Use of Mobile Phone and its Apps in Extension Services

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Abstract

Information and Communication Technology (ICT) and its application have shown great prospects in remodeling extension services in both developed and developing countries. The present era is an era of science and technology and those related to these fields are showing a tremendous increase in their value and functionality. Linking extension services to emerging technologies should be focused upon for better results and efficient services, due to the fact that a majority of the people are now connected to one another through mobile phones. These devices and their apps can be used for better linkages and to provide farmers with latest information instead of creating new devices for extension activities.

Keywords: ICT, extension, mobile phones, application, technology

Introduction

The use of Information and Communication Technology (ICT) tools has potential to change the economy of livestock, agriculture, and rural artisans in India (Sasidhar and Sharma, 2006)). Tiwari *et al* (2010) argued that the livestock sector should come up with need based, location specific and local language content in the form of computer software and other electronic material with regard to livestock disease control, dairy herd management, livestock production and for marketing of livestock and livestock produce. With intensification of crop/ livestock production systems and increased market demand for animal based products, the importance of information is growing in many developing countries (Morton and Matthewman 1996). Among various ICT tools, mobile phone has emerged as one of the widely accepted and adopted instruments in most parts of the world to ease the information communication process among farming communities (Hayrol *et al.* 2009). Next to the radio and television the mobile phone users are increasing rapidly in India particularly in rural areas, creating a

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Article *received on 14-11-2016;* Article *accepted on 20-07-2017*

platform for information dissemination through value added services like Short Message Service (SMS).

The Government of India spent US$60 million on public agricultural extension programs in 2010, yet a series of surveys in 2009 and 2010 reveal variable success across regions, with as many as 51.2 per cent of farmers citing public agriculture extension staff as a main source of information in one region and as few as 7 per cent in another. In the absence of experts, farmers often rely on word of mouth, generic broadcast programming, or agricultural input dealers. As of 2015, around half of Indian farmers (120 million) were estimated to have a wireless subscription (Cole and Fernando, 2016) The mobile phone looks like today's most likely access device for information dissemination. Livestock related information such as vaccination alert can be delivered through the mobile service provider before the monsoon.

Status of Mobile Phone Technology in India

According to the latest report released by Telecom Regulatory Authority of India (TRAI, May 2016), the number of telephone subscribers in India increased from 1,051.88 million at the end of February 2016 to 1,058.86 million at the end of March 2016, thereby showing a monthly growth rate of 0.66 per cent. The urban subscription increased from 608.42 million at the end of February 2016 to 609.69 million at the end of March 2016 and rural subscription increased from 443.46 million to 449.17 million during the same period. The monthly growth rates of urban and rural subscription were 0.21 per cent and 1.29 per cent respectively during the month of March 2016. The overall Tele-density in India increased from 82.89 at the end of February 2016 to 83.36 at the end of March 2016. While Urban Tele-density increased from 153.93 at the end of February 2016 to 154.01 at the end of March 2016, Rural Tele-density increased from 50.76 to 51.37 during the same period. The share of urban subscribers and rural subscribers in total number of subscribers at the end of March 2016 was 57.58 per cent and 42.42 per cent respectively. As per the reports received from the service providers, the number of broadband subscribers increased from 144.87 million at the end of February 2016 to 149.75 million at the end of March 2016 with a monthly growth rate of 3.37 per cent.

Use of Mobile Phones in India for Extension Services

The agricultural extension system has been traditionally funded, managed and delivered by the public sector in India. However, it suffered a series of attacks beginning from 1980s when the government and economists began to express concern with the cost of public extension. Subsequently the expenditure on the

public extension system began to decline. Further, public sector extension is being criticized for not being relevant, ineffective, time consuming and expensive (Chauhan, 2006).

The social and economic benefits obtained from mobile phones by the livestock owners were useful for their endeavor. Majority of the livestock owners perceived medium level of satisfaction, among overall respondents. So, the service delivery may be improved furthermore to attain high level of satisfaction (Gensis, 2010). The farmers were spending money on mobile phone calls to veterinarians to seek information related to animal husbandry. This shows their willingness to pay for the service they received. Most of the livestock owners from rural areas perceived language and network coverage as main constraints than in peri-urban areas. Hence, providing mobile enabled services either by text messages or voice messages in the local language according to the literacy rate of that area may mitigate this constraint.

