Mysore J. Agric. Sci., 56 (3) : 16-28 (2022)

Digital Literacy in Indian Farming : Opportunities, Challenges and Lessons Learnt during Covid-19 Pandemic

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Received : April 2022

Accepted : August 2022

Abstract

Science and technology are the main drivers of a country's development. With the advent of science and technology digital world is now flourishing than ever before. In many sectors, digital platforms are vaguely being used as a growth engine. Therefore, illiteracy in digital platforms causes knowledge poverty and it ultimately acts as a prime barrier in development. India being the country with agrarian background, for its comprehensive development digital literacy certainly complements with traditional wisdom in agriculture. Digital platforms have range of utility in agriculture, most importantly timely supply of required information on production, processing, marketing, extension etc., unfortunately, digital literacy among Indian agriculture inhabitants is meagre. If the opportunities available in digital sciences are properly explored, there is ample chances of making agriculture more productive, efficient and profitable. Despite innumerable opportunities, technophobic farmers, substandard educational and economic status, fragmented land holdings, lack of awareness and exposure to contemporary technologies are some of the reasons which can be attributed to this kind of snail's pace adoption.

Keywords: Agriculture, Challenges, Digital literacy, Farming, Opportunities, Pandemic

India is an agrarian country; vast group of its residents (58 %) are still dependent on agriculture for their way of life. The varieties of agriculture products produced in rural India are contributing immensely in securing food and nutritional needs of the country's besides complementing to the national GDP. Furthermore, vast group of people involved in various agro based industries and its associated segments are also obtaining lucrative employment from agriculture. Agriculture, horticulture and animal husbandry being the three vital components of Indian farming, in all these components India is demonstrating consistent growth over the period of time (Fig. 1). As per the estimates of 2019-20 crop year, the food grain production in India has reached a record of 296.65 million tonnes and there is a target of 298 million tonnes by the year 2020-21. Similarly, about 319.56 million metric tonnes of horticulture farm produce was produced for the year 2020 and it is also showing promising growth at various horticulture ecosystems. With respect to livestock production, India made remarkable progress and at present around 535.78 million livestock units are there in India which translates around 31 per cent of the world population as a result, significant amount of milk and its subsidiary products are being produced (Fig. 1).

On the other side, digital boom is revolutionising the country. The utility of digital gadgets is invading in all directions and penetrating to the remotest places of the human inhabitation. People of the developing countries are empowering themselves by the way of its utility in accessing the information, communication, services and know-how in all walks of their life. But, scenario of digital literacy in Indian farming is highly discouraging even at this point of time. As per the recent reports of Digital Empowerment Foundation, more than 90 per cent of Indian residents are digitally

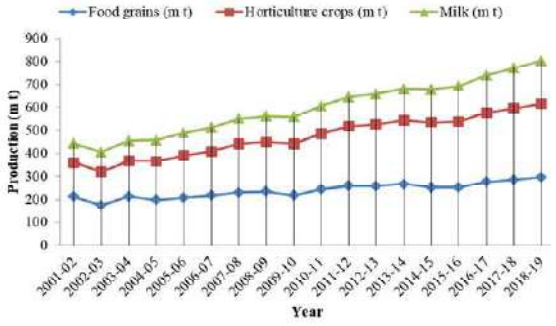

Fig. 1 : Trends in food, horticulture and livestock production in India

Source : Development of Agriculture, Cooperation and Farmers Welfare (2019) and Basic Animal Husbandry Statistics, DAHD&F, GoI (2019)

illiterate (Anonymous, 2020). The reason could be due to its most of the population residing in rural area and are inherently poor and divide of education but they are highly trained and focused in agriculture since ages. Most of rural Indian farmers are still adhered to primitive food-based agriculture, as a result farming failed in providing hand full of income and employment, especially, in rainfed agro ecosystems exhibiting a kind of disguised unemployment due to shortest length of growing period and uncertainty in climatic situation. Due to all these phenomenon agriculture is failing to attract youths to involve in it, as a result huge group of rural youths are moving to urban places in search of employment and livelihood as a result villages in India are becoming old and sick. In this situation, adoption and utilization of front-line sciences like information and digital technologies are highly difficult. From their study Patil *et al.* (2008) revealed that illiteracy, cost and lack of awareness were major adoption constraints of contemporary developments of digitals science in agriculture. Exposure to modern practices, new crops and crop varieties, production technologies, management tool and real time information on local and international markets are need of the hour to make agriculture profitable and sustainable. Hence, there is an urgent need to shift traditional paradigm to knowledge driven modern digital based agriculture to make it more remunerative and competitive. In order to achieve this goal information technology and utilization of digital knowledge centres are essential (Patil *et al.,* 2008).

