INNOVATIONS IN DIGITAL EXTENSION

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FOREWORD

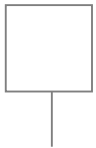
The advent of digital extension marks a transformative era in agricultural outreach, where modern communication technologies seamlessly integrate with traditional extension practices to address the evolving needs of stakeholders in the agriculture, veterinary and allied sectors. By leveraging digital tools, we are now able to reach remote regions, provide real-time updates on critical issues such as weather changes, disease outbreaks, and market fluctuations, all while significantly reducing costs and inefficiencies inherent in conventional methods. This shift towards digitalization is not just about efficiency, but about enhancing engagement, fostering learning, and empowering stakeholders to make data-driven decisions that optimize productivity. The integration of mobile applications, SMS, voice services, social media platforms, web portals, IoT devices, geospatial technologies, AI, blockchain, drones, and satellite imagery has revolutionized the way agricultural information is delivered. Each tool plays a unique role: mobile apps and SMS provide essential information even to those without smartphones; social media promotes collaborative learning; IoT and sensors collect critical data; geospatial technologies and AI offer advanced analytics; and drones and satellite imagery enable precise monitoring and planning. Together, these technologies make information not only accessible but actionable, fundamentally changing how we approach extension services.

The digital revolution in agricultural extension signifies a crucial leap towards modernizing the sector, ensuring that farmers and other stakeholders have the knowledge and tools they need to enhance productivity, sustainability, and profitability. This transformation is essential not just for agriculture's growth but for its long-term resilience in a rapidly changing world.

In this context, I wholeheartedly commend the collaborative efforts of ICAR–Indian Veterinary Research Institute and National Institute of Agricultural Extension Management (MANAGE), Hyderabad, for their visionary initiative in developing a book on "Innovations in Digital Extension." The book will act as a significant resource towards equipping scholars and professionals with the necessary skills to develop and deploy ICT tools that can effectively reach underserved communities. The focus on capacity building in such a vital area is both timely and forward-thinking.

I am confident that the readers of the book will greatly benefit from the insights shared by the distinguished authors. This book will undoubtedly serve as an invaluable resource, inspiring readers to harness the potential of digital technologies to bridge the gap between agricultural organizations and those they aim to serve. As we look to the future, I believe this collaboration of agriculture and technology will play a pivotal role in driving the growth and development of our agricultural and livestock sectors.

(Triveni Dutt)
Director cum Vice Chancellor
ICAR-IVRI, Izatnagar



PREFACE

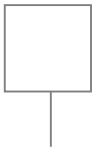
In an era defined by rapid technological advancement and an increasing reliance on digital platforms, the field of extension services is undergoing a transformative shift. "Innovations in Digital Extension" explores how digital tools and methodologies are reshaping the landscape of agricultural extension, community engagement, and knowledge dissemination.

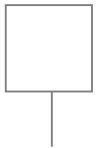
As we navigate the complexities of global challenges from food security to sustainable development the role of extension services becomes ever more critical. This book highlights the innovative practices and technologies that are not only enhancing traditional extension methods but also expanding access to information and resources for farmers and communities worldwide. Throughout the book, we will delve into case studies, theoretical frameworks, and practical applications that illustrate the power of digital solutions in fostering collaboration, improving decision-making, and promoting sustainable practices. We aim to inspire extension professionals, researchers, policymakers, and practitioners to embrace these innovations and harness their potential for positive impact. With a blend of theoretical insights and practical examples, the book aims to provide a clear and accessible understanding of how Information and Communication Technologies (ICTs) are shaping the future of extension services.

By equipping professionals with digital expertise, this book envisions a future where sustainable agricultural growth is driven by continuous innovation in the digital realm. It not only serves as a guide to existing platforms but also lays the groundwork for future strategies that will further enhance digital extension services. The book encapsulates the knowledge and insights on various digital initiatives through out the country, offering readers a comprehensive understanding of current digital extension tools and a glimpse into future advancements in the field.

The editors, extend their deepest gratitude to the experts who contributed chapters to this volume, offering their invaluable perspectives on digital extension. We hope that this book will serve as a valuable resource for the academic community, particularly for students, educators, and researchers keen on exploring the world of digital extension.

—Editors





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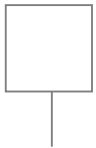

Introduction to Digital Extension Services

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ABSTRACT

India's agriculture sector, contributing 18.2% to GDP in 2023-24, remains vital despite its declining economic share. To boost productivity, digital extension or cyber extension using ICT tools like mobile phones, the internet, and AI is essential. These technologies bridge the gap between research and farmers, providing real-time information, supporting market access, and improving disaster management. They address challenges faced by traditional agricultural extension methods and are crucial for marginalized farmers, offering cost-effective, wide-reaching solutions. Radio and television have historically played key roles in agricultural extension in India, beginning with the Indian Broadcasting Service in 1930 and All India Radio in 1936. Programs like the Farm and Home Unit (1966) and Kisan Vani (2004) aimed to educate farmers. ICT-based digital extension services, such as Kisan Call Centres, AGMARKNET, and community kiosks, have expanded to offer more comprehensive agricultural support. Initiatives from both public and private sectors, along with NGOs, like e-Chaupal and Digital Green, provide vital resources, improving market access, weather forecasting, and best farming practices. Globally, similar e-extension initiatives have empowered farmers, improved productivity, and increased incomes, enhancing collaboration and decision-making.

Keywords*: Digital extension services, Public sector initiatives, Private sector initiatives, NGO initiatives*

Introduction

India is generally referred as country with an "Agriculture Economy, i.e., *Krishi Pradhan Desh*" and an essential part of Indian agriculture, animal husbandry has been instrumental in the lives of the people since ancient times by supporting the source of income for about two-thirds of those living in rural areas. As per Economic Survey 2023-24, India's agriculture sector contributed 18.2% to the country's GDP in 2023-2024 at 4.18 percent yearly growth on average. The agriculture industry not only boosts the Indian economy but also the industrial sector and global import and export commerce. Even though the agricultural sector employs the largest number of people nationwide, its share of the Indian economy is declining. So, it is the need of the hour to include improved synchronization between research, marketing networks, and farmers which leads to efficient functioning and better productivity. Extension is very crucial for effective linkages between farmers and research. Traditional extension methods are not sufficient to fill the information gap, hence we need to go beyond the conventional approach of extension by using various modern tools like ICTs. When these ICT tools are used in the field of agriculture and the allied sector it is better known as digital extension or e-extension or cyber extension

Concept and definition of digital extension

Extension means to spread out. The term digital extension describes to the stretching out of knowledge beyond the boundaries of the institution with the help of ICT tools. ICTs include devices, networks, services, and applications. These may include modern Internet technologies and sensing tools, as well as older technologies like radio, telephones, mobile phones, television, and satellites. The utilization of radio, television, computers, the internet, mobile phones, etc. to facilitate the dissemination of agricultural information and technology is known as cyber extension. ICT is revolutionized the globe in various ways and thereby reducing the information gap by providing real time information to the people and extend the reach to the last mile. Regulatory frameworks, agriculture innovations systems, capacity development and empowerment, financial services and insurance, food safety and traceability, sustainable farming, disaster management and early warning systems, enhanced market access, etc are some of the roles ICTs play in agriculture. In a world that is evolving quickly, the roles of ICT in agriculture are changing at the same pace from telephone to interactive voice response systems, from broadcasting to expertise sharing, and from computers and websites to AI-enabled analytics.

In the context of agriculture, e-extension means the dissemination of knowledge with the help of computer communication, digital interactive multi-media provides a more efficient alternative to the traditional extension system. ***Wijekoon*** (2003) defines A system for exchanging agricultural data over cyberspace—the virtual area created by interconnected computer networks via communication—is known as cyber extension. It makes use of the power of networks, computer communications, and interactive multimedia to facilitate information-sharing mechanism

The primary constraint is the absence of enough workforce. There are not enough service-providing specialists in public sector organizations to establish connections with the sizable farming community. They are overburdened with additional duties, primarily financial difficulties.

