It is a platform through which wholesalers and retailers can source products through their website. Emsika also proposes to introduce an app to further enhance its performance. However, this platform can only be accessed by individuals with above average literacy level and only serves those with large scale mechanized or semi-mechanized commercial farms.

Digitally-enabled value chain integrators (Market access (off-take) integrators)

One Acre Fund: Provides an online platform that enables small-scale farmers in rural areas gain access to farming raw materials such as seeds, fertilizer, equipment etc, and they can make payment using mobile money and eventually deliveries are made to their home town. The organization also provides remote consultation services to farmers who can't afford to hire a qualified farm manager.

Digitally-enabled value chain integrators (End-to-end integrators)

In Nigeria, easyagro is a tech-driven company which owns an e-commerce marketplace platform (easyagrog.com.ng) created specifically for small-holder farmers (Agribusinesses) and consumers of Agricultural products and services. easyagro is web-based marketplace platform that can be accessed through subscription, it is designed to empower small holder farmers to have direct access to the urban market demands at the comfort of their farm. It also provides a link to a mixed bag of key players like manufacturing companies, groceries, eateries, value adding companies, hotels, agro-storage companies, logistics, the urban market trade Union and to the final consumer of Agricultural products and services.

Mechanization access services (Pay-as-you-go agriculture machinery)

InspiraFarms provides agribusinesses and food distributors with turnkey, modular, energy efficient cold rooms, pack houses, and automated ripening chambers. These significantly cut energy costs, helps farmers to meet international food safety certification standards, and allow for remote performance monitoring. They also provide technical assistance and affordable asset financing terms that allow agribusinesses to leapfrog financial barriers to emerging technology and grow sustainably.

Mechanisation access services (Shared Services for Mechanisation)

AgriZoom: Is a crowd funding and e-commerce platform powered by an Android app that is revolutionizing agriculture in the Congo DR. Its core funding activity is aimed at scaling from subsistence to commercial agriculture and to reenergize cooperatives in farmers, fishermen and processors of agricultural products

E-commerce services (Agri-input e-commerce)

Nyarkaera-Easygro: Is a Kenya-based e-commerce marketplace for agricultural inputs and equipment. It accepts payment through digital money (M-PESA), cash, or credit.

E-commerce services (Food e-commerce)

Farm Fresh: Is a platform that has tweaked the marketplace to include home delivery. It is a premier online food store and delivery service in the Gambia. By partnering with smallholder farmers, Farm Fresh ensures a regular source of income generation for farmers thereby contributing towards poverty alleviation. It thus intervenes in the value chain by bridging the existing gap between production and delivery. The platform enables Gambians in the diaspora to order and pay directly online to purchase fresh and healthy food for their families.

E-marketplaces (Input e-marketplaces)

Esoko is an award-winning agricultural profiling and messaging service platform, it is leveraging on the explosive growth of cellular services in Africa. It is primarily a platform that enables the user to collect and send out market data that includes market prices of different commodities using simple text messaging. The Esoko platform provides automatic and personalized price alerts, buy and sell offers, bulk SMS messaging, stock accounts and SMS polling. Esoko has a partner support program focused on capacity building and financial sustainability, with an emphasis on market data enumeration and business development services.

E-marketplaces (Off-take e-marketplaces)

KHULA Is one of the South African apps and platforms that address the area of logistics (transportation, cold chain and warehousing). KHULA as a driver app allows for shared logistics costs amongst many farmers. Its warehouse management platform that manages farmer profiles, allows the viewing of inventory levels in the warehouse location radius. In addition, it allows for the

sharing of cold chain to enable the delivery of products fresh every time.

iii. Supply Chain management: Digital supply chain management solutions are business-to-business services that help agribusinesses, cooperatives, nucleus farms, input agro-dealers and other smallholder farmer value chain intermediaries to manage their smallholder relationships in ways that lower costs through greater efficiency, improve value chain quality through better traceability and accountability and ultimately increase smallholder farmer yields and incomes by making it easier for more commercial players to formally engage with large numbers of smallholder farmers as depicted by Aker J., (2017).