Presently, information technology and digital platforms are the vaguely used means of information source, retriever, analysis and precise problem-solving tools, with these basic capabilities of digital platform various front-line sciences are harnessing best possible benefits of it and growing further. On the contrary, agriculture is although regarded as one of the fast-growing sectors in India and has undergone intensive metamorphosis from primitive food-based agriculture to utmost eye catching agro tourism designations in some parts of the nation (Kumar *et al.,* 2020). There is a high requirement of harnessing digital science in the field of agriculture to improve agricultural production, processing and marketing, while its potential is not yet fully harnessed in agriculture (Milovanovic, 2014). Reasons could be many, important are lack infrastructure, knowledge, cost-effectiveness, language barrier, encouragement, policies etc. In India, many digital empowerment programmes and policies were announced by the government during recent past to bridge the digital divide *i.e.,* 'Digital India'. The objectives and aspirations of Digital India had tempted us to review the impacts it made in the field of agriculture and allied sector. In this paper review, we made the possible acquisition of information published on similar line and are discussed in the light of present-day context.

Concept of Digital Literacy

In simpler terms the word 'Digital Literacy' refers to an individual's ability to find, analyse, evaluate and communicate information in verbal or non-verbal means through various digital platforms available. Digital literacy essentially indicates the utilization of information and communication technology gadgets such as smart phones, computers, internet of things (IoT), artificial intelligence (AI), sensors, scanners etc. Digital literacy not just the communication enabler, it also paves the way for new dimensions of economic opportunities, social, political and educational progress of the humanity. Currently, any sector of the society who is deprived of digital literacy is termed as digitally poor citizens. This digital poverty is having became another add in to gauge poverty in the society. In order to alleviate these new dimensions of poverty

government has formulated many programmes and are briefed below in the Table 1. Digital literacy among the citizens of the country provides the multifarious advantages and facilities; among them important are timely availability of reliable single window information, bridge the inequality, universal exposure, eradicate human induced mall practices in transactions and governance, ease of monitoring, timeliness. In such circumstances, the highly complex agriculture production and marketing practices could be better managed with the digital platforms if it properly thought.

Opportunities for Digital Literacy in Agriculture

India is the second populous country in the world with 1,391 million residents (Statista, 2021). Of this more than 58 per cent of the population is residing in rural areas and involved directly in agriculture in various agro ecosystems. According to recent reports of India Cellular and Electronics Association (2020) rural India witnessed a phenomenal gain in mobile phones and communication gadgets usage, at present a total of 760.53 million smart phone users in India and is exhibiting significant gain in future (Fig. 2). Furthermore, smart phone usage in rural India is also raised to 25 per cent at present as against 9 per cent in 2015 (Statista, 2021). This phenomenal gain in smart phone adoption could be due to advancement in information and communication technologies and competitive market in telecom sector that has revolutionised the outreach of digital platform to remotest place of the country. Among the digital technologies evolved in recent past, cellular phones gained the lots of attention and became part of life

TABLE 1

Digital literacy initiatives in India

Digital literacy programmes	Year	Objectives
Digital India	2015	To make government's services made available to every citizen electronically through online infrastructure, increase internet connectivity all over the country and to make country digitally empowered
National digital literacy mission	2018	To impart IT training to Anganwadi and ASHA workers and authorized ration dealers in all the States/UTs across the country so that the non-IT literate citizens are trained to become IT literate so as to enable them to actively and effectively participate in the democratic and developmental process and also enhance their livelihood
Pradhan Mantri Gramin Digital Saksharat Abhiyan	2019	Empower rural citizens with information, knowledge and skills and enable them in actively participate in governance
National e-Governance Plan	2006	To make all government services available to the citizens of India via electronic media
Unified Mobile Application for New-age Governance	2017	To provides a single platform for all Indian Citizens to access pan India e-Gov services ranging from Central to Local Government bodies and other citizen centric services
Digi-Locker	2015	Aimed at providing paperless governance to the citizen of India
Bharat Bill Payment System	2013	Bharat Bill Payment System is an integrated bill payment system in India offering interoperable and accessible bill payment service to customers through a network of agents of registered member as Agent Institutions, enabling multiple payment modes, and providing instant confirmation of payment
e-Sampark	2004	It enables the government to communicate with the citizens about several programs and initiatives

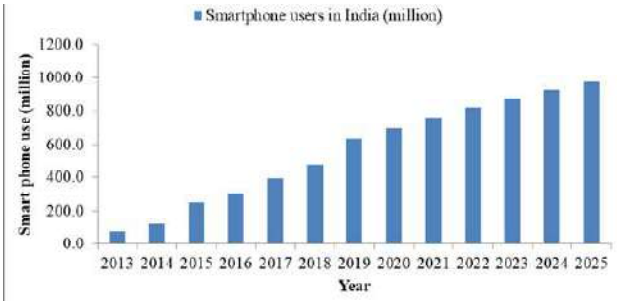

Fig. 2 : Number of smart phone users in India in 2015 to 2020 with a forecast until 2025