Mobile telephony is growing manifold when compared to other Information and Communication Technologies (ICTs) in rural areas. Mobile phones are the success story of bridging the rural digital divide bringing tangible economic benefits and acting as agents of social mobilization through improved communication. According to Waverman *et al.* (2005) of the London Business School, ten extra phones per hundred inhabitants can lead to 0.59 per cent extra annual growth in a typical low income country like India. Dissemination of information through mobile phones is a newly emerging concept in agriculture and allied sectors. Introduction of mobile phones to Kerala fishermen could decrease price dispersion and wastage by facilitating the spread of information which made the markets more efficient by decreasing risk and uncertainty (Jensen, 2007; Abraham 2007). An ICRIER study (Mittal and Tripathi, 2009) among farmers highlights the key role played by mobile phones in lowering transaction costs and raising the income-levels of farmers, by efficiently addressing their immediate agricultural information requirements. Farmers also emphasized that timing of precise information is central to minimizing wastage and therefore increasing efficiency. Mittal *et al.* (2010) conducted a study on impact of mobile phones on the crop sector and, in particular on small farmers in India. The key finding of this research was that mobile phones can act as a catalyst to rejuvenate the extension services in the country. A recent survey among farmers of Uttar Pradesh, Rajasthan and Maharashtra revealed that farmers were confident of the utility of the mobile phone in reducing costs and enhancing earnings. Farmers can bridge or alleviate the information gap by the use of mobile phones (Mittal and Tripathi, 2009). Mobile phones along with mobile

enabled services provide lot of hope to improve the extension system. Information through mobile phone has a major impact on the overall farm output in areas where biotic and abiotic conditions are not so favorable for cultivation. Timely intervention through the right kind of prescriptions can help increase yields by 10.00-25.00% (Gupta, 2009). There has been increasing evidence about the use of mobiles for dissemination of agricultural information among farmers.

Mittal and Tripathi (2009) reported the key role played by mobiles in lowering transaction costs and raising the income levels of farmers, by efficiently addressing agricultural information requirements, while Inigo *et al.* (2014) and Mittal *et al.* (2010) reported that mobile phones contribute greatly to agricultural and animal husbandry information dissemination. Mobile telephony is a new phenomenon in seeking dairy related information by opening up opportunities in accessing information about various aspects like disease, management, marketing *etc.* However, lack of customization of these services to serve the specific needs of farmers and lack of operational knowledge are some of the impediments in effectively leveraging the potential of mobile phones (Inigo *et al.* 2014). This leads to the fact that, role of mobile phones for dairy farmers in information access, is an area which has not received due attention. Though, mobile is considered as an emerging tool in Indian dairying (Rathod and Chander 2014), still there is a need to emphasize the initiatives of the public sector for information delivery through mobiles, and study the perception of multi-stakeholders *viz.* dairy farmers, scientists and extensionists towards use of mobile in Indian dairying.

In a similar study, Inigo *et al.* (2014) also reported that dairy farmers in Tamil Nadu used mobile phones for seeking information about animal husbandry and dairying from various sources. They also pointed out that farmers were ready to pay for mobile phone calls to seek information related to animal husbandry and dairying. Rathod *et al.* (2016) revealed that farmers had various problems with mobile use and hence, they demanded support from various stakeholders like research and extension institutes, government *etc.*

Mobile based Extension Services

mKisan

mKisan is a mobile based extension service aiming to provide information on crops, livestock, market prices and weather based advisories to resource poor farmers, strengthen linkages between experts and the farming community. The service is

made available to the farmer through a short code 556780 which is integrated with Mobile Network Operators. Information on livestock under various knowledge domains like General Care and Management, disease management, feeding, reproduction & breeding is delivered through regional Interactive Voice Response Systems (IVRS) supported with SMS, voice messages and a Call Centre. The service is user friendly and is available 24x7 and can be accessed from any basic low cost handset. It also overcomes literacy barriers by providing information through Interactive Voice Response System. This suite of agriculture and livestock advisory services on mobile is providing information in the most cost effective and efficient manner. Farmers can easily access any information related to crop and livestock in the regional language of the state. The initiative of providing a knowledge platform helps to empower the smallholder farmers having 1-3 livestock by improving the livestock productivity, improved livelihoods, better income and decision making ability. At present there are 1,70,000 unique users (farmers) accessing the service.