Digitally-enabled value chain integrators

eProd is a recognised and affordable solution that is designed to handle large numbers of suppliers. It enables you to respond to the requirements of your demanding markets and to address the management challenges that aggregators and food processors experience while sourcing from large numbers of small scale suppliers.

Logistics

Logistimo is a hosted web service offering logistics and supply chain management tools for rural emerging markets.

Quality assurance/ anti-counterfeiting

SourceTrace: Used to digitize 240,000 cocoa farmers to grow cocoa certified under UTZ, Rainforest Alliance and Fair Trade in the West African . The solution provides users with complete visibility into the Agri supply chain, beginning with farm-gate to cold storage and eventually onto exports for efficient management & traceability.

Supply chain ERP solutions (Specialist supply chain ERP enterprises)

eProd is a recognized and affordable solution that is designed to handle large numbers of suppliers. It enables users to respond to the requirements of the demanding markets and to address the management challenges that aggregators and food processors experience while sourcing from large numbers of small scale suppliers. It improves the productivity of the farmers, including monitoring the field activities, managing input distribution and product aggregation, and enabling traceability and quality-based payments.

Supply chain ERP solutions (B tech agribusiness ERP solutions)

SAP: Builds a sustainable and fully traceable agriculture supply chain. It's designed for agribusiness companies, and it connects smallholder farmers to the agricultural value chain and offers full transparency into the source of your raw materials.

Supply chain ERP solutions (Proprietary/in-house agribusiness ERP)

The Olam Farmer Information System, or OFIS, is a novel survey tool that is used by our field staff to collect data, record GPS data points for farms and social infrastructure, manage training activities and track all "first mile" transactions, such as financing, input distribution and crop purchases. This in turn results into comprehensive and detailed models of what's happening, so that farmers and other participants in the supply chain can maximize the effectiveness of their efforts.

iv. Financial access: Digital financial services (DFS) relevant for smallholder farmers, such as digital payments, savings, smallholder credit, and agricultural insurance, which increase financial access and equip smallholder farmers to improve yields and incomes and invest in the longer-term growth of their farms (e.g., via better inputs, mechanization and expansion to new crops). It also entails business-to-business digitalisation and data analytics services for financial institutions that enable such institutions to serve

smallholder farmers at substantially lower cost and risk according to Giuliana D., & With H., (2019).

Payments

Agri-wallet: a digital wallet, a mobile financial tool, for the agricultural sector providing business accounts for farmers, so that they can use to save, buy, and receive income. Farmers can open an Agri- wallet account for free. When farmers earn revenue through sales, they can choose the payment mode to be M-Pesa (a Kenyan mobile payment system) or (partly) in tokens for their wallet. Tokens are then earmarked for purchasing input supplies from merchants that have been vetted by Dodore, comparable to a voucher system. These tokens can be used to purchase inputs for the next cropping season. Furthermore, because credit takes the form of tokens rather than currency, lenders are more willing to provide farmers with loans.

Savings

MyAgro is a mobile platform that enables farmers to make savings towards agricultural inputs such as seeds, fertilizer, and attend training that is offered in batches with the aid of their mobile phones. While the majority of microfinance institutions provide loans for farmers to purchase agricultural inputs, my Agro empowers farmers to save their own finances through small mobile deposits avoiding high interest rates and long trips to formal banking institutions. With myAgro's tailored retail products, farmers are also able to access smaller packages of high quality seeds and fertilizers to meet their needs. My Agro serves smallholder farmers across Mali, Senegal, and Tanzania

Credit

DigiFarm's end users are farmers while the solution's customers are B2B and B2G partners across the entire agricultural value chain, extending across FMS-providers (Farm Management Software), crop insurance, financial institutes (banks), and soft commodity based traders, food processors/retailers, land management and government agencies

(agriculture). These models help clients (and users) optimize prediction capabilities, logistics, crop-yield forecasts, determining in-season crop-damage, reduce operational costs and increase revenue, creating stability to the sector. The primary application field is within agriculture and specifically precision agriculture, however, the data and models DigiFarm delivers have significant use-case and value-add for the entire agricultural supply-chain from pre-production all the way through retailers.