Need of digital extension

Digital extension is needed to accelerate agriculture growth, provide a productive feedback system, expand knowledge resources and better information access, cost-effective and timely delivery of services, and augment insufficient technical personnel (the ratio of extension worker: farmer is as wide as 1: 1162 in India (Reddy, 2018), bolster marginal and small-scale farmers, stronger research-extension-client system linkage, support farm stakeholders in ways other than technology transfer. Digital extension has characteristics that make it unique among other extension approaches. As it is demand-driven & client-focused, equal and inclusive, pluralistic, flexible and adaptive, continuously available, lower costs and wider reach participatory, interactive, overcomes Geographical barriers, saves money, time, and effort, etc.

Tools and techniques

Several tools like radio, TV, computers, mobile phones, kiosks, and GIS are used for delivering extension services. Besides this e-extension comprises components that are used in transferring information SMS, File Transfer Protocol (FTP), News & Discussion Groups, Websites or Portals, Call Centres, Videoconferencing, Blockchain technology, Expert systems, Interactive Voice response systems, Mobile apps, Bots, AR/VR module, AI-based etc.

The **Clients of Digital Extension Services** include farmers, livestock keepers, agricultural fishers–producers, and adult women & men of all ages and abilities. The value chain and market participants linked to producers represent a second significant client category for e-extension services.

Classification of Digital Extension

Based on ownership: Public cyber extension, Private cyber extension/ Corporate social responsibility, Cyber extension by NGO

Based on the mode of action: mobile-based, Kiosks-based model, Web portal-based model, etc.

The main purpose of ICT in agriculture is to meet farmers' information needs. Farmers need information on various aspects, such as best practices, advisory and consultancy, the latest techniques and technologies, rural development programs and subsidies, early warning and management of diseases and pests, weather forecasting, insurance/claim processing, market information, etc., for efficient farm management.

Radio Journey in India

Radio history officially began when Italian scientist Guglielmo Marconi created the first workable wireless radio communication device in the 1890s. The advent of radio in India was marked by the launch of the Calcutta Radio Club in 1923. On July 23, 1927, the Indian Broadcasting Company (IBC) was established, but it was forced to liquidate within three years. The Indian Broadcasting Service began operations on an experimental basis in April 1930. The next month saw the launch of a private radio station in Mysore called Akashvani. The first rural broadcast was attempted in 1935 in Allahabad as a govt organization to inform, educate, and entertain the masses. On June 8, 1936, the Indian State Broadcasting Service became All India Radio. Six radio stations were operational in India at independence: Delhi, Bombay, Calcutta, Madras, Tiruchirappalli, and Lucknow. In 1956, the National Broadcaster was renamed AKASHVANI. When the Vividh Bharati Service was first introduced in 1957, its primary feature was music from popular films.

Rural Radio forum (1956) Jointly by the Ministry of Information & Broadcasting and the UNESCO Programme for rural audiences in 150 villages of five districts of Maharashtra- Pune, Ahmednagar, Nasik, North Satara, Kolhapur. Broadcasted bi-weekly and held post-broadcast discussions to be answered by the expert. **Farm and Home Unit AIR (1966)** farm broadcasting at seven AIR stations with aim to utilize the services of AIR for the launch of the Intensive Agricultural District Programme (IADP). Avg. duration of broadcast: 60 to 100 minutes/day. **Farm School on AIR (1973)** It was among the most cutting-edge gadgets, with extensive training modules covering certain agriculture and related topics. All of the specialty courses were filled with registered listeners. To ascertain the degree of knowledge transfer, the participating farmers were required to take an exam following the listening session. Under the farm school on air ***Radio Krishi Shiksha*** programme was launched at two stations namely Trichur & Vijayawada to diffuse agriculture innovation sequentially. ***Kisan Vani*** **(2004)** In partnership with the Ministry of

Agriculture, AIR has increased its agricultural broadcasting efforts with the introduction of the exclusive project Mass Media Support to Agriculture Extension, known as Kisan Vani, on February 15, 2004, over 23 FM radio stations. This initiative was launched in partnership with the Ministry of Agriculture (AIR). The goal is to provide local farmers with up-to-date information on daily market rates, weather forecasts, and other micro-level details specific to their fields. Currently, 96 Rural Area FM stations around the nation are broadcasting the Kisan Vani program.

On September 15, 1959, in Delhi, India, television was first broadcast, just over 20 years after the British Broadcasting Corporation (BBC) launched the world's first television station in 1936. It all began with the assistance of UNESCO and the Ford Foundation. A School Educational Television (STV) initiative was added to these broadcasts in 1961. Krishi Darshan debuted on Doordarshan in 1967 which is India TV's longest-running programme Beginning in the middle of the 1970s, television in India saw a tremendous rise due to three key factors. The Satellite Instructional Television Experiment (SITE) in 1975 was the first, arrival of INSAT-1A (communication satellites) second and the third major catalyst was the introduction of satellite TV by international programmers in the early 1990s. Television service was separated from radio in the year 1976. Doordarshan became a national broadcaster and Live broadcasting with color TV started in the year 1982. India's first channel dedicated to farmers launched on 26th May 2015.

According to Jones (1997), agricultural extension is an essential mechanism for the delivery of knowledge and advice as an input for modern farming. In India, several government agencies, state agricultural universities, non-governmental organizations, businesses, and numerous others have launched ICT-based e-extension projects. The goals, target audiences, types of these projects, information quality, and methods of execution differ.

Fig. 1.1 Public sector digital initiatives

Digital extension services of the **public sector** include three types of services based on the mode of action for service delivery namely first one is **mobile advisory services** such as **Warana Wired Village Project-1998** by PMO's IT Task Force started in Kolhapur and Sangli districts of Maharashtra to provide information on market prices, employment schemes, and communication facilities, **M4agrinei** launched by Digital India Corporation in collaboration with CAU, Imphal in the region Khasi & Garo of north-eastern states for Agro-advisory services, Ministry of Agriculture started **Kisan Call Centre (2004)** to address the queries of the farmers through helpline number. **e-Sagu (2004)** developed by IIIT Hyderabad, and funded by Media Lab Asia started in the Warangal district in Andhra Pradesh to provide Agro-advisory services via SMS. BSNL started its SMS services on market prices via **Mandi on mobile service in 2009** and **Digital Mandi** in 2011 with IIT Kanpur. **KVK** at various places like Babhaleshwar (Maharashtra), Pathanamthitta district Of Kerala, and Pravara (Maharashtra) started SMS service to give insights on Weather forecasts, disease forecasts and market information, alerts of important training. **KVK Baramati** besides weather forecasts, current market rates for agricultural commodities and futures trading rates, Agro advisory, and farmers trips, runs a community radio station Sharada Krishi Vahini, and developed a

KRUSHIK Mobile App. **Rubber Board, (India)** in the year 2010 started a subscription-based SMS service in Kottayam (Kerala) to get the rubber market price update.

Initiatives based on web portals include Agricultural Marketing Information Network (**AGMARKNET**)- launched in the year 2000 by the collaboration of DMI, NIC, and APMC all over India to have market information, **AGRISNET** (Agricultural Resources Information System and Networking)- 2002, joint venture between the central and state govt. for providing services like market prices, soil information, crop diseases and management, etc., **Agropedia**- 2009, a portal of GOI & sponsored by the World Bank through the NAIP across India under the guidance of T. V. Prabhakar of IIT Kanpur which has knowledge modules, interaction platform through forums and blogs. The **Rice Knowledge Management Portal** (2011) initiative of ICAR- IRR is a one-stop shop for rice knowledge.