Source : (Statista, 2021)

irrespective of rural urban disparity. Due to their usefulness, ease-of-use and affordability of cell phones are being used by all segments of society. Currently, many sectors have widely adopted digital platforms in their work, notably marketing (Castells & Himanen, 2002 and Oztas, 2015), health care (Mosa *et al.,* 2012 and Habib *et al.,* 2014) and education (Cheung & Hew 2009 and Milrad & Spikol, 2007). Agrarian society is also not exceptional to this, today cell phone become a useful tool in agriculture because their mobility matches the nature of farming, the cost of the device is highly accessible and their computing power allows a variety of practical applications in agriculture (Pongnumkul *et al.,* 2015).

Farming

Farming refers to chain of activities undertaken in day to day basis in field such as sowing, weeding, fertilizing, inter-cultivation, irrigation etc. Further more, farming also deals many other activities like monitoring crop growth, pest identification and their management and estimation of growth and yield of crops. The features available with present day smart phone allow us to perform some of these agricultural activities in precise manner. The smart phones what we use today are additionally equipped with varieties of physical sensors which enable us to utilize them as a promising tool to assist diverse farming tasks (Pongnumkul *et al.,* 2015). Agriculture being the complex resource management system, in order to achieve utmost accuracy and use efficient one adoption of these front-line sciences is the order of the day. From their study Pongnumkul *et al.* (2015) reviewed agriculture could be efficiently supported with digital platform in 12 farming applications, 6 farm management applications, 3 information system applications and 4 extension service applications. Various scholars during recent past have tried to integrate digital platforms in to different dominies of agriculture such as disease management, nutrient management, soil status monitoring, crop health management and irrigation water management (Table 2). In all such applications data retrieved were timely and highly precise. Hence, there is an ample scope for outreach of digital technologies into farming operations to make it productive and efficient.

Farm Management

Farm management is crucial aspect for successful agriculture, wherein complete track of records are maintain based on those records viability, profitability and economics of the production systems are analysed whenever it is needed. Traditionally, paper forms of record keeping was in practice, further in large scale production units shifted to desktops and portable laptops. This traditional way of book keeping and computers approach often results in non-integrated data, making it difficult to extract valuable information from such data. With the invent of smart phone technology has revolutionised and made ease in various farm management drudgeries. Primarily, the portable nature of the smart phones allows users to access stored farm information at anywhere and anytime. Furthermore, smart phone equipped sensors such as microphone, camera, GPS, accelerometer and several others features has tremendously ease the farm record keeping and other farm management tasks (Pongnumkul *et al.,* 2015). For an instance, under large farming situation, farm manager or farmers can take photos of crops planted and weeds found on the field with GPS coordinates, to label the photos taken, besides typing, some applications use speech recognition technology are also available in today's smart phones (Frommberger *et al.,* 2013). Several of such utilities could be experienced with most common digital gadgets available among the farmers (Table 3).

TABLE 2

Digital platforms and their utility in crop and soil management in agriculture

Digital gadget	Category	Utility	Reference
Camera equipped smart phone	Disease management	Pictures of leaves are taken, then processed, and sent to labs for further disease diagnosis	Prasad *et al.* (2014)
Camera equipped smart phone	Soil management	Cameras function as soil color sensors	G´omez-Robledo *et al.* (2013)
Camera equipped smart phone	Water management	Photographs of the River Dee are captured for water condition assessment	Aitkenhead *et al.* (2013)
Camera equipped smart phone	Soil management	Photograph of the soil of interest is captured for topsoil organic matter and carbon contentprediction	Aitkenhead *et al.* (2013)
Camera equipped smart phone	Crop health management	Brightness is analyzed for estimating light radiation on plants	Sumriddetchkajorn (2013)
Camera equipped smart phone	Crop health management	Pictures of rice leaves are taken to analyze chlorophyll contents	Sumriddetchkajorn (2013)
Camera equipped smart phone	Harvesting assessment	Pictures of fruits under white and UV-A light sources are taken to determine ripeness levelsfor green fruits	Sumriddetchkajorn (2013)
Camera equipped smart phone	Water management	Images of leaf canopy are acquired to estimate Leaf Area Index (LAI), which in turn gives crop water requirements	Confalonieri *et al.* (2013)
Camera equipped smart phone	Crop health management	Pictures of rice leaves are taken to analyze chlorophyll contents	Intaravanne and Sumriddetchkajorn (2012)
GPS equipped smart phone	Pest management	GPS locations are used to generate location-aware pest/disease alerts to farmers	Wu and Chang (2013)
GPS equipped smart phone	Soil health management	Soil characteristics and information, such as pH, soil carbon, N, P, and K, are delivered based on users' GPS locations in Scotland	Aitkenhead *et al.* (2013)
GPS equipped smart phone	Water management	Users can view location-based river conditions in the River Dee catchment based on their GPS positions	Aitkenhead *et al.* (2013)
GPS equipped smart phone	Weather and soil monitoring	User's locations are used to imply elevation, climate and geology based on available digital maps and then to predict top soil organic matter and carbon content	Aitkenhead *et al.* (2013)
GPS equipped smart phone	Weather monitoring	Based on GPS data, the application calculates the extraterrestrial solar radiation and other parameters related to solar position in real-time	Molina-Martýnez *et al.* (2011)

