**Digital transformation for sustainable agriculture: a progressive affair for small holders farmers**

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**Abstract**

The farming and agri-production system is in danger. This sector is continuously posing threats to life and living. Challenges have become a common phenomena for sustaining agriculture food system. As we go along with SDG 2030 goals, to achieve “Zero Hunger” status, the system will demand more performing, skillful, holistic and adaptive food ecosystem. Digitization will bring a revolution to the current food system provided farmers are adopting and applying in their routine farming operations from food to fork. In rural areas, digital literacy is crucial for using digital technologies. Establishing and strengthening a ‘digital agriculture ecosystem’ requires an enabling ambience from grassroot innovations learnt from farmers perspectives.

**Key words :** Digitization, sustainability, agri-food system, rural population, digital literacy

Technological, economic, ecological and community-based sustainability is alarmingly attracting attention of all stakeholders. Climate change precisely weather aberrations is a threat that distracts the existing agriculture models thus endangering sustainability. Digitalization bears the potential of bringing remarkable change in the rural farming sector. To feed the rising population of developing countries like India, farming needs to be more digital to make it more work efficient, holistic, inclusive and sustainable. To make farming digitalized to attain sustainability, we want to impact with increasing production and productivity, optimum utilization of resources, energy efficient action and also protect our environment and biodiversity. The relationship between the two exists in the sense that digital farming should help our resource poor small and marginal farmers to grow profitably and at the same time conserve natural resources to reduce distress scars on environment. Agbalance is a life cycle assessment tool that enables a farmer to assess and review the contribution of the present farming operation and how it impacts the social, economic and environmental dimensions. With well defined sustainability it is now more required how technology and data can fit into broader areas to realize efficiency, accuracy and transformation. Robotics in farming take the play to do all these things more precisely and also projected to grow two fold in next 5 years. The all encompassing food production system need to be more resilient. Digital farming interventions will supervise and assess resource optimising opportunities and generate information to face the adversity so as to bring equilibrium by balancing all dimensions (social, technological, financial) of food production system.

Timely information accessibility is a pre-requisite significant for decision making in farming sector. ICTs are known for expediting timely dissemination of information and advisory services. Mobile phones are the commonest form of ICTs. Mobile phones penetrated almost to all nook and corners of rural India thus shrinking the digital gap resulting in increasing application by several Govt. Organizations. Mobile apps or farming apps are the best, convenient and useful media to guide farmers to take their own decision and that too without any financial liability. Though we have more
than 70% farmers depending on agriculture as livelihood but majority don’t have easy access to healthy information and advisory. At this point mKRISHI, a mobile application developed by the Tata Trusts plays it role and hold record achievement in providing information to 2 lakh Farmers in Punjab only regarding best practices for improving yield and income. Similarly Pusa Krishi by IARI, Agriapp, Kheti badi, Kissan Suvidha are few of the apps used by farmers to find out the soil suitability, water status, product availability, value of agri-products, temperature and rainfall, crop protection measures and other information delivery services.

Such ICT platform can increase the farmers, farm implements and services interactive platform. The FAO predicts the collective food production scenario’s demand on increase of 70% to fulfill the target by 2050. To address this challenge, efficient management for reducing the over use of inputs and appropriate timely information to take correct decision is mandatory. This is where digital agriculture like Internet of Things (IoT) and sensors can be deployed but it is associated with small scale producers challenges viz. Small scale farmers which are less market oriented and earn less than 33% from off-farm sectors an use these platform. Probable solutions to make digital farming accessible to farmers are:

1. Innovative technology oriented knowledge oriented solution required to be developed to provide internet access at an affordable price.
2. Small and marginal farmers are generally deprived of finance. As a result ICT enabled solution needs to be economical. Innovation need to be done to make the task less costly.
3. Farmers from emerging countries have low literacy with poor technical knowhow. Technologies should be friendly to small holder farmers.
4. Irrelevant information serve as an efficient barrier to small holder farmers so that they become resilient to shocks and stresses.

Sustainable agriculture w.r.t digital farming is gradually being observed that agriculture can adapt with emerging challenges Declining incomes and increasing restrictions to the food supply is a threat to production security pressurising growers to take different options. More than 70% small holders have opined their fate as horrible. According to World Bank, 76% small holders experience reduction in income whereas in Phillipines it was 80 percent. In the Philippines, that ratio climbed to 80 per cent. In Indian context, 44.2% of agricultural workers and more than 78% small and marginal farmers are deprived of own land. Indian GDP which rose to 5.2 and 4.4 percent in Q1 and Q2, reduced by 23.9% and 7.5% respectively. Digitally enabled ecosystem is able to reinstate the concept and processes, to use the accurate real time data to make farming happen coupled with predictions, and future-orientations so as to attain sustainability. Digital advisory (particularly credit access and online money transaction) and agrobased forum linking market with farmers have made felt probable solutions to meet towards rising threat. All digital farming services went high during 2020. To
support, digital info-delivery service Ama Krushi famous for dissemination, agronomic advisory through IVR hotline is a success.