Kiosk-based public sector initiatives include **GYANDOOT** (2000) a project of GOI started in Dhar (MP) for e-governance and e-commerce services, **Community Information Centres** (CICs) in the year 2002 by the GOI who set up 487 CICs in the eight NE states for browsing, e-mail, and training in computer fundamentals, to increase access to the market, provide e-consulting and weather-related information to the farmers. **Village Resource Centre** (2004) was set up by the ISRO, on a pilot scale, in association with various NGOs, Trust, and Government Agencies in various states. The major benefits of the VRC program include advisories related to agriculture, market prices, govt schemes, weather forecasts, Tele healthcare, tele-education, etc. **ASHA: 2005** (Accredited Social Health Activist) implemented by NIC in partnership with Oracle Assam for agri-business services through CIC. **Common Service Centres (CSCs)** Scheme are the locations where the delivery of Government-to-Citizen (G2C) e-services like e-governance, financial, educational, healthcare, etc. within the reach of the citizens launched in the year 2006 by the GOI. **e-Arik** (2007 to 2009) project was implemented by CAU, funded by DSIR (GOI) and started in Yagrung village of East Siang District of Arunachal Pradesh for providing information about government schemes, market information, and weather forecasts.

Besides the efforts of the government in making farmers' income double through the use of various ICT initiatives, various private agencies also took part in the development of farmers through CSR. These CSR initiatives include (a) mobile advisory services like **Soochna Se Samadhan Sewa** (2006) initiatives of Lifeline India in the Bundelkhand region of Uttar Pradesh. It provides an IVR System to access the services by dialing – 022-39116000. **IFFCO *Kisan Sanchar Limited (IKSL)***- started in 2007 by IFFCO, in collaboration with Telecom Giant Bharti Airtel and Star Mobitel to provide services like weather forecasts, real-time mandi prices, farming tips to help farmers in making their farming decisions resulting in crop yield. ***Fisher Friend Mobile App***- 2007 implemented jointly by QUALCOMM, MSSRF, Tata Tele services, and Asute system technology in Tamil Nadu for safety and weather information, locations of fishing areas, real-time market prices, etc. ***Reuters Market Light (RML)*** was launched in the year 2007 by RML AgTech in Maharashtra for services like market price, and weather forecast. ***m-Krishi*** is the platform launched in 2009 by Tata Consultancy Services in Tamil Nadu, Gujarat, Maharashtra to deliver a range of personalized services such as weather updates, market information, supply chain management to farmers on their mobile phones through SMS, calls and IVR.

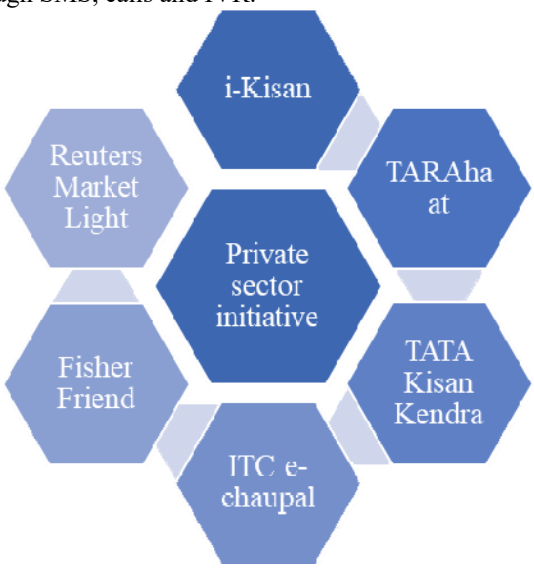

Fig. 1.2 Private sector digital initiatives

i-Kisan (1999) is an agricultural portal that acts as a one-stop information resource for the farmer is an initiative of Nagarjuna Fertilizers and Chemicals Ltd started in Hyderabad (Andhra Pradesh) and Tamil Nadu markets prices, weather, Agri news, diagnostics & solutions, facilitation of trading. ***TARAhaat*** is a website used for placing order that was launched in 2000 by the Development Alternatives Group in Bundelkh and (MP and UP), Bathinda (Punjab), and Haryana for e-comm services. Various franchisee outlets called Tara Kendras were set to access the portal via TARAdhabas (Kiosks that provide rural people a means to access the services of TARAHaat.com). ***India Agriline Portal*** was launched in 2001 by EID Parry enterprise & Connectivity is provided by n-Logue. It acts as one-stop shop for the interchange of goods and information for the people of Nellikuppam, Tamil Nadu.

TATA Kisan Kendra was started in the year 1988 by Tata Chemicals Ltd in Punjab, Haryana, UP, Bihar & WB to provide advisory services, access to technology, established crop clinics, SMS service, etc. These TKKs were renamed in 2002 as Tata Kisan Sansar which acts as a stop shop for fulfilling the Indian farmer's requirements. ***e-Chaupal*** was launched in June 2000 by ITC in Khasrod Madhya Pradesh for holistic- customized knowledge, market & agriculture information with the help of Sanchalak (coordinator) and Sanyojak (collaborator). ***Sahaj e-Village Limited*** (2006) is an initiative of SREI Infrastructure Finance Ltd. Launched in WB, Asam, Orissa, Bihar to provide services through ICT-enabled Sahaj Kendra's.

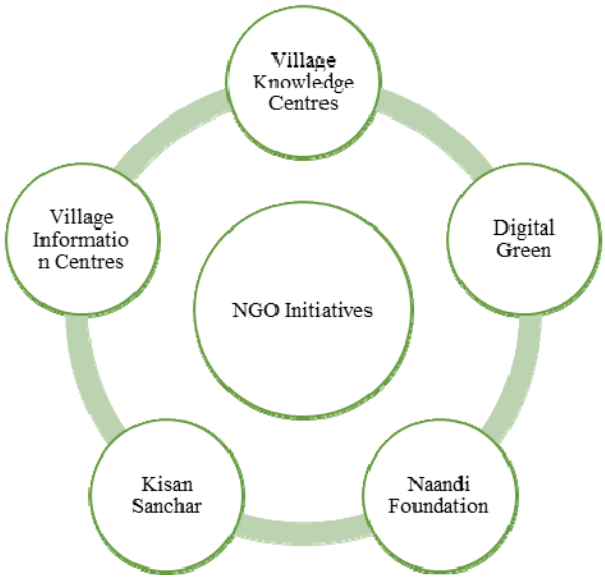

Fig 1.3 NGO sector digital initiatives

NGO's Initiatives:

Village Knowledge Centres (VKCs): established in 1998 by the M. S. Swaminathan Research Foundation (MSSRF), are located in Villianur, a village in Pondicherry. These centers serve as hubs of information and communication technology for rural communities, providing essential services like audio and video conferencing, phone-in programs, Skype calls, and the exchange of voice and audio messages. By leveraging these tools, the VKCs aim to bridge the digital divide and empower villagers with timely information, enhancing their access to education, healthcare, and agricultural practices, thereby contributing to sustainable development in rural areas. The ***Naandi Foundation*** established in the 2000s, has played a pivotal role in the Araku region of Andhra Pradesh by promoting the marketing of Araku coffee. Owned by the Naandi Foundation, this initiative focuses on empowering local tribal farmers by providing them with the means to cultivate, process, and market high-quality organic coffee. Through this effort, the foundation has not only improved the livelihoods of the farmers but also brought global recognition to Araku coffee. ***Kisan Sanchar:*** launched in 2010 by Srishti Gyan Kendra, is an innovative initiative based in Rohtak, Haryana, and later expanded to Gujarat in 2011. It aims to empower farmers by providing them with timely and relevant agricultural information. The service offers daily prices of Basmati rice to farmers, ensuring they stay informed about market trends. Additionally, it provides field advisory services for registered subscribers, offering expert guidance on best practices in farming. By leveraging mobile communication, Kisan Sanchar plays a crucial role in enhancing the economic well-being of farmers and promoting sustainable agriculture in the region. ***Village Information Centers:*** started in 2001 by the DHAN Foundation, are strategically located in Madurai District and coastal districts of