The project was conceptualized, designed and developed in-house within the Department of Agriculture & Cooperation and has widened the outreach of scientists, experts and Government officers down to the Block level to disseminate information, give advisories and to provide advisories to farmers through their mobile telephones. SMS Portal was inaugurated by the Hon'ble President of India on July 16, 2013 and since its inception nearly 327 crore messages or more than 1044 crore SMSs have been sent to farmers throughout the length and breadth of the country. These figures are rising ever since (http://mkisan.gov.in/aboutmkisan.aspx).

Use of Mobile Apps in India for Extension Services

1. Kisan Suvidha

Kisan Suvidha mobile app has been developed to help farmers by providing relevant information on current weather and over the next 5 days, information on dealers, market prices, agro advisories, plant protection, IPM Practices *etc.*

2. Pusa Krishi

Pusa Krishi app helps farmers know about the various types of crops and information about those.

3. Shetkari Masik Android App

The app can be used to download Shetkari Masik magazine and can be read without internet connectivity. "Shetkari Masik" is one of the most popular monthly magazines in the Agriculture sector, published since 1965. It is published by Department of Agriculture, Maharashtra.

4. Farm-o-pedia App

The app is targeted for rural Gujarat and is useful for farmers and anyone involved in agriculture business. The app can be used to get information on suitable crops as per soil and season, crop wise information, check weather in your area and manage your cattle.

5. Crop Insurance Android App

Crop insurance mobile app can be downloaded and used to calculate the Insurance Premium for notified crops based on area, coverage amount and loan amount in case of loanee farmer. The app can also be used to get details of normal sum insured, extended sum insured, premium details and subsidy information of any notified crop in any notified area.

6. AgriMarket

Agri Market mobile app can be used to get the market price of crops in the markets within 50 km of the device's location capture by GPS. There is another option to get price of any market and any crop in case a person does not want to use GPS location (http://www.sarkariyojna.co.in/7-android-apps-farmers-launched-narendra-modi-government/).

7. Miscellaneous Mobile Apps

a. SmartAgri: Dr. Vijayaragavan Viswanathan, is a scientist with the European Organization for Nuclear Research. Growing up in southern India, Dr. Viswanathan saw how limited access to education and basic crop information kept many farmers locked in a cycle of low productivity and poverty. To combat this situation-and capitalize on the fact that India has almost a billion mobile subscribers-he developed SmartAgri, an app that communicates with underground sensors to deliver easy-to-understand data, such as soil moisture and mineral levels, to farmers' mobile devices. "In India today, more people have access to mobiles than to running water," says Viswanathan. "These new apps present an opportunity like no other to revolutionize life for farmers there."

b. Jayalaxmi Agro Tech created an app to equip illiterate farmers with crop-specific information using audiovisual tools.

c. Mandi Trades lists government crop price updates, important information for farmers in remote villages.

d. Rainbow Agri connects local buyers and sellers.

e. mPower Social offers simple veterinary advice for cattle owners (http://modernfarmer.com/2016/01/agriculture-apps-india/).

f. Life Tools was created by Nokia in 2009 and consists of basic information pertaining to agriculture, weather and farm machinery.

g. A similar app called M Krishi was created by Tata in 2009.

Integrating Mobile Phone-Based Learning and Credit for Women Livestock Producers

VIDIYAL, an Indian NGO, uses L3 (Life Long Learning) to promote community banking among 5,000 women organized into self-help groups (SHGs). During 2008, nearly 300 women from the SHGs became partners and decided to build their capacity through open and distance learning related to various aspects of sheep and goat production. As poor labourers, most of the women felt that attending classes or watching multimedia materials restricted their ability to work and attend to household chores. They asked VIDIYAL and COL (Commonwealth of Learning, Canada) to explore the use of mobile phone as a learning tool, because they would not need to be confined to any particular place or time during the learning process.

COL and VIDIYAL developed a business proposal in which each member would obtain credit for buying nine female goats, one buck, and one mobile phone. The local bank agreed to the proposal and sanctioned a loan of US$ 270,000. The credit and the legal ownership of the assets are in the names of the participating women. The 300 women bought simple mobile phones, and VIDIYAL entered into an agreement with IKSL (IFFCO Kisan Sanchar Limited), one of India's major mobile network operators, to send audio messages to the women's phones free of charge and enable free calls among group members. The company felt that this strategy would enhance its mobile service in the long run. VIDIYAL and some of the participating women were trained in developing audio content for mobile phone-based learning. Learning materials are prepared within the broad principles of open and distance learning to meet the learners' time and geographical constraints. VIDIYAL developed the materials in consultation with the Tamil Nadu Veterinary and Animal Sciences

University and contextualized them to the local culture and dialects (http://www.vidiyalngdo.in/ict.htm, http://www.vidiyalngdo.in/lifelong.htm).