TABLE 3

Digital platforms and their utility in crop and soil management in agriculture

Digital gadget	Category	Utility	Reference
Camera equipped smart phone	Resource monitoring	A short video of water flow is taken and then analyzed to estimate the water level, surface velocity and discharge rate	Luthi *et al.* (2014)
Camera equipped smart phone	Resource inventory	Images of object/area of interest are captured for geographic information collecting purpose	Frommberger *et al.* (2013)
GPS equipped smart phone	Labour management	The application sends location-aware task lists to farmers on the field	Murakami (2014)
GPS equipped smart phone	Labour management	Working patterns of farmers and frequency of visiting certain plot of the farm can be inferred based on GPS locations in the field	Sharma *et al.* (2013)
GPS equipped smart phone	Machinery management	GPS coordinates of tractor rollover accidents are reported	Liu and Koc (2013)
GPS equipped smart phone	Resource inventory	Images of object/area of interest are mapped for geographic information collecting purpose	Frommberger *et al.* (2013)
Microphone equipped smart phone	Machinery management	The application determines usage of different agricultural machines (e.g., tractor and chopper) by sound data	Sharma *et al.* (2013)
Microphone equipped smart phone	Resource inventory	Microphone is used to annotate images of object/area of interest via speech recognition for geographic information collecting purpose	Frommberger *et al.* (2013)
Accelerometer equipped smart phone	Labour management	Accelerometer is used to detect various body movements in order to identify farm workers' activities	Sharma *et al.* (2013)
Accelerometer equipped smart phone	Machinery management	Accelerometer is used to obtain a roll angle and pitch angle of the tractor in order to detect a rollover event	Liu and Koc (2013)
Gyroscope equipped smart phone	Machinery management	Gyroscope is used to obtain a roll angle and pitch angle of the tractor in order to detect a rollover event	Liu and Koc (2013)
Inertial sensors equipped smart phone	Resource monitoring / Resource inventory	Based on the data from inertial sensors, the distance of the object from the camera, and GPS location, the coordinates in the photo are projected to real-world coordinates, yielding a geo-object of exact original geometry	Frommberger *et al.* (2013)

Extension

Agriculture is the main driver of economy in India. In order to promote agriculture in all possible manners both central and state governments of different states of India has formulated several policies, programmes and schemes. The effective outreaches of those policies are only possible when there is well equipped agriculture extension wing. Agriculture extension imparts the education on new crops, crop varieties and technologies in production, protection, processing, value addition and marketing and also creating awareness about subsidy and incentives offered by government. Conventionally, agricultural extension services were provided by extension workers and experts by personal visit to farms to provide farming advice and solutions to specific problems. This requires extensive travelling, time consuming and resource intensive venture despite it provides limited cover. Digital platforms and information technology have recently made the process easier and more accessible. For instance, agriculture information intended to convey could be articulated in vernacular language and pass through the smart phones, tablets, community radios, televisions and kiosk maintained at local institutions. Digital literacy for farmers imparts more convincing agriculture production and management practices since it provides in both audio and video dimensions which is even difficult with in person extension. In Tamil Nadu Jhunjhunwala *et al.* (2013) implemented a voice-based service through call center to provide personalized solution to 1,200 farmers. This project was later inspired by the success of call center business model in modern industries, which provides personalized solution to customers who face technical problems and seek help through their mobile phones. In call center web technology, customer information is logged in their database and some FAQ pages allow relatively untrained call center operators to assist with the customer's problems. Further, Indian Agricultural Advisory System (AAS) was built by using the call center technology. Farmers can call in to seek help. Farmers can also send pictures taken from their mobile phones to the central server to allow call center personnel and experts to visually inspect their problems. Location data from the mobile device informs call center operators and experts about where the problem occurs. Similarly, Saha *et al.* (2012) explored the design and implementation of an Android based prototype, *m-Sahayak*, to allow experts to diagnose and treat plant's (and people's) disease remotely. Similar such efforts and success stories were also documented by several scholars and are summarised Table 4.