Tamil Nadu. These centers are dedicated to bridging the information gap in rural areas by offering teleconferencing facilities, educational support, and basic computer training. In addition to enhancing digital literacy, they provide vital communication services and disseminate information on government schemes. By empowering villagers with access to technology and knowledge, these centers play a key role in improving livelihoods and fostering sustainable development in rural Tamil Nadu. ***Digital Green:*** initiated in 2007 by Microsoft Research, operates in regions including Jharkhand, Madhya Pradesh, Orissa, Bihar, Andhra Pradesh, and Karnataka. The program focuses on using participatory video as a tool for agricultural extension, enabling farmers to learn from the experiences and practices of their peers. By creating and sharing videos that showcase effective farming techniques, Digital Green empowers local communities to adopt innovative agricultural practices. This approach not only enhances productivity but also fosters a sense of ownership and collaboration among farmers, contributing to sustainable agricultural development in these regions.

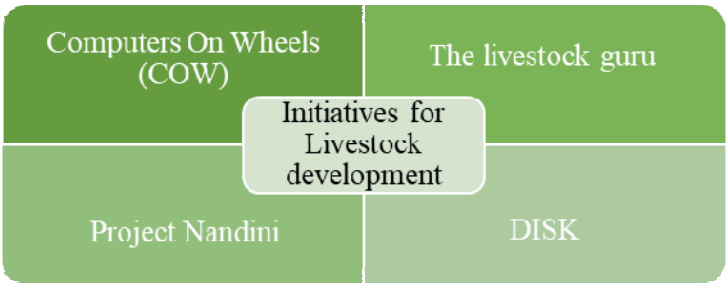

Fig 1.4 ICT Initiatives for Livestock Development

ICT Initiatives for Livestock Development

The Computers on Wheels (COW): initiative was started in Mahboobnagar, Andhra Pradesh, in 2003 by the non-governmental organization ViDAL. This creative approach uses motorbikes with laptops to convey digital literacy directly to rural areas through visiting villages. COW bridges the digital divide and improves educational and economic prospects in distant locations by providing villages with basic computer skills and information through hands-on training and technological access. ***The Livestock Guru:*** established in 2005 by the Livestock Development Group of the University of Reading (UK), operates in the Cuttack, Khurda, Puri, and Ganjam districts of Orissa. This multimedia learning program is designed specifically for poor livestock keepers, providing them with essential knowledge on animal husbandry practices. By leveraging audio-visual content, the program empowers farmers with the skills needed to improve livestock health and productivity, ultimately enhancing their livelihoods and economic stability. ***Project Nandini:*** launched in 2009 by Orissa e-Governance Services Limited (OeSL) in collaboration with UNDP and the University of Reading (UK), operates in the districts of Jagatsinghpur, Cuttack, and Mayurbhanj in Orissa. The project is designed to systematically monitor the reproductive life cycle of crossbred cows, using advanced data management and e-governance tools. By tracking key health indicators and reproductive events, Project Nandini aims to enhance the productivity and health of these cows, benefiting farmers through improved milk yields and livestock management. This initiative plays a crucial role in advancing the dairy industry and supporting rural livelihoods in the region. ***Akashganga***: initiated in 1996 by Kamdhenu in Gujarat, revolutionizes the dairy industry by automating all milk procurement operations at village milk collection centers. This system streamlines the collection, weighing, testing, and payment processes, ensuring accuracy and transparency for both farmers and cooperatives. By integrating technology into traditional practices, Akashganga enhances efficiency and trust in the milk procurement process, significantly benefiting dairy farmers and contributing to the growth of the dairy sector in Gujarat.

Digital extension scenario in the world

The origin of digital extension traces back to Sweden with the establishment of telecentres in 1975. The use of ICTs promoted all over the world because it offers significant potential for improving agricultural extension services, reaching a wider audience, and providing real-time information and feedback. Examples of an digital extension initiative are **AgriSafe** was formed in 2003 by rural nurses who believed that together they could improve the health and safety of farmers and ranchers in the USA. **Farm Answers** is the Largest Source of Information for Beginning Farmers by USDA-NIFA**. e-Soko (2007)** Online agricultural marketing and messaging service, based in Accra, Ghana. **e-Rwanda** (2006-2010) was

an e-governance project, and **e-Afghan Ag (2011-2014)** was an Online extension initiative of UC Davis (University) in Afghanistan. **Growth Enhancement Support** (GES) scheme in July 2012 by the govt of Nigeria to deliver government-subsidized farm inputs directly to farmers via GSM phones. **Agtube** (2019) is a website (video-sharing platform) that is a project of the worldwide non-governmental organization Access Agriculture that enables people and local communities to share their experiences and inventive local solutions to motivate others. This website promotes farmers and pastoralists to use training videos.

Impact of digital extension services

It has boosted yields, crop quality, improved access to information, increased collaboration and networking, and market opportunities which has improved agricultural and allied sector production and livelihoods. As a result, the agriculture sector is now more productive and makes better decisions (Tata and McNamara, 2018), resulting in higher farming profitability and productivity (Gouroubera *et al.*, 2023) enhanced market accessibility, and higher farmer incomes (Daum *et al.*, 2022), decreased post-harvest losses and enhanced food output (Blum *et al.*, 2020). Digital extension services in India were found to have a favorable effect on farmers' knowledge, attitudes, and crop management methods by Mallik *et al.* (2021).

Conclusion

Radio and television have played, and continue to play, a significant role in agricultural extension and connecting farmers with essential services. There has been a major shift in modernizing extension and advisory services from radio to artificial intelligence. As per Mark Bell and Judith Payne (2011) ICT in extension helps in the identification of farmers' problems and opportunities which further promotes behaviour change. These tools provide the opportunity to collect feedback and facilitate two-way communication. Due to the deployment of technology, the cyber extension gives the target population a very practical way to swiftly access enormous volumes of information without the geographical restrictions associated with more conventional ways of information sharing. One of the most important prerequisites for the farming systems' sustainable development is having access to these new information sources. Technology has the potential to boost agricultural output in India. Cyber extension's storing capacities make it significant. It is possible to store and retrieve vast volumes of data on several different topics within a fraction of a second. Any information is available around the year and at any given time which is not possible in traditional centres.

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Communicating messages: Importance and strategies

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ABSTRACT

The communicating message is the information may be facts, feelings, opinion, attitude etc. which communicator wishes his/her audience to receive, understand, accept and act upon. For effective communication, message must be clear, pertinent, accurate, attractive and timely. Further attractive and comprehensive message must include attention statement indicating the importance of information for end users followed by introduction, body and conclusion. At the end, residual message is most important as it helps the user to rethink the information. The residual message is one which decides the usage of any new technology. The treatment of message by communicator is important as it is the first step by communicator to treat the message well and then only audience will sustain the interest. Communicator must take care of message distortion as it may lead to disaster. Communicator must take care of communication skills, language barriers and cultural differences if any. Excellent message carries life-long impression.

Key words: *Message, characteristic, types and dimensions, models, message distortion, effective communication*

Introduction

The basic recipe on which communicating messages forms the foundation is: Start with a base of clarity, add a pinch of simplicity, a dash of transparency, a good shake of "what it means to me" and top it all off with a voice that makes people want to dive right in.