Use of Mobile Phones for Extension Services in other Countries

Santos (2002) reported that, the National FMD Task Force of Philippines uses an information system in managing data regarding disease situation, vaccination, and animal movement, which give accurate information on the animal disease situation of an area in the quickest possible time.

In Italy, to control the blue tongue disease in cattle effectively, a surveillance system was established that included clinical, entomological and serological surveillance elements. The National Reference Centre for Veterinary Epidemiology developed a Web-based National Information System (NIS) and a Geographical Information System (GIS) to collect and manage data from Veterinary Services across Italy. Surveillance data are displayed to the user in different ways: reports, tables and interactive maps.

Garner and Beckett (2005) reported that Department of Agriculture, Fisheries and Forestry, Australia, developed a sophisticated spatial model (AusSpread) for foot-and-mouth disease control that operates within a geographic information system framework. The model allows for interactions between herds or flocks of different animal species and production type, and considers the role that such interactions are likely to play in the epidemiology of a regional outbreak of foot-and-mouth disease.

There are several initiatives in Africa that employ ICTs in offering extension services and training to small-scale farmers. Munyua (2008) cites several examples of such initiatives that have employed ICTs to restructure extension services in Africa which include; the Machobane Farming System (MFS) in Lesotho, the Agricultural Technology and Information Response Initiative (ATIRI), and the Linking Local Learners (LLL) initiative in Kenya, the Virtual Extension Research and Communication Network (VERCON) in Egypt, the National Agricultural Advisory Services Programme (NAADS) in Uganda, the Agricultural Research and Extension Network (ARENET) in Uganda and the District Agricultural Training and Information Centers (DATICS) in Uganda. The use of SMS is an example of solutions that should find more use as they offer easy accessibility. However, SMS carries only a limited amount of information and requires a basic level of literacy. Angello (2015) reported that different types of ICTs in Tanzania were used by urban livestock keepers to learn and disseminate livestock information though

some ICTs *e.g.* mobile phones were used more (92.1%) than other ICTs *e.g.* radio (21.7%) and television (24.6%). Internet was used by very few livestock keepers (2.4%) due to computer illiteracy.

Colombia's Ministry of Agriculture and Rural Development, in collaboration with partners, facilitates AGRONET, the National Agricultural Information and Communication Network of Colombia (www.agronet.gov.co). Through SMS, producers receive updates on AGRONET's platform, including changes in its databases and other news and events pertinent to agriculture. The Ministry plans to expand the service to reach more producers with context-specific information on agricultural markets, inputs and supplies, weather alerts, and other subjects. Over the medium term, AGRONET plans to provide content and information services to producers by adding capacity in digital television. In Uganda, ARENET (Agricultural Research Extension Network) is a web portal (www.arenet.or.ug/index) created to strengthen the links between the National Agricultural Research System and the National Agricultural Advisory Services program and its related extension service providers. The portal provides access to practical and technical agricultural information from national and international sources.

'iCow' is a trust worthy SMS based information and education platform. The service aims at helping small scale farmers increase their productivity by giving them access to pivotal information. iCow is very simple to use and is not reliant on smart phones. 'M-Farm', a real time group buying and selling market for farmers was launched in 2011 in Kenya along with iCow. 'Kilimo Salama' enables small holder farmers to insure their agricultural inputs against adverse weather conditions. 'Kuza Doctor' 'a farmer's mobile toolkit from farm to fork' provides knowledge to farmers using SMS. SALI (Sustainable Agricultural Livelihood Innovation) by Christian Aid provides farmers with weather updates. All the above listed apps are used in Kenya.