Marketing

Digital marketing is defined as the marketing and advertising of a business, person, product or service using online channels, electronic devices and digital technologies. Now-a-days with the advent of many e-commerce platforms, digital marketing is a force to reckon with especially for non-agricultural products and services and many companies are making big bucks utilising this platform. In spite of limitless scope for farmers, producer organizations and agribusiness companies to flourish in the digital space, participation of these stakeholders is still minimal. India being the young country with world's largest youth population. These people are highly tech savvy and fed with excess information with respect to all product related aspects like price, quality, variety, size, shape etc. A significant transition from cereals to protein rich foods, fruits and vegetables and packaged processed foods in consumption pattern has forced agribusiness companies to pull up their sleeves to strengthen their supply and value chains. Now these Generation Y and Generation Z people need not necessarily visit brick and mortar stores but are shopping 24x7 (Mishra, 2020) with plenty of e-commerce platforms like flipkart, amazon etc. at their disposal. Hence time and place aren't a constraint for them anymore. Furthermore, some of the prove one digital marketing opportunities demonstrated are 'AGMARKNET portal' (www.agmarknet.gov.in) under Market Research and Information Network (MRIN) Scheme is covering 3356 wholesale mandies across the country, wherein Agricultural Produce Market Committees (APMCs) markets are reporting data on mandi arrivals and

TABLE 4

Digital platforms and their utility in agriculture extension

Digital gadget	Category	Utility	Reference
Camera equipped smart phone	Pest management	Images of any infestation or potential problem are captured and sent to the operator's dashboard in real-time using Pest and Disease Image Upload (PDIU) feature, because sometimes it is difficult to find words to describe the problems	Jhunjhunwala *et al.* (2013)
Camera equipped smart phone	Disease management	Images and videos of the diseased plants are captured and sent to the central server for agricultural scientists to inspect and provide solution	Saha *et al.* (2012)
Camera equipped smart phone	Field inspection	Images of land plots are taken by technical staffs and sent to the central office as a verification that the land has been visited	Mesas-Carrascosa *et al.* (2012)
Camera equipped smart phone	Crop management	Images and videos can be sent along with a farmer's query to an expert to seek advice	Jagyasi *et al.* (2011)
GPS equipped smart phone	Field inspection	Field workers use GPS data to record farm locations when registering farmers. Spatial data (farm plots with water bodies, drainage and irrigation channels) are included in the farmer'srecord	Jhunjhunwala *et al.* (2013)
GPS equipped smart phone	Field inspection	GPS data is used to verify that the correct land is visited	Mesas-Carrascosa *et al.* (2012)
Microphone equipped smart phone	General enquires	Farmers can use the microphone to record their voiced questions to send to agricultural scientists	Saha *et al.* (2012)
Microphone equipped smart phone	General enquires	Audio queries can be recorded and sent to experts	Jagyasi *et al.* (2011)

prices of their traded agricultural commodities on daily basis. The farmers have free access to the Agmarknet portal for getting market price information easily. Department of Agricultural Marketing, Govt. of Karnataka have started their own market information portal named Krishimaratavahini (www.krishimaratavahini.kar.nic.in) in the lines of Agmarknet which collects all the day to day market information from APMC's of Karnataka. According to a study done in Odisha pertaining to the reach of AGMARKNET to farmers, majority of the farmers acknowledged the role of AGMARKNET in providing timely market information.

'National Agriculture Market (e-NAM)' (www.enam.gov.in) facilitates an online virtual trading platform to provide farmers with opportunity for transparent price discovery and remunerative prices for their produce through competitive online bidding system. So far, 585 wholesale regulated markets of 16 States and 02 UTs have been integrated with e-NAM platform. Small Farmers Agribusiness Consortium (SFAC) is the lead agency for implementing eNAM under the aegis of Ministry of Agriculture and Farmer's Welfare, Govt. of India. The compound annual growth rate of traded quantity and value of food grains was 9.39 per cent and 21.71 per cent respectively for the study period 2016-17 to 2019-20, which indicated a higher positive growth under the presence of a robust e-NAM platform (Kumar and Pant, 2020).

'Karnataka State Mango Development and Marketing Corporation (KSMDMC)' (http://karsirimangoes.karnataka.gov.in) had tied up with the Postal Department to deliver the fruits within a week of receiving the orders during COVID-19 induced lockdown in 2020. Consumers located within Karnataka were allowed to place their orders on the website and in turn received mangoes through postal deliveries. Apart from the postal service, 'KSMDMC' had also tied up with Resident Welfare Associations in Bengaluru to allow farmers to supply directly to customers which was termed as 'farmer to flat process'. The 'Uzhavan app' is run by State Agriculture Department of Tamil Nadu which has helped farmers to sell their produce at a good price by providing an online platform that connects the farmers with traders directly (Narayani, 2020). An ex-post facto research undertaken in Thanjavur district of Tamil Nadu, India pertaining to Uzhavan app usage by farmers revealed that the information searching time was relatively lowered and it had created more awareness about Government Agricultural Schemes (Kumar and Karthikeyan, 2020). Similarly, many private companies are the fore runners compared to government in utilising the digital space more effectively in the marketing of agricultural products notably ITC e-Choupal, Ninjacart, Ikisan and BigHaat.com are some of the succeeded examples in digital marketing field in agriculture.