Communication as the process by which two or more people exchange ideas, facts, feelings or impressions in ways of common understanding of the meaning, intent and use of messages (Leagans 1961). Communication is the process by which messages are transferred from a source to a receiver' this definition given by Rogers and Shoemaker (1971). Communication as the process of sending and receiving messages through channels which establishes common meanings between a source and a receiver Van den Ban & Hawkins (1988).

In communicating message, a message is facts, feelings, impressions, attitude, information etc. that a communicator wishes to receive, understand, accept and act upon (Berlo 1961). In another word, a message is the information, a communicator wishes his audience to receive, understand, accept and act upon.

Dimensions of Message

Broadly there are three dimension of message which includes**:**

1. **Message code:** It includes group of symbols that can be structured in a meaningful way. Language is code. Painting is code. Thus, Code consists of elements and structure.
2. **Message content:** The material which is selected for conveying the information to the audience. It is very crucial as based on need and importance of message the audience will stay tuned. While selecting the content, the source must know the denotation and connotation. Denotation is the basic meaning of a word, just like you'd find in a dictionary. Connotation refers to the emotional or cultural resonance of a word. For instance, while the word "home" might denote "a place where one lives," its connotation might include feelings of warmth, security, and love. Another example, the word "rose" means a kind of flower but its connotation indicates love.
3. **Message treatment:** The decision source makes in arranging both code and content in order to have comprehension on receivers' end. In other way, how the communicator has arranged the message for the audience and how the audience reacted upon the information conveyed.

Types of messages

According to Hasling, 1998 there are three distinct types of messages in communication which includes primary, secondary, and auxiliary.

1. **Primary messages** refer to the intentional content including verbal and nonverbal. These are the words or ways you choose to express yourself and communicate your message. For example, if you are sitting at your desk and a coworker stops by to ask you a question, you may say, "Here, have a

seat." These words are your primary message. Even such a short, seemingly simple and direct message could be misunderstood. It may seem obvious that you are not literally offering to "give" a "seat" to your visitor, but to someone who knows only formal English and is unfamiliar with colloquial expressions, it may be puzzling. "Have a seat" may be much more difficult to understand than "please sit down."

2. **Secondary messages** refer to the unintentional content, both verbal and nonverbal. Your audience will form impressions of your intentional messages, both negative and positive, over which you have no control. Perceptions of physical attractiveness, age, gender, or ethnicity or even simple mannerisms and patterns of speech may unintentionally influence the message. Perhaps, out of courtesy, you stand up while offering your visitor a seat; or perhaps your visitor has an expectation that you ought to do so. Perhaps a photograph of your family on your desk makes an impression on your visitor. Perhaps a cartoon on your bulletin board sends a message.
3. **Auxiliary messages** refer to the intentional and unintentional ways a primary message is communicated. This may include vocal inflection, gestures and posture, or rate of speech that influence the interpretation or perception of your message. When you say, "Here, have a seat," do you smile and wave your hand to indicate the empty chair on the other side of your desk? Or do you look flustered and quickly lift a pile of file folders out of the way? Are your eyes on your computer as you finish sending an e-mail before turning your attention to your visitor? Your auxiliary message might be, "I'm glad you came by, I always enjoy exchanging ideas with you" or "I always learn something new when someone asks me a question." On the other hand, it might be, "I'll answer your question, but I'm too busy for a long discussion," or maybe even, "I wish you'd do your work and not bother me with your dumb questions!"

Creating interesting message

When you create a message, remember to keep following points in mind

Attention statement: As one might expect, the purpose of the attention statement is to draw the listener in. It can be used anywhere in your message, but this is the best place to use it. There are various strategies to grab readers' or listeners' attention, but one of the best is the "what's in it for me" approach, which involves explaining how your message will help them. An audience is likely to pay attention to an attention-grabbing remark such as, "I'm going to explain how you can save up to Rs 5000 a year on car insurance."

Introduction: Now that you have the audience's interest, let's get started with the introduction. You will clearly express your topic at the beginning, which is also the moment to build rapport with your audience. Making reference to the person who introduced you or using well-known or shared experiences to establish common ground with the audience are two ways to achieve this. You could also describe why this message is important to you, why you choose to share it now, what sort of experience you have, or how your own life has influenced you to share it.

Body: After the introduction comes the body of your message. Here you will present your message in detail, using any of a variety of organizational structures. Regardless of the type of organization you choose for your document or speech, it is important to make your main points clear, provide support for each point, and use transitions to guide your readers or listeners from one point to the next.

Conclusion: At the end of the message, your conclusion should provide the audience with a sense of closure by summarizing your main points and relating them to the overall topic. In one sense, it is important to focus on your organizational structure again and incorporate the main elements into your summary, reminding the audience of what you have covered. In another sense, it is important not to merely state your list of main points again, but to convey a sense that you have accomplished what you stated you would do in your introduction, allowing the audience to have psychological closure.

Residual message: The residual message, a message or thought that stays with your audience well after the communication is finished, is an important part of your message. Ask yourself of the following:
What do I want my listeners or readers to remember?
What information do I want to have the audience retain or act upon?
What do I want the audience to do?

Characteristics of ideal or effective message

Following are some of the characteristics, which make the message more effective and acceptable:

- **Accurate** – Scientifically sound, factual and correct
- **Adequate** – Theory and practical should have a relation
- Applicable in real life situation
- Appropriate to the **channel** selected
- **Attractive** – According to the urgent need, interest and problems of the audience
- **Clear**- it should be easy to understand
- According to the mental ability of the learner
- According to the objective of the extension work
- According to the social, economical and physical capability of the audience
- **Manageable**- it should be able to be handled by the communicator
- **Significant**- socially, economically and aesthetically to the needs and interests of the audience
- **Simply stated**– covering one point at a time
- **Specific**- no irrelevant materials
- Supporting both sides– positive and negative sides
- **Timely**- According to season
- It should be in local language
- Message must contain something worth saying

Key Aspects of Effective Messaging

1. **Make information clear and simple:** Most importantly based on types of client the communicating messages should be written. If the stakeholder is farmer, then vernacular language should be preferred. It should be kept in mind that clear and simple word with pictorials catches more readers. Instead of long, narrative pieces, make the content easy to access by breaking it into sidebars, bullets and charts.
2. **Make it relevant:** Too often, it is observed that the communicating messages are written based on theoretical knowledge of text books, organisational needs or for the fulfilment of score cards with less importance of farmers' actual needs and/or practical solutions to their problems.
3. **Explain the 5 W & 1 H:** Communicating message must includes for whom the message it important, why and when it is important, under what circumstances it can be utilised, from where the advisories can be availed and how it is important to the stakeholder.
4. **Write in a friendly voice:** Stakeholders will respond better to a friendly tone rather than an authoritative one.

There are various purposes of messages for digital extension

1. **Informational Messages**: When any digital extension platform is used for sharing information regarding any scheme, policies etc. When any institute uses e-platform like website, whatsapp status etc. for the advertisement of upcoming events i.e. trainings, workshop etc.
2. **Instructional Messages**: When message includes guidelines for performing any task or use of any product. It includes eManuals, how-to guides, and customer support responses often fall into this category.
3. **Persuasive Messages:** When message is created with the aim to influence or persuade the stakeholders for any particular action or adoption. This includes advertisements, sales pitches, and motivational speeches.
4. **Request Messages**: Ask for something, such as requesting information, favours, or permissions. Examples are formal requests for time off or a query for more details about a service.
5. **Status Updates:** Inform others about the current state of events. Examples include forthcoming events update corner on website, blogs, shorts on youtube or social media updates about personal activities.
6. **Apology Messages**: Express regret for a mistake or wrongdoing. These can be formal, like a corporate apology for a service failure, or informal, such as a personal apology to a friend.
7. **Congratulations**: Communicate praise or celebrate achievements. This includes congratulating someone on a promotion, graduation, or any other accomplishment. Often company celebrates their anniversary as well as customer's anniversary with offering huge discount through messaging on email or mobile number etc.