Insurance

IFAD, the International Fund for Agricultural Development, has been improving access of poor rural residents so that they can access successfully finance services for over forty years. To enhance service provision, IFAD has been specializing in agricultural insurance since the year 2008.

FSP digitalization

First Access is a financial technology company that aims to use data to improve financial access in emerging markets. It has developed a customizable credit scoring platform for lending institutions, and has worked with microfinance institutions in Africa, Asia and Latin America.

Crowd-farming

Complete Farmer: Was founded in 2017 to provide advisory services to farmers.

It helps farmers overcome the challenges on the production side regarding accessing information to obtaining inputs, services, and financing to support improved yields for farms with export potential.

v. Macro Agricultural Intelligence: Fonta et al (2018) depicts that data analytics solutions and digital decision support tools that integrate a variety of data sources on smallholder farmers, farms and markets and convert this information into useful country- and value-chain-level insights and decision tools for

government policymakers, extension agencies, agronomists, agribusinesses and investors.

Government agriculture sector tracking dashboards

The purpose of Group on Earth Observations Global Agricultural Monitoring Initiative (GEOGLAM) is to increase market transparency and improve food security by producing and disseminating relevant, timely, and actionable information on agricultural conditions and outlooks of production at national, regional, and global scales. This is achieved through strengthening the international community's capacity to utilize coordinated, comprehensive, and sustained Earth observations.

Agriculture extension system management tools

World Food Program: The World Food Programme is the world's largest humanitarian organization, saving lives in emergencies and using food assistance to build a pathway to peace, stability and prosperity for people recovering from conflict, disasters and the impact of climate change. In a participatory pilot initiative, climate advisories will be tailored to enable smallholder farmers to adapt to the impact of climate change.

Satellience

Precision agriculture services bring intelligence and advisory services to the farm level by utilising farm-specific agronomic data, such as on-farm sensors.

Agronomy/R&D agenda setting digital tools

Investiv Group. (2019) depicted that the Olam Farmer Information System, or OFIS, is a novel survey tool that bridges that gap. OFIS allows our field staff to collect data, record GPS data points for farms and social infrastructure, manage training activities and track all "first mile" transactions, including financing, input distribution and crop purchases. This yields comprehensive and detailed models of what's happening, so that farmers and other participants in

the supply chain can maximise the effectiveness of their efforts.

AG Observatory

It supports the World Bank and partners to access and deploy high resolution and near real-time geospatial Ag-meteorological data. It also enables and empowers WBG analytical and operational programs for strategic, proactive and timely decision-making as well as giving promising disruptive technology applications into the hands of farmers and other stakeholders.

vi. Big Data: This technology brings large sets of data together to generate deeper insights. Big data allows companies to store, aggregate and analyse large sets of data to generate insights that inform business decisions. Applying big data to Sub-Saharan African agriculture can improve farmers' livelihoods and inform better decision-making at the macro level. Big data capabilities are allowing Digital solution actors to generate insights from the vast amounts of data now being generated. According to Tollefson, J. (2018), Big data analytical capabilities are empowering enterprises' ability to utilize the data that they are collecting from, IoT connected devices. Ideally, big data is transforming disciplines like genomics, crop breeding, climate modelling, and agronomy. Analyzing new datasets in more powerful ways, triggers the development of better responses to some of the most pressing challenges facing Sub-Saharan Africa which include: climate change, food insecurity, and environmental degradation. Donors and developing country governments have woken up to the imperative of bringing big data to agriculture. Kilimo Salama (now ACRE Africa), a company launched in 2009 that offers an insurance product for smallholder farmers. It combines real-time weather data with regional-level historical climate and crop yield data to estimate indemnities more accurately and efficiently. The project has now expanded to other countries in the region (e.g., Rwanda, Tanzania). Evidence suggests that farmers who were clients of ACRE Africa invested