**Digital technologies for sustainable agriculture is a progressive affair for farmers:**

Digital agriculture has all capabilities to orient agriculture systems towards sustainability. Recent innovations like application of artificial intelligence (AI) and Remote Sensing (RS), block Chain (BC) and Internet of Things (IoT) are revolutionising agri-value chain and changing farming techniques. In contrast to India, countries like Netherland and Israel have widely accepted such innovations. Agricultural Digital Infrastructure (ADI) solution developed by CISCO is very interesting in enhancing farming knowledge sharing. Jio Krushi agriapp digitises agroecosystem along agri-value chain to strengthen farmers. The National Agriculture Market (eNAM) came into existence in 2016 PAN India, that connect APMCs to create an Universal marketing platform. The world agriculture needs to meet the growing food demand (Finger, R., Swinton, S.M., El Benni, N., Walter, A., 2019). Smart farming 4.0 is to address these challenges utilizing information into meaningful decision making (OECD, 2019; Bacco et al., 2019). The ICT mediated technologies includes a wide range for decision support starting from simple mobile app to field sensors and to drones and robots for the processes {OECD (2019)}. A resilient agriculture system in the days ahead will require digital farming technologies (Walter et al., 2017), which use Artificial Intelligence (AI), cloud computing, Internet of Things (IoT), and blockchain among others (Torky and Hassanein, 2020; Klerkx et al., 2019). Labor is expensive. Labor-saving technologies in agriculture have been the prime cause of worry. Anywhere from 26% to 40% of total production cost is dedicated to labor and the cost is often incurred by the producers only. With the digital applications farmers are able to supervise the IoT-based mechanism which can monitor agricultural land — soil moisture, humidity and temperature — with the help of sensors and machine-led irrigation practices. A farmer will get an alert if his farm is sufficient or deficit of moisture. The farmer can keep an eye on water, fertilizer and pesticides requirement through sensors. ISRO’s Geo-platform, Bhuvan, which provides valuable data on the plantation, pest surveillance and weather saves labour which also otherwise would have employed labours to do so. So digital technologies can help reduce labour cost but small and marginal farmers how they can manage is sometime worrisome.

Digital India programme initiated by government helps farmer to bring changes to farm production and farmers’ income by delivering Better prices, Virtual ecosystem, Tailored recommendations and Direct cash transfer: Digital India will support the government which would again help in increased agricultural productivity as well as reduce farmer’s burden.
The diffusion of innovation and its adoption (DOI) given by Rogers (2003) and the Technology Acceptance Model (TAM) of Davis (1985). Astonishingly they appear to be less pondered for increasing functions and falling prices of mobile handsets (World Bank, 2012). Mobile applications that deliver advisory about field crops growth, implements, identification of pests and diseases provide real-time data about rainfall and alert regarding calamity, local markets offering optimum price for agriproduce.

Digital transformation signifies few pertinent factors regarding digital efficacy like strategic angle, customer focussed, ICT enabled assets, talent, sharpening capacity, innovation and establishment culture. Smart farming technologies results in a dynamic change in world economy and society, and all endeavours are on impactful economy models. For service , improvement and change ; ICT is inevitable.

Climate related challenges are associated with stress and shocks and always there is a confusion among marginal growers, policy framers and stakeholders.

Resilient food production system requires continuous consideration of social, technological and
economical situations, and an emerging economy model called the circular economy which will balance all odds. Holistic sustainable issues are gaining significance. Digital farming innovations can influence the whole value chain from input providers to consumers and association with other industries require an entire method of farming.

Sustainability achieved through digital farming with some examples:
The country’s population is growing, but per capita land availability is shrinking. It is understood agriculture productivity needs to be sustainable so Digitalization in farming can help us deploy our resources efficiently and sustainably, empowering farmers to get the optimum output.

1. **Farm management**: All ICT mediated interventions require specific farm management skills and focus in knowing each piece of land, thus allowing farmers to need base use of seeds and pesticides in small areas. Judicious use improves productivity by reducing cost.

2. **Financial Services**: The Association for People of Haryana (AFPOH) is an ICT-based agriculture initiative in India that facilitates smallholder farmers to access finance for improved agriculture.