8. **Sympathy and Condolence Messages**: Offer comfort and support during times of loss or difficulty, such as sending a note of sympathy to someone who has experienced a bereavement.
9. **Reminder Messages:** Help ensure that someone remembers to do something, like reminding a friend about a meeting or sending a follow-up on a task through email, whatsapp, mobile etc.
10. **Greeting Messages**: Offer a friendly hello or introduction. Examples include welcome messages for new employees or friendly greetings in emails.
11. **Feedback Messages:** Provide comments or evaluations about someone's performance, work, or behaviour. This can include performance reviews or casual feedback on a task.
12. **Complaint Messages**: Express dissatisfaction or concerns about a service or product, often with the expectation of resolution or compensation.

Each type of message serves a different purpose and is tailored to fit the context and audience it addresses.

Message Flow Models

1. **Hypodermic needle model:** Mass media had direct, immediate powerful effects on a mass audience. The influence of mass media according to hypodermic model of communication is direct. It is based on SR model.
2. **Two step flow model:** In USA 1940, it was discovered that ideas flow from radio and print to some active members of a social system called **key communicators** and from them to less active members of the audience.

   Limitation
   i. Key communicator may be active or passive
   ii. This model implies a dichotomy between key communicator & others but it is continuous variable.
   iii. Flow of information may involve more than 2 steps
   iv. It implies reliance by KC on mass media channels

3. **One step flow model:** Mass media channels communicate directly to the mass audience, without the message passing through opinion leaders. However, message passing through to receivers doesn't have equal effect. It is improvement of hypodermic needle model. It recognizes that media are not all powerful, screening aspects of selective exposure, perception and retention, differential impact of message and allows for direct flow of information to members
4. **Multistep flow model:** this model implies a variable number of relays in the flow of information from the source to a large audience. The number of steps depends on intention of source, availability of mass media and nature of message and relevance of message to receiver

Message Distortion

The distortion of message is any kind of loss, deformation, or misrepresentation taken place in original message while sending it to audience. There are three types of distortions of message viz., systematic or stretch distortion, fog distortion and mirage distortion.

1. **Systematic or sketch distortion**: In case of systematic distortion, no information is lost but it is changed or recorded in an orderly or systematic way. Thus in this case the information is purposely changed in a systematic way to serve some specific objective. This type of distortion may be useful for extension workers for effective treatment of the message.
2. **Fog distortion**: In fog distortion, information is lost, masked or fogged over, because of the inability of communicator to encode or communicate and or the inability of the receiver to interpret message with complete fidelity.
3. **Mirage distortion**: In mirage distortion, audience receives something that 'which is not there actually'. Mirage distortion gives extra, unwanted information. It is unwanted because it is likely to result in mistaking the distorted message as relevant information, thus it introduces errors into insight. Extension workers, while painting a shining picture with regard to new ideas, may create a mirage- type distortion in the mind of the farmers.

The common causes of message distortion can be

Poor Communication Skills: Inadequate articulation, unclear language, or lack of coherence can lead to misunderstandings.

1. **Noise**: Physical or psychological interference can distort a message. For example, background noise, technical issues, or distractions can make it hard for the receiver to understand the message.
2. **Language Barriers**: Differences in language, jargon, or technical terms can lead to misinterpretation if the sender and receiver do not share the same understanding.
3. **Cultural Differences**: Variations in cultural norms and practices can affect how messages are perceived and interpreted. A message that is clear in one culture might be confusing or offensive in another.
4. **Emotional State**: The emotional state of the sender or receiver can affect how a message is delivered or received. For example, stress or anger might lead to harsher or more emotional communication.
5. **Preconceived Notions**: If the receiver has preconceived opinions or biases, they might interpret the message through that lens, leading to distortion.
6. **Feedback Loops**: Lack of or ineffective feedback can lead to misunderstandings. If the receiver doesn't ask for clarification or provide feedback, distortions might go uncorrected.
7. **Medium of Communication**: The choice of medium (e.g., email, phone, face-to-face) can affect message clarity. For instance, written messages might lack tone, leading to misinterpretation.
8. **Context**: The context in which a message is delivered can affect its interpretation. Without proper context, the receiver might misinterpret the intent or meaning of the message.
9. **Overloading Information**: Providing too much information at once can overwhelm the receiver, leading to confusion or the distortion of key points.

Ineffective communication caused by message:

In the process of communication, content of message and other qualities of the message are the key factors to attract the attention of audience. Some of the following inaccuracies in the component of message can produce unproductive communication:

1. Fail to convert your message into easy to understand form
2. Fail to explain advantages of the message
3. Fail to prepare and organize message properly
4. Fail to present the message in a proper way
5. Fail to select the message as per the need of the audience
6. Fail to separate key message from the set of the content
7. Fail to time the message
8. Fail to view the message from the point of view of audience
9. Use of inaccurate symbols may be words, visuals or models

Treatment of message

The treatment of the message is the arrangement or ordering of the content by the sender. In order to make the message more attractive and receptive, the communicator should arrange the effectively content. The treatment of the message plays an important role in communication.

This process depends upon communicator's communication skills, attitudes, knowledge level, position in social system and culture. Emotional appeal has relatively more effect than rational appeal. However, research evidence is not very consistent on this point. The impact of a communication is also influenced by order in which the various points are presented.

There are four methods of giving treatment to the message. These ways are methods of general organization, methods of attracting attention, methods of talking and methods of symbol variation and device for presentation of idea.

1. **Methods of general organization**: it is how effectively you present the message.
    i. Replicate key ideas or key concepts.
    ii. Try to compare and dissimilarity of important ideas.
    iii. Present the thoughts in sequential, logical or mental sequence.
    iv. Try to illustrate one side or both sides of an idea based on situation and audience.
    v. Try to begin with powerful argument.
    vi. Present message with reasoning.
    vii. Describe clear end product or give that chance to audience to decide.
2. **Methods of attracting attention:** It is how effectively you attract attention of audience
    i. Intensity: use loud noise, a flash of light to attract attention of audience.

ii. Extensity: use of large stimulus to attract attention.
iii. Movement: present message with unusual movement, gestures to attract attention
iv. Change and contrast: change in rate of movement, loudness to attract the attention.

3. **Methods of talking:** It is how efficiently you present ideas by way of effective speech.
   - **i.** Try to cover only one idea.
   - **ii.** Try to present idea in your own natural style, never try to act.
   - **iii.** Present timely idea in a specific manner with accurate and the latest background
   - **iv.** If possible do not read your speech always.
   - **v.** After knowing the audience, try to speak their language to make them realized that you know them and take care of them.
   - **vi.** Never try to criticize audience and their views
   - **vii.** Try to speak in local language and use proverbs, stories, humour with personal touch.
4. **Methods of using symbols:** It is how efficiently you select methods of presentation. Looking to the situation, try to use different symbols or methods to bring novelty while communicating message. One can use word symbol- speech, real object, model, specimen, graphs, film, slides, picture to make message understandable and acceptable.

Conclusion

In the era of digital world, there is much importance of pertinent and credible information. As the social media is flooded with lots of information some are credible on the other side of coin some are biased or influenced. Hence, audience has to be wise enough to trust and sometime choose which information. Let us understand with the example of recent happening, the government employee has to opt NPS or UPS. There is difference of opinion with several channels. The digital world carries fake information as well; therefore, selecting credible source is always a challenge for viewer. User has to be careful with fraud information. Thus, credible, specific and timely communicating message has no replacement.