Digital marketing certainly able to establish a direct connect with the farmers which will eliminate the prominence of the middlemen leading to a significant decline in the input prices. Farmers will establish direct contact with big institutional buyers like organized retailers, restaurant chains, residential associations etc. Overall, a strong backward and forward linkage will be established for the farmers. Despite these many remarkable benefits and opportunities technophobic farmers, fragmented l and holdings, lack of quality management, lack of grading and standardization etc. are some of the reasons which can be attributed to this kind of snail's pace adoption.

Challenges in India

Digital divide is the greatest set back in Indian agriculture. As per the report of According to National Sample Survey Office, Govt. of India only 4.4 per cent of rural households are having computer and aware of its utility, of which only 14.9 per cent equipped with internet connectivity (Anonymous, 2020). From the study conducted by Nielson (2019) revealed that about 70 per cent of the rural inhabitants does not exposed to an active internet facility, especially with the states like West Bengal, Bihar, Jharkhand and Odisha having the lowest internet penetration. Further, smart phones being another affordable digital platform

TABLE 5

Digital literacy status in in India

Ability	Rural		Urban	
	Male	Fe-Male	Male	Fe-Male
Basic knowledge of computer usage	12.6%	7.0%	37.5%	26.9%
Basic knowledge of internet usage	17.1%	8.5%	43.5%	30.1%

Source : Ministry of Statistics and Programme Implementation (2019)

as it gained immense popularity and penetrated to the rural India. Inspite of increasing affordability as well as numerous government initiatives smartphone user base is being widen in recent years. Despite all such popularities, utility and encouragement around 800 million people in the rural areas are still do not have access to smart phones. Even if substantial gain in smart phone purchase, the audio and visual content which is actually needed for various agriculture learning, data acquisition, processing, analysis and transmission needs requires high-speed internet. Again, a study conducted by Indian Cellular and Electronics Association during 2018 indicated 99 per cent of rural people access internet on mobile phones, of which majority are students and almost nil for farming utility.

Lessons Learnt during Covid - 19 Pandemic

Agriculture productions being highly season bound programmes. Precise and timely execution is essential to attain desired output. It involves thorough understanding of weather, crop, genotype, inter-cultivation, plant protection, harvesting, processing marketing etc. In recent day intensive agriculture adoption of improved production technologies recommended by agriculture technocrats are very much necessary besides implementing farmers traditional wisdom. Until now physical contact was the only ways and means for information dissemination in agriculture. Therefore, outreach mandates of various agriculture-based organizations usually conduct frequent and share the information. However, the Covid-19 pandemic being experienced in recent past has pave the way for many unforeseen challenges in India and agriculture landscape is not exceptional to it. Due to the unexpected outbreak of unprecedented pandemic greatly restricted the movement of the agriculture stake holders. During this situation digital technologies available around has slowly started gaining their importance. For an instance a study conducted by Mahesh Chander (2020) to know about role performed by the digital platforms in agriculture during the lockdown indicated, the ICAR through its KVK systems has provided advisory on ICT platforms to most of the farmers on various crop production, protection and marketing aspects effectively, specially enabled the farmers to market their produce comfortably. The services such as SMS, small video clippings, other messages can be sent to farmers through WhatsApp and other social media.

Although seeking information over digitals platforms viewed as impracticable venture by most of the farmers earlier, due to Covid-19 pandemic demonstrated the new normal in information gathering and its adoption. Gradual utilization and getting proficiency of digital sciences certainly ease the most of the agriculture operations. Digital gadgets such as computers, smart phones and internets of things were gradually being welcomed by farmers in various agriculture operations, most importantly in getting technical knowledge and finding marketing channel. At present most of the technical deliberations are made by agriculture universities, research institutes, extension units, NGOs and lane departments through virtual platform and are viewed as new normal under Covid-19 pandemic.

REFERENCES

AGRMARKNET, 2021, Commodity profiles, acessed on 08.01.2022, https:// agmarknet.gov.in/ Commodity Profiles/Default.aspx.

AITKENHEAD, M., DONNELLY, D., COULL, M. AND BLACK, H., 2013, 'Esmart: environmental sensing for monitoring and advising in real-time,' *IFIP Advances in Information and Communication Technology*, **413** : 129 - 142.

AITKENHEAD, M., DONNELLY, D., COULL, M. AND BLACK, H., 2013, 'Esmart: environmental sensing for monitoring and advising in real-time,' *IFIP Advances in Information and Communication Technology*, **413** : 129 - 142.