20% more in their operations and generated 16% more income than did those farmers who were not insured. But big data analytical capabilities in Africa are still limited. Big data analysis is often conducted by third-party private firms that offer their analytics capabilities to private and public clients. For example, MNOs like Safaricom and lenders such as Central Bank of Africa use firms such as Cignifi and Experian to produce consumer-risk profiles according to GSM, (2018).

vii. Machine learning: Unlocking the predictive capabilities of data by automating learning . Parker, S. (2018), depicted that Machine learning is the application of artificial intelligence to allow systems to learn and improve themselves without explicit programming. If IoT is enabling the capture of billions of farm-level data points, machine learning is enabling the analysis of these data to improve automatically and continuously. As firms capture increasing amounts of data, machine learning can help them automatically improve the level of tailoring and precision of insights for specific smallholder farming segments, value chains, and geographies. There is also hope that machine learning may help solution providers overcome digital literacy challenges without solely relying on extension agents, e.g., through the use of interactive voice response (IVR) systems and chatbots. Machine learning solutions are currently at an even earlier stage than IoT. Machine learning requires thousands of data points for computers to build accurate algorithms, and the system needs to be fed with new data regularly to continue to improve its accuracy. There have been some experiments to test solutions built for other markets (e.g., the US) in Africa, but those solutions have often fared poorly in initial trials and hence the need for more local information before they are proven accurate in the local context. Second, the talent required to build machine learning capabilities is significant (more so, even, than for big data analysis); the IT talent shortage in Africa is already acute. Machine learning entails taking some risks, since the underlying algorithms might be biased or there data on

a specific segment might be insufficient, additionally machine learning might not always offer the best solutions for specific communities. This can often be hard to notice or correct because the machine learning algorithms are not comprehended well by users. A number of machine learning experiments in the field of agriculture are already underway. For instance, Apollo Agriculture in Kenya uses agronomic machine learning to deliver customised and immediate advice to smallholder farmers. Farmers are able to call a local hotline and, through a conversation with an intelligent and interactive robotic system, access information about daily market prices, use of fertilisers, and expected crop yield. Even though it is still a challenge to set up an IVR system that is fluent across multiple local languages, the system has already enabled Apollo to improve its service offering in selected regions of Kenya. Another interesting application of machine learning is WeFarm which uses machine learning and the power of the crowd to source the best answers culled from the platform's network of more than 1.3 million farmers in Kenya and Uganda. Wefarm's network has provision for small-scale farmers to make inquiries on anything related to agriculture and then receive feedback inform of conversations or articles. Wefarm's machine learning algorithms then match each question to the purported responder. In Africa, AI-enabled solutions are helping farmers combat plant pests and disease, likely the most mature application of machine learning in the Digital solutions sector. For instance, the app known as Nuru was crafted by taking thousands of photos of infected leaves. After experts diagnosed the diseases, the photos were organised into a database, which was used to train the software using machine learning to recognise the symptoms. The app is user-friendly, and farmers or extension agents simply align their smartphone camera with the several cassava leaves and Nuru gives appropriate diagnosis. In terms of effectiveness, its developers say that the app is now twice as good at detection as extension workers according to Schiller B, (2017).