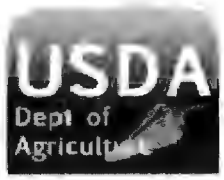
In Cameroon, 'Agro-Hub' uses mobile technology to drive demand for farmers' products, attract better prices, and increase farmer's income. In East Africa, 'SAGONeT' is involved with an application that helps the farmers to record the daily milk production from their cows. In Ghana, 'Esoko' service allows the farmers to access the market prices and allows them to place orders, buy or sell. 'CocoaLink' launched by Ghana Cocoa Board and World Cocoa Foundation, connects cocoa farmers with information about Good Farming Practices. The free service uses SMS and IVRS. In Senegal and Mali, 'E-TIC' portal and a series of training sessions

are destined for youth, women and community journalists that aims at sharing knowledge for better farm management. In Zambia, South Africa Tele centre Network (SATNET) aims to give rural training for effective use of communication and information services (www.oafrica.com/list-of-mobile-agriculture-services-and-applications/). National Livestock Market Information System (NLMIS) was developed to provide a timely price and volume information on livestock markets in Ethiopia, Kenya and Tanzania. The objective was to improve and expand the analytical, reporting, and geographical relevance of livestock price and volume information to wider stakeholders in Ethiopia. The NLMIS allows data entry into the system via short messaging service (SMS) by mobile phones. Coding system allows data collectors to send livestock price and volume information by SMS. The data is stored in a central server in headquarters. The stakeholders can request the price and volume information for specific markets using SMS. The data are also made available through the Internet via a market information portal (www.lmiset.net).

Use of Mobile Apps for Extension Services in USA

Table 1. Examples of some applications used by Farmers in United States of America

Sr. No.	Logo	Name	Use
1.		**Commodity Prices**	Track corn, soybeans, wheat, cotton, lean hogs, live cattle, feeder cattle and more. The app has a clean interface and is simple to operate.
2.		**Cash Grain Bids**	One can input their ZIP code to find out cash bids and base levels in their area and get bids from the five closest elevators.

3.		**Weather Undear-ground**	This weather app provides information regarding temperature, visibility and humidity. One can view hourly and seven-day forecasts, too.
4.		**USDA News Reader**	One can create own news feeds, learn about recovery plans and programs, and easily navigate the USDA website in a mobile-friendly environment.
5.		**Virtual Farm Manager**	This subscription-based service helps one to store, view and log information about their fields. This app was developed by farmers Jacob Fannik of Max, N.D., and Ryan Raguse of Wheaton, Minn.
6.		**SoilWeb**	USDA-National Resources Conservation Service soil survey information at the touch of a button. The app works with the phone's GPS receiver to identify soil properties anywhere in the lower 48 states where there is cell phone coverage.
7.		**Livestock Manager**	A number of mobile apps are targeted to livestock producers. This app allows users to track information about their animals, including parentage, transport information, medicine administration *etc.*
8.		**Agrian Mobile**	One can view product labels and material safety data sheets for more than 8,000 crop protection products. One can browse usage rates, pre-harvest and re-entry intervals, worker safety information and more.
9.		**Nutrient Removal**	This app provides growers and retailers with valuable nutrient removal data in support of higher yields. The app also allows users to test potential yields, generating results that are crop- and region-specific. *(iPhone, iPad, Droid)*

10.	JOHN DEERE	**JD Link**	This equipment management app from John Deere is a telematics system designed to remotely connect owners and managers to their equipment, providing alerts and machine information including location, utilization, performance and maintenance data to manage where and how equipment is being used. *(iPhone, iPad)*
11.		**iHerd**	From iApps. iHerd, provides the user with lifetime traceability of the herd such as treatment and location movements and is a more simplistic approach than other software which requires information to be recorded in the paddock and then entered manually into the computer.

(Adapted from 'Apps for Agriculture' by National Institute of Food and Agriculture, USDA; Texas A&M Agrilife Extension; Southern Risk Management Education Centre, USA)

Mobile Phones as Tools for Farmer Surveys and Feedback

Voice of Farmer (VoF) or Farmer's Voice is a pilot project testing a structured approach to obtain broad-based, low-cost, and frequent feedback from farmers in Kenya, Tanzania, and Uganda, using mobile phone technology. The pilot was conducted between January 2010 and March 2011 by Synovate Panafrica, with funding from the Bill and Melinda Gates Foundation. The approach was designed to help organizations collect a steady supply of empirical, actionable data more rapidly and cost-effectively. Feedback from target constituencies enables organizations to assess whether they need to change their activities and approach to better meet their constituents' needs. Findings are available to participating organizations through an online portal in the shortest possible time (www.eeas.europa.eu/Uganda/projects/list_of_projects/improving_food_security_en.htm).