ANONYMOUS, 2020, Annual Report of Digital Empowerment Foundation 2018-19, https:// www.defindia.org/annual-reports/

ANONYMOUS, 2020, http://mospi.gov.in /sites/ default/ files/ publication _ reports/ KI_Education_ 75th_ Final.pdf

ANONYMOUS, 2021, Statista Research Department, https://www.statista.com / statistics/467163/ forecast-of -smartphone-users-in-india/ retrieved on 11.06.2021.

ARAVINDH KUMAR, S. AND KARTHIKEYAN, C., 2020, Factors influencing the utilization of 'Uzhavan App' as perceived by the farmers in Tamil Nadu. *Madras Agric. J., 2020; doi:10.29321/MAJ.2020.000382.*

CASTELLS, M. AND HIMANEN, P., 2002, The information society and the welfare state : Finnish Model. Oxford, UK: Oxford University Press.

CHANDAN KUMAR MISHRA, 2020, Digital marketing : Scope opportunities and challenges, *Promotion and Marketing Communications*, Umut Ayman and Anil Kemal Kaya, IntechOpen, DOI: 10.5772/intechopen. 92329.

CHEUNG, W. S. AND HEW, K. F., 2009, 'A review of research methodologies used in studies on mobile handheld devices in K-12 and higher education settings,' *Australasian Journal of Educational Technology*, **25**(2) : 153 - 183.

CONFALONIERI, R., FOI, M. AND CASA, R., 2013, 'Development of an app for estimating leaf area index using a smartphone. Trueness and precision determination and comparison with other indirect methods,' *Computers and Electronics in Agriculture*, **96** : 67 - 74.

FROMMBERGER, L., SCHMID, F. AND CAI, C., 2013, Micro-mapping with smartphones for monitoring agricultural development, in *Proceedings of the 3rd ACM Symposium on Computing for Development (DEV '13)*.

GOMEZ-ROBLEDO, L., LOPEZ-RUIZ, N., MELGOSA, M., PALMA, A. J., CAPITAN-VALLVEY, L. F. AND SANCHEZ-MARANON, M., 2013, Using the mobile phone as munsell soil-colour sensor: an experiment under controlled illumination conditions. *Computers and Electronics in Agriculture*, **99** : 200 - 208.

HABIB, M. A., MOHKTAR, M. S., KAMARUZZAMAN, S. B., LIM, K. S., PIN, T. M. AND IBRAHIM, F., 2014, Smartphone-based solutions for fall detection and prevention: challenges and open issues, *Sensors*, **14**(4) : 7181 - 7208.

http://karsirimangoes.karnataka.gov.in

https://www.intechopen.com/books/promotion-and-marketing-communications/digital-marketing-scope-opportunities-and-challenges)

INTARAVANNE Y. AND SUMRIDDETCHKAJORN, S., 2012, Baikhao (rice leaf) app: a mobile device-based application in analyzing the color level of the rice leaf for nitrogen estimation, in *Optoelectronic Imaging and Multimedia Technology II*, Vol. 8558 of *Proceedings of SPIE*, The International Society for Optical Engineering, November 2012.

JAGYASI, B. G., PANDE, A. K. AND JAIN, R., 2011, Event based experiential computing in agro-advisory system for rural farmers, in *Proceedings of the IEEE 7th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob'11)*, pp. : 439 - 444.

JHUNJHUNWALA, A., UMADIKAR, J., PRASHANT, S. AND CANAGARAJAH, N., 2013, A new personalized agriculture advisory system reality, potential and technology challenges, in *Proceedings of the 19th European Wireless Conference (EW'13)*.

KRISHIMARATAVAHINI, 2021, Market profile, acessed on 08.06.2021, https://www.krishimaratavahini.kar.nic.in/

KUMAR, R. M., YAMANURA AND NAGESHA, N., 2020, Agro-Eco-Tourism : A new dimension of green economy. *Food and Scientific Reports.,* **1**(8) : 20 - 24.

LIU B. AND KOC, A. B., 2013, Safe Driving : A mobile application for tractor rollover detection and

emergency reporting, *Computers and Electronics in Agriculture*, **98** : 117 - 120.

LUTHI, B., PHILIPPE, T. AND PENA-HARO, S., 2014, Mobile device app for small open-channel flow measurement, in *Proceedings of the 7th International Congress on Environmental Modelling and Software* (*iEMS's 14*), **1** : 283 - 287.

MAHESH CHANDER, 2020, Blog 107 - COVID - 19 : what can eas do to support Indian farmers?

MESAS - CARRASCOSA, F. J., CASTILLEJO-GONZ´ALEZ, I. L., DE LA ORDEN M. S. AND GARCIA-FERRER, A., 2012, Real-time mobile phone application to support l and policy, *Computers and Electronicsin Agriculture*, **85** : 109 - 111.