3. **Knowledge and Information Services**: Timely delivery of relevant information is key to sustainability. Kenya Agricultural and Livestock Research Organization (KALRO) is progressing fast in developing more than 14 apps for crop and livestock farmers.

4. **Market Services**: “E-Krishok and Zero Hunger” in Bangladesh and “Farmers’ Advisory Information System” in Tanzania provides advisory services on farm inputs.

5. **e-Government Services in Agriculture**: Governments is the key player in agriculture development sector.

6. **Digital Farmer Profiling Platforms and Services**: This platform assist farmers in all type of informations.

The rural internet penetration in rural areas of India has shown an increasing trend. Rural broadband access number increased by 23.64 million households throughout the year, reaching 117 million households in the rural areas. India’s smart agriculture potential market size has increased to 21% which means small holder farmers are being benefitted.

**Digital farming is enabling progressiveness amongst farmers**

Digital technology is transforming global agriculture around the world. An app “Scouting” developed by Xarvio - Digital Farming Solutions which helps farmers in weed identification. Farmers can easily download the app for free and its identify, document weed species at early growth stages by taking sharp pictures from maximum distance of 50 cm. The algorithm discovers all features of weed, disease and pest incidence, nutrient deficiencies, leaf damage.

Digital technologies combined together can assist in farm production, supervising and are ushering in the modern day agriculture. Through these technological advancements, farmers are able to improve their yields while conserving resources, more quickly identify areas of their fields that require attention, collect and categorize data, and more. Digital agriculture technologies — some of which were developed by Crop Life International member companies — are already in use in many markets. We have showcased some of these technologies in our CropTech innovations series highlighting the latest advancements in crop protection technology. In 2021, we will likely see even more widespread focus on these innovations as companies work to deliver these digital solutions to farmers all over the world.

Suggestive measures to make Digital farming to happen in rural India are 3 A’s (availability, affordability, accessibility): Extensive use of internet, social media, mobile phones and digital skill enhance network coverage in rural areas (one-third rural population receive coverage by 3G network) and IT education in rural schools. (Education and Internet are the strong determinants of internet use.

Determining factors like Mobile phones can reduce market disturbances and support farmers to plan production process. Agricultural Robots (agrobots) can deeply influence agriculture in the future. Farm agri-robots map, measure and optimize water and irrigation use. Importance of ERP software in agriculture enable farmers to respond more organically to environmental challenges. MyCrop enables information empowerment and increases production and productivity and Blockchain to identify and
detect poor quality food in food chains.

**FUTURE STRATEGIES:**

1. Enabling the collection of field data about digital technologies. Mobile phones diminish market interferences and assist farmers in better planning. Suggestive measures to make big farming happening requires ICT education amongst farmers.
2. Creation of sustainable business models for inclusion of small farmers.

![Fig 2: A typical Voice based agro-advisory message flow showing sustainability](image)

Down the road we also believe digital technology will be employed to help reduce food waste throughout the value chain.

**Digital technologies help to advance the United Nation’s Sustainable Development Goals:**

Digital farming helps to advance many SDGs, but primarily these three: Zero Hunger, by building sustainable and productive farming practices and increasing overall production output worldwide; Climate Action, by reducing the negative impact nitrogen leakage has on the soil and groundwater; and Life on Land, protecting, restoring and promoting sustainable use of terrestrial ecosystems by reducing human impact on soil degradation stemming from low nutrient use efficiency.

Digital agriculture helps to make farming techniques easier, safer and more affordable. World’s first Internet of Things and artificial intelligence systems for soil and crop management are developed. This system will positively impact agriculture practices, leading to societal and environmental benefits. Traditional agricultural practices are best combined with technological and digital innovations. It optimizes both productivity and efficiency, in terms of cost, labor, resources and so on. Some of the emerging technological advancements that seem exciting are robotics, machine learning, AI and IoT.

**Conclusions**

The advantages of applying digital technologies like Big Data and Analytics, Internet of Things, Artificial Intelligence and Machine Learning, Blockchain, and Cyber-F systems are primarily adopted to improve farm efficiency and competency.

Digital farm technologies put forth probable solutions to increase social, ecological and financial sustainability. Farmers gradually becoming technology friendly and agri-digitisation is progressively growing with wider perspectives. We can say that digitisation is the future ahead but atleast for its the face of global agriculture. The outcome of digitalization has borne fruits to the endeavour and has set up benchmark for food producers for utilization and its impact on their livelihood. Digital farming goes almost synonymous with smart decision making, higher productivity, better quality produce and profitable market that uses advanced technologies towards shaping a brighter tomorrow.
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