Mobile Geospatial Applications for Extension

Mobile applications that incorporate geospatial technologies, including both GPS (Global Positioning System) and GIS (Geographic Information Systems), are undergoing rapid development and widespread adoption, and have the potential to help Extension professionals in a wide variety of tasks and educational settings.

These tools are now available to smart phone and GPS-enabled tablet users through a number of mobile geospatial applications ("apps"). In 2013, 56 per cent of adult Americans owned a smart phone (Smith, 2013), and 35 per cent of adult Americans owned a tablet computer. Extension professionals working in a variety of fields - from natural resources, to agriculture and education can enhance the

effectiveness of their programs by leveraging the use of these hand-held devices along with the use of geospatial applications.

Conclusion

The extension personnel have been disseminating technological messages to the farmers manually. This approach has not been able to reach a majority of the farmers who are spread across the whole country, due to scarcity of expert human resource, especially in terms of manpower. This gap remains a challenge for the extension system even today. To reach over 110 million farmers, across the country is an uphill task. The diversity of agro-ecological situations adds to this challenge further. The studies conclude that researchers and extension experts need to be familiarized about use of mobiles to disseminate information and improve productivity in the agriculture sector. In one of the studies by Mittal and Mehar, 2012, it is evident that 87.2 per cent farmers got better connected to markets, 71.7 per cent got better market prices, and 34.6 per cent witnessed increase in their yields after using mobile based information. This implies that one can increase the output and productivity of the farmers by the use of mobile telephony. Further, the scientists have to generate and transfer field relevant, profitable and sustainable tools and techniques with the involvement of farmers as partners of research and extension for effective generation and transfer of technological innovations. With the effective use of mobile phone technology, one can provide technology in every farmer's hand and pave his way to a bright and profitable future.

References

7 Android Apps for Farmers Launched by Narendra Modi Government. Retrieved August 14, 2016, from http://www.sarkariyojna.co.in/7-android-apps-farmers-launched-narendra-modi-government/\

About mKisan. Retrieved August 14, 2016, from http://mkisan.gov.in/aboutmkisan.aspx.

Abraham, R. (2007). Mobile phones and economic development: Evidence from the fishing industry in India. MIT Press; 4(1), 5–17.

Agricultural Research Extension Network. Retrieved August 10, 2016, from www.arenet.or.ug/index.

Agronet Inicio. Retrieved August 10, 2016, from www.agronet.gov.co.

Chauhan J. (2006). Communication and Extension Management. 1st edn. Anjali Prakashan, Kanpur (UP), India 9 (1): 1-3.

Cole, Shawn, and Asanga Nilesh Fernando (2016). " 'Mobile'izing Agricultural Advice: Technology Adoption, Diffusion and Sustainability." Harvard Business School Working Paper, Cambridge, April 2016. Retrieved January 31, 2017, from https://www.povertyactionlab.org/evaluation/mobile-phone-based-agricultural-extension-india.

Consolata Angello (2015). Exploring the use of ICTs in learning and disseminating livestock husbandry knowledge to urban and peri-urban communities in Tanzania. International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2015, Vol. 11, Issue 2, pp. 5-22.

EEAS - European External Action Service. Retrieved August 9, 2016, from www.eeas.europa.eu/Uganda/projects/list_of_projects/improving_food_security_en.htm.

Didem Tali, January 7, 2016. In India, Mobile Apps are Transforming Agriculture. Retrieved January 31, 2017 from http://modernfarmer.com/2016/01/agriculture-apps-india/.

Garner, M.G., Beckett, S.D. (2005). Modeling the spread of foot and mouth disease in Australia. Australian Veterinary Journal 83(12), 758–66.

Gensis, A.V. (2010). Potential of Mobile Phones in Utilization of Livestock Related Information – An Exploratory Study in Erode District of Tamil Nadu. M.V.Sc. Thesis, IVRI, Izatnagar, Bareilly, India.

Gupta, A.(2009). A noble prescription. Business India, Dec 13, pp.114-116.

Hayrol Azril, M.S., Md. Salleh, H. and Inon, B. (2009). "Level of Mass Media Usage (Television, Radio and Newspaper) among Malaysian Agro-Based Entreprenuers", Journal of Communication Knowledge Communique 1, pp. 28-38.

ICT based Life Long Learning (L3) Farmers and Knowledge Infomediary. Retrieved August 14, 2016, from http://www.vidiyalngdo.in/ict.htm.