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Empowering Agriculture through VISTAAR: A New Era of Agricultural Extension in India

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ABSTRACT

VISTAAR (Virtually Integrated System to Access Agricultural Resources) is a pioneering Digital Public Infrastructure initiative launched by the Ministry of Agriculture and Farmer Welfare, in partnership with Digital Green Trust, aimed at addressing the critical challenges faced by Indian agriculture. This platform seeks to empower small and marginal farmers—who represent a significant portion of the agricultural workforce—by enhancing access to timely, localized information, thereby improving productivity and sustainability. VISTAAR operates on a federated architecture that integrates advanced Artificial Intelligence (AI) to facilitate the flow of agricultural knowledge through a digital advisory library, capacity building for extension workers, and the creation of regionally relevant content in local languages. The system connects various stakeholders, including farmers, extension workers, and data providers, ensuring comprehensive support across the agricultural ecosystem. By employing multimodal communication tools like AI chatbots and interactive voice response systems, VISTAAR ensures accessibility for users with varying levels of digital literacy. The initiative is designed to evolve in phases, with initial focus on providing reliable advisories, and future developments anticipated in agri-commerce, finance, and sustainability practices. VISTAAR not only aims to enhance individual farmer capabilities but also supports collective efforts through farmer groups and organizations, fostering a more resilient agricultural landscape in India.

Keywords: *VISTAAR, Digital Public Infrastructure, Digital Green Trust, interactive voice response systems*

Introduction

The agriculture sector stands as the backbone of India's economy providing livelihoods to around 55% of the population and contributing nearly 18% to the nation's GDP. It plays a pivotal role in ensuring food security, promoting rural development, and driving economic growth. However, despite its significance, Indian agriculture is facing several challenges in today's rapidly changing world. Small and marginal farmers, who make up a substantial part of the agricultural sector, are struggling with issues like low yields, low productivity, inefficient resource use, lack of market access and unsustainable farming practices. Climate change further aggravates these issues leading to an increase in temperatures, floods, droughts, pest outbreaks etc. The population of India is expected to grow to 2 billion by 2050, placing immense pressure on the country, to produce more food with fewer resources. Addressing these challenges is essential to ensure the growth and sustainability of Indian agriculture.

Farmers need access to timely, accurate, and localized information to make informed decisions about crop management, irrigation, and market opportunities. The Agricultural Extension System plays a crucial role in transferring modern agricultural technologies and disseminating crop-related information to farmers. The system is largely public funded and has been continuously evolving to meet the changing needs of the farmers and has introduced many innovative extension methods from time to time.

However, the growing needs of the changing agriculture sector and the wide ratio between extension agents to farmers demand effective ways of managing the extension system and transforming the existing setup through the integrated advanced digital modern tools & technologies to access information, services, and professional guidance.

Recognizing the need for a farmer-centric solution to address the wide range of challenges Ministry of Agriculture and Farmer Welfare (MoA&FW), Government of India launched the Digital Public Infrastructure (DPI) known as VISTAAR (Virtually Integrated System to Access Agricultural Resources) in public private partnership mode with Digital Green Trust.

VISTAAR is an open, interoperable, and federated public network aimed to revolutionize agriculture by making knowledge more accessible, empowering farmer's voices and sharing the collective wisdom of the agricultural community through advanced Artificial Intelligence (AI).

The project is proposed with three main objectives:

1. To enhance the efficiency and effectiveness in providing access to advisories in agricultural and allied sectors for farmers across India by developing a digital platform that serves as a digital advisory library to Front Line Extension Workers, para extension workers and farmers
2. To enhance the capacity of Extension workers and para extension workers like Krishi Mitra, Krishi Sakhi, Pashu Sakhi etc., in the delivery of digital advisory services at the grassroots level.
3. To create documents and audio-visual contents in Agricultural & allied sectors including Rural Development in regional languages which will also be disseminated among the farmers by the FLEW and para extension workers or directly accessed by farmers from digital platforms.

VISTAAR Architecture:

VISTAAR is designed with a federated architecture and a multi-layered approach. On the supply side we have the entities that provide information and services to the VISTAAR platform. These may include data sources (like weather or soil data), advisories (best farming practices), and content providers (educational videos, guides). An AI powered layer enhances these data sources by optimizing the flow and quality of information to farmers and extension workers. AI-powered tools analyse complex data like real-time weather patterns, soil health, market trends etc. and translate them into actionable insights for farmers.

On the demand side, we have the users of the platform, including farmers and extension workers, who access the information provided by the supply side. These users can connect to the system through AI Bots, web portals, and mobile applications. Local language support through tools like Bhashini ensures that farmers from diverse regions and backgrounds can benefit from the platform. The platform also integrates with other Digital Public Infrastructures, such as Kisan Call Centers (KCC), Krishi DSS, and ONDC-eNAM, to offer comprehensive support for farm management and market access.

VISTAAR operates on a unified structure (protocols, specifications, APIs) that allows different systems to work together. It is built with data privacy as a core feature, ensuring the security and scalability.

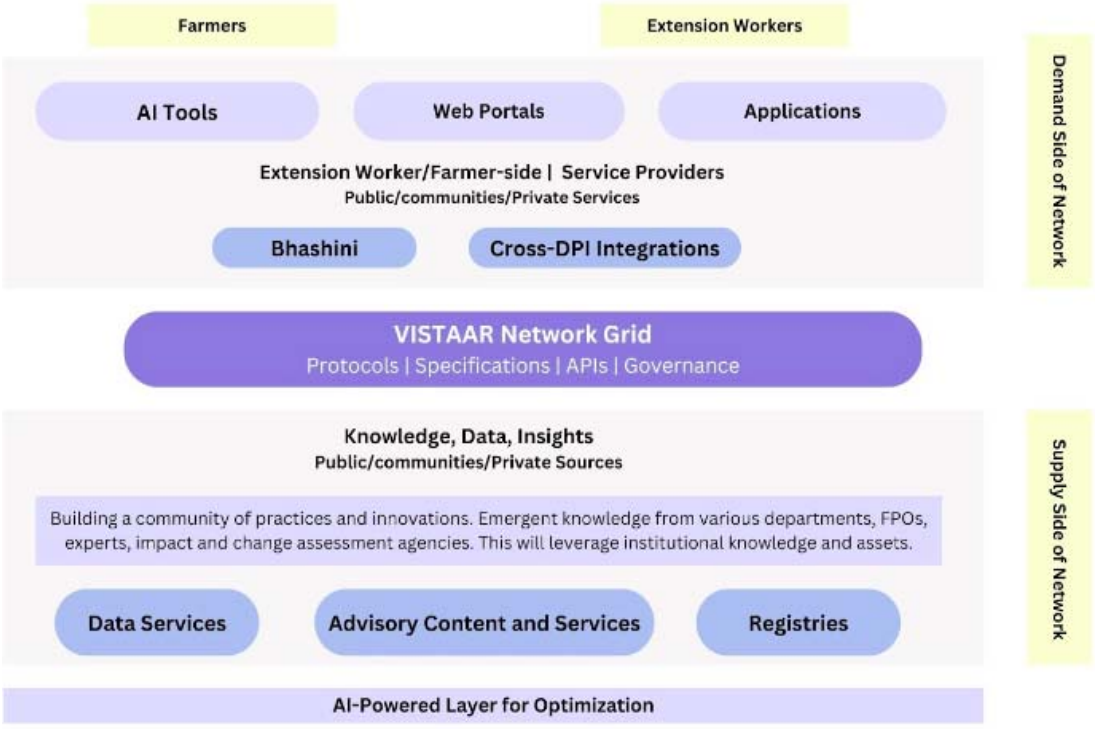

Fig. 3.1 VISTAAR Architecture

The success of VISTAAR is due to its design, which acts as a catalyst for connecting all participants in the agricultural ecosystem. Recognizing that a single organization cannot meet the needs of all farmers, the platform connects various agricultural services and offerings (government, private companies, and

others) to ensure that farmers get the support they need. Different organizations can also participate in VISTAAR by adding their own content (advisories, videos, etc.) and developing their own tools (like chat bots). This helps them reach more people and have a greater impact on India's agricultural sector.