viii. Block chain: This technology is handy with regards to optimizing for transparency, efficiency, and safety in the Agricultural sector. At the most fundamental level, blockchain can help provide farmers with secure, portable digital identities. Using those digital identities, organisations working with farmers (from non-profits to commercial enterprises) can come up with a digital footprint for farmers that includes their transaction history and a registry of their assets. This footprint, in turn, helps farmers prove their identity, and opens the door to a range of services (particularly financial services) that they might otherwise be unable to access. Haider I, (2018) notes that Block chain technology can also be used to trace the production and transaction journey of agricultural inputs and outputs. This builds trust at each point of the supply chain, so that farmers can be confident that they are actually receiving the high-quality inputs like seeds and fertilizers' in exchange of their money. Block chain can also help providers who are serving as small scale farmers. For instance, block chains ensures that every transaction within the supply chain from the movement of a crate to the payment is tracked. These data can be used by agribusinesses and others to better understand their supply chains and take action to improve efficiency and effectiveness and ultimately lowering costs. Additionally, Block chain has the potential to transform support services that farmers rely on, such as banking. For example, by making verification easier, the technology can facilitate lending to farmers, insurance and other financial services. Block chain could also help to quickly identify the source of disease outbreaks on the farm. The high level of transparency enables buyers and sellers to work more directly with each other rather than through intermediaries. Block chain has been embraced across many products and this include: Cellulant's Agrikore that facilitates supply chain logistics management, traceability and access to finance for farmers as all contracts and transactions are recorded in an immutable system.

Hello Tractor relies on a block chain solution, developed in partnership with IBM, to provide a tamper-proof record of demand-side and supply-side processes ranging from tractor booking requests, to order fulfilment, payments for tractor services, distribution of proceeds to the tractor owners on the platform, and invoicing to farmers. The platform thus serves as a block chain- enabled supply chain, finance, and logistics management ERP system.

Tulaa utilizes a block chain-enabled system to track input and off-take supply chain logistics with its farmers, e.g., using the block chain to validate hand-offs at key points across different value chain players to prevent agri-input fraud and ensure ultimate product quality.

Twiga is partnering with IBM to use block chains to manage its loan application process for its retailers and farmers. Block chain makes the application easier, faster, more transparent and as a result more affordable for clients to access financing.

b. Statistics on the Usage Index

Agriculture in Kenya accounts for 34.6% of Kenya's GDP. There are 16 million smallholder farmers in the country. More than three-quarters of Kenyans make some part of their living in agriculture. The sector's primary crops are: maize, coffee, and tea. Yields in the country are about 12% higher than Sub-Saharan African averages but agricultural productivity has stagnated in recent years, maximum yields have not been achieved, and only 20% of land is suitable for farming. Moreover, drought and disease continue to pose a risk to food security for many vulnerable populations in the country according to USAID website. Kenya has more digital solutions enterprises and users than any other Sub-Sahara African country. Over 100 solutions that have been rolled out in the market ,31% of operators on the continent have locations in Kenya. And 20– 30% of Kenyan farmers are touched by more than one digital solution. The projected revenues of digital solutions players in Kenya is €18-40 million in 2024. Large and fast-growing

solutions include WeFarm (1.4 million users), iCow (0.8 million users), Pula (0.6 million users), KCB/Mobigrow (0.4 million users), and PAD (0.4 million users). Kenya's digital-friendly environment has helped digital solutions flourish. Digital solutions enterprises benefits from Kenya's high levels of connectivity, mobile phone usage, and data transparency. Safaricom's M- Pesa and the rise of mobile money over the last decade has made Kenyans more comfortable with digital products, particularly for transactions, according to World Bank Group,(2019). Nairobi's emerging community of ICT entrepreneurs has also strengthened growth.

III.CONCLUSION

Agricultural sector is a key driver of any country's Gross Domestic Production, and besides it has also enhanced the food security and the duo has led to the improved living standards of the citizens. Digital solutions are products that have triggered production in the Agricultural sector through automation, increased efficiency, enhanced security to data and information in transit, effective solutions to problems, increased mitigations schemes and faster records archival. The products have eventually driven the digital economy index upwards through enhancing skills and awareness to stakeholders in the sector and this has improved global trade in the Agricultural products. Last but not least, digital economy index has also increased through vast transactions and communications by use of the digital products.

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