MILOVANOVIC, S., 2014, The role and potential of information technology in agricultural improvement. *Economics of Agriculture* 2/2014 UDC: 004.738. **5** : 631

MILRAD M. AND SPIKOL, D., 2007, Anytime, anywhere learning supported by smart phones: experiences and results from the musis project,' *Educational Technology and Society*, **10**(4) : 62 - 70.

MISHRA, 2020, R. K. Reach of agmarknet to farmers in the State of Odisha. CCS-NIAM Project Report.

MOLINA-MART´INEZ, J. M., JIM´ENEZ, M. RUIZ-CANALES, A. AND FERN´ANDEZ-PACHECO, D. G., 2011, RaGPS : A software application for determining extrater restrial radiation in mobile devices with GPS, *Computers and Electronics in Agriculture*, **78**(1) : 116 - 121.

MOSA, A. S. M., YOO, I. AND SHEETS, L., 2012, A systematic review of healthcare applications for smartphones,' *BMC Medical Informatics & Decision Making*, Vol. 12, No. 1, Article 67.

MURAKAMI, Y., 2014, iFarm : development of web-based system of cultivation and cost management for agriculture, in *Proceedings of the 8th International Conference on Complex, Intelligent and Software Intensive Systems (CISIS '14)*, pp. : 624 - 627.

NARAYANI, P. A., 2020, Uzhavan App's e-market comes as a boon to farmers. *The Hindu.*

NATIONAL AGRICULTURE MARKET, 2021, Mommadities, Acessed on 08.01.2022, https://enam.gov.in/web/commodity

NIELSON, 2019, https://cms. iamai.in /Content/ Research Papers/ d3654bcc- 002f-4fc7-ab39-e1fbeb00005d.pdf

OZTAS, B. B. Y., 2015, The increasing importance of mobile marketing in the light of the improvement of mobile phones, confronted problems encountered in practice, solution offers and expectations. *Procedia - Social and Behavioral Sciences,* **195** : 1066 - 1073.

PATIL, V. C., EHUD GELB, AJIT MARU, YADARAJU, N. T., MONI, M. AND HAREKRISHNA MISRA, 2008, Adoption of information and communication technology (ICT) for agriculture : An Indian case study. *Proceedings of World Conference on Agricultural Information and IT,* pp. : 685 - 692.

PONGNUMKUL, S., CHAOVALIT, P. AND SURASVADI, N., 2015, Applications of smartphone-based sensors in agriculture : A systematic review of research. *Journal of Sensors,* 2015: 18 http://dx.doi.org/10.1155/2015/195308

PRASAD, S., PEDDOJU, S. K. AND GHOSH, D., 2014, Energy efficient mobile vision system for plant leaf disease identification, in *Proceedings of the IEEE Wireless Communications and Networking Conference* (*WCNC '14*), pp. : 3314 - 3319.

ROHINI SWAMY, 2020, There's a mango in your mail. Karnataka postmen to home deliver the fruit from today. *The Print.* (https://theprint.in/india/theres-a-mango-in-your-mail-karnataka-postmen-to-home-deliver-the-fruit-from-today/402397/)

SAHA, B., ALI, K., BASAK, P. AND CHAUDHURI, A., 2012, Developmentofm - Sahayak - the innovative android based application for real - time assistance in Indian agriculture and health sectors, in *Proceedings of the 6th International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies* (*UBICOMM'12*), pp. : 133 - 137.

SATHYENDRA KUMAR, A. D. AND SATISH CHANDRA PANT, 2020, Benefits of eNAM process to farmers. CCS-NIAM Project Report.

SHARMA, S., RAVAL, J. AND JAGYASI, B., 2013, Mobile sensing for agriculture activities detection, in *Proceedings of the 3rd IEEE Global Humanitarian Technology Conference (GHTC '13)*, pp. : 337 - 342.

SUMRIDDETCHKAJORN, S., 2013, Mobile device-based optical instruments for agriculture, in *Sensing Technologies for Biomaterial,Food and Agriculture 2013*, Vol. 8881 of *Proceedings of SPIE*, The International Society for Optical Engineering.

THEGUARDIAN, 2021, Food, acessed on 14.8.2020, https:// www.theguardian.com/food

WEBFX, 2021, Digital Marketing: The Definitive Guide to Digital Marketing, Acessed on 14.08.2021, https:// www.webfx.com/ digital-marketing / glossary/ what-is-digital-marketing/

WU, Y. AND CHANG, K., 2013, Anempirical study of designing simplicity for mobile application interaction, in *Proceedings of the 19th Americas Conference on Information Systems (AMCIS '13)*, Vol. 1, pp. : 331 - 338.