VISTAAR Ecosystem

Farmers and extension workers form the core of VISTAAR ecosystem. They are the primary users of the services, knowledge, and resources facilitated by the VISTAAR network**.** The seeker organizations seek information from the VISTAAR network to distribute it effectively to farmers and extension workers. These organizations are responsible for supporting farmers and extension workers by providing relevant resources, knowledge, and tools. Whereas, the provider organizations are the entities that supply data, services and tools to the VISTAAR platform. These could include government bodies, research institutes etc. The VISTAAR network acts as the central facilitator that connects seeker organizations with the provider organizations. It ensures that information, services, and innovations flow efficiently and are accessible to those who need them.

Fig 3.2 VISTAAR Ecosystem

Bhashini, ONDC (Open Network for Digital Commerce) and UPI (Unified Payments Interface) represent the integrated digital public infrastructure components that play a vital role in enabling regional language communication, marketplace access, and financial inclusion for farmers and extension workers. AgriStack is the digital infrastructure by the states and central government which acts as a repository of all farmer information, including crop details, land records etc. The other key participants in the ecosystem include Agri-tech companies and institutes, Non-profit organizations, policy makers, administrators, network evangelists, tech enablers and data services.

VISTAAR's Working Process

VISTAAR operates by creating an open network of networks, connecting various players of agricultural ecosystem with farmers throughout the value chain. The image given below demonstrates the integration of various ecosystem players at each stage of farming to provide farmers with the knowledge, tools, and resources they need.

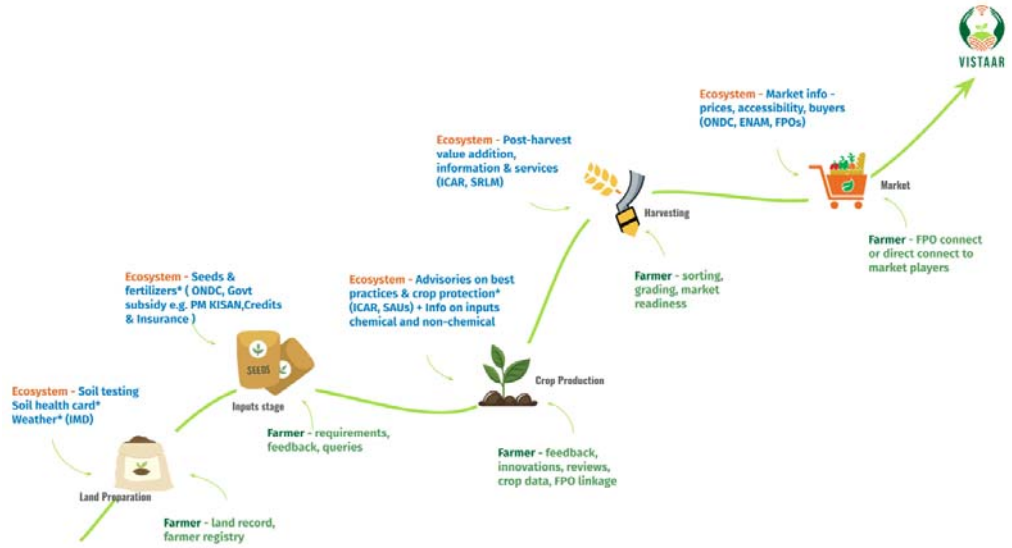

Fig. 3.3 Integration of VISTAAR Ecosystem players with Agriculture Value Chain

For the farmers to access the critical information, VISTAAR employs a variety of multimodal solution providers, like Chat bots, Interactive Voice Response System (IVRS), Web portals ensuring ease of use for farmers with varying degrees of digital literacy. For example, farmers and extension workers, can ask questions in their local languages using AI-powered chat bots and receive answers instantly, in text and voice, along with helpful videos and tips specific to their region and season.

Moreover, VISTAAR will continuously improve the accuracy and relevance of its recommendations to local farming conditions by actively collecting the feedback from users. Thus, with more locally customised advisory, farmers will have the ability to adopt climate smart farming practices that lead to increased productivity and income.

In addition to helping individual farmers, VISTAAR will support farmer groups, self-help groups led by women, cooperatives, and farmer producer organizations (FPOs). These groups can use the network to access government programs for investment in infrastructure, crop insurance, and climate-smart farming practices. This will help these organizations provide more value to their communities and improve the overall farming system.

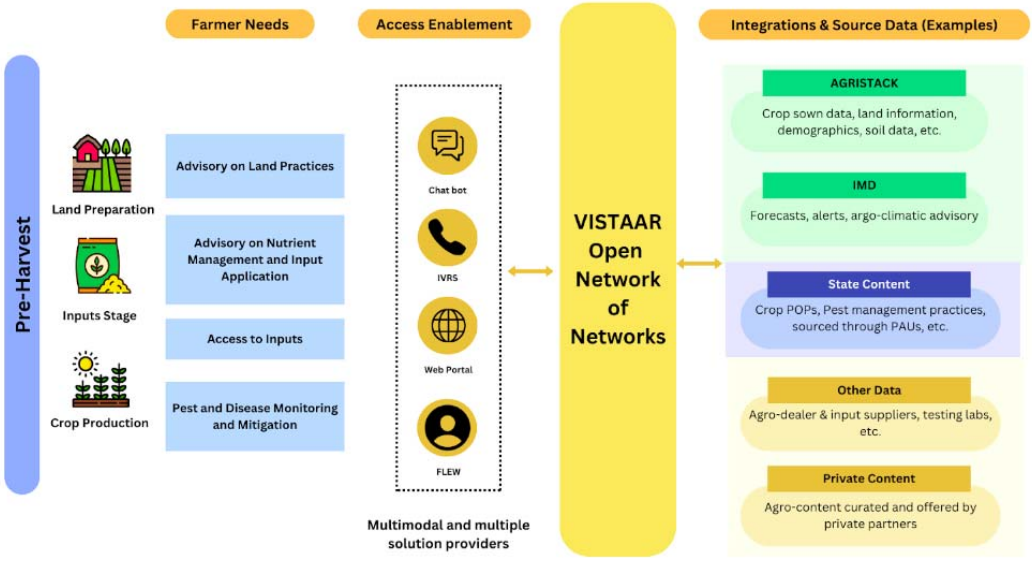

Fig. 3.4 VISTAAR as open network of networks

Implementation of VISTAAR

VISTAAR is envisioned to be rolled out in phases. In the first phase, the project aims to provide farmers and Frontline Extension Workers (FLEWs) with accurate and timely advisories through easy access to reliable information, data, and learning resources. The future phases will drive innovation in areas like Agri-commerce, Agri-finance (credit, insurance), Agri-supply chain, logistics, and green energy, helping make Indian agriculture more sustainable and climate-resilient.

An AI chat bot, which is an automatic responsive system was developed and field tested in various states. The Artificial Intelligence integrated in the digital platform will support in providing the solutions based on the data services, content services and registries. Farmers/Extension workers can ask through voice or text and BoT provides response in voice, text and videos in their local languages. To ensure the quality, feedback mechanism is enabled and user can ask further questions suggested through the AI model to continue engagement. BoT is available in the telegram, a mobile application.

User testing of the BoT is completed in UP, MP, Jharkhand, Rajasthan states, and received positive responses from the users. A progressive women farmer from UP expressed that it is a Self-Guided Learning platform helping her to find the solutions just by asking the question. However, BoT is in its infant stage evolving everyday based on the interaction and feedback received.