Inigo G, Chander M, Thakur D and Bardhan D. (2014). Potential of mobile telephony in utilization of dairy related information: Empirical evidence from Tamil Nadu. Indian Journal of Dairy Science 67: 91–96.

Jensen, R.(2007). The digital provide: Information (technology), market performance, and welfare in the South Indian fisheries Sector. The Quarterly Journal of Economics, 122(3), 879-924.

Life Long Learning (L3) and Social Capital. Retrieved August 14, 2016, from http://www.vidiyalngdo.in/lifelong.htm.

Livestock Information Network Knowledge System (LINKS). Retrieved August 9, 2016, from www.lmiset.net.

Mittal, S., Tripathi, G. (2009). Role of mobile phone technology in improving small farm productivity. Agricultural Economics Research Review, 22, 451- 459.

Mittal, S., Gandhi, S., Tripathi, G. (2010). Socio-economic impact of mobile phones on Indian agriculture. Available at: http://www.comminit.com/en/node/.

Mittal S., Mehar M. (2012). How Mobile Phones Contribute to Growth of Small Farmers? Evidence from India. Quarterly Journal of International Agriculture 51 (2012), No. 3: 227-244.

Morton, J., Matthewman, R. (1996). Improving livestock production through extension: information needs, institutions and opportunities. Natural Resource Perspectives 12, Overseas Development Institute, London, UK.

Munyua, Hilda., Adera, Edith., and Jensen, Mike.(2008). Emerging ICTs and their potential in revitalizing small scale agriculture in Africa. Retrieved August 9, 2016, from http://www.cabi.org/gara/FullTextPDF/2008/20083298152.pdf.

NSSO (2005). Access to Modern Technology for Farming, Report No. 499(59/33/2), National Sample Survey Organization, Ministry of Statistics and Program Implementation, Government of India.

oAfrica, Dyanamic African Digital Landscape. Retrieved August 10, 2016, from www.oafrica.com/list-of-mobile-agriculture-services-and-applications.

Rathod, Prakashkumar, Mahesh Chander and Yogesh Bangar (2016). Use of mobiles in dairying for information dissemination: A multi-stakeholder analysis in India. Indian Journal of Animal Sciences 86 (3): 348–354, March 2016/Article.

Rathod P and Chander M. (2014). Identification of socioeconomically important dairy innovations in India: A perspective of scientists. E. Karamidehkordi (eds), Proceedings of the First International Conference of the Asia and Pacific Islands Rural Advisory Services (APIRAS) and the Fifth Congress of Extension and Education in Agriculture and Natural Resources Management: Facilitating Information and Innovations for Empowering Family Farmers. 2–4 September, 2014, University of Zanjan, Iran. pp–101.

Santos, I.J. (2002). FMD information management system as a disease surveillance tool in FMD control and eradication program in the Philippines. Special Research Journal Edition 6 (10), 108–115.

Sasidhar, P.V.K., Sharma, V.P. (2006). Cyber livestock outreach services in India: a model framework. Livestock Research for Rural Development. Volume 18, Article #2. Retrieved February 15, 2011, from http://www.lrrd.org/lrrd18/1/sasi18002.htm.

Smith, Aaron. (2013). Smartphone ownership (2013). Pew Internet & American Life Project. Retrieved August 9, 2016, from http://pewinternet.org/Reports/2013/Smartphone-Ownership-2013/Findings.aspx.

Stephen Rudgard (FAO), Peter Ballantyne (ILRI), Riccardo Del Castello (FAO), Philip Edge (consultant), May Hani (FAO), Ajit Maru (GFAR), Estibalitz Morras (FAO), Karin Nichterlein (FAO), Enrica Porcari (CGIAR), Sophie Treinen (FAO), Topic note 6.3: Venkatraman Balaji (Commonwealth of Learning) and K. Balasubramanian (Commonwealth of Learning). ICTs as Enablers of Agricultural Innovation Systems.

Tiwari, R., Phand, S., Sharma, M.C. (2010). Status and scope of information and communication technology for livestock and poultry production in India– A review. Indian Journal of Animal Sciences 80 (12), 1235–1242.

Waverman, L., Meloria, M., Fuss, M. (2005). The impact of telecoms on economic growth in developing nations. In Africa: The impact of mobile phones. The Vodafone Policy Paper Series, 3, 10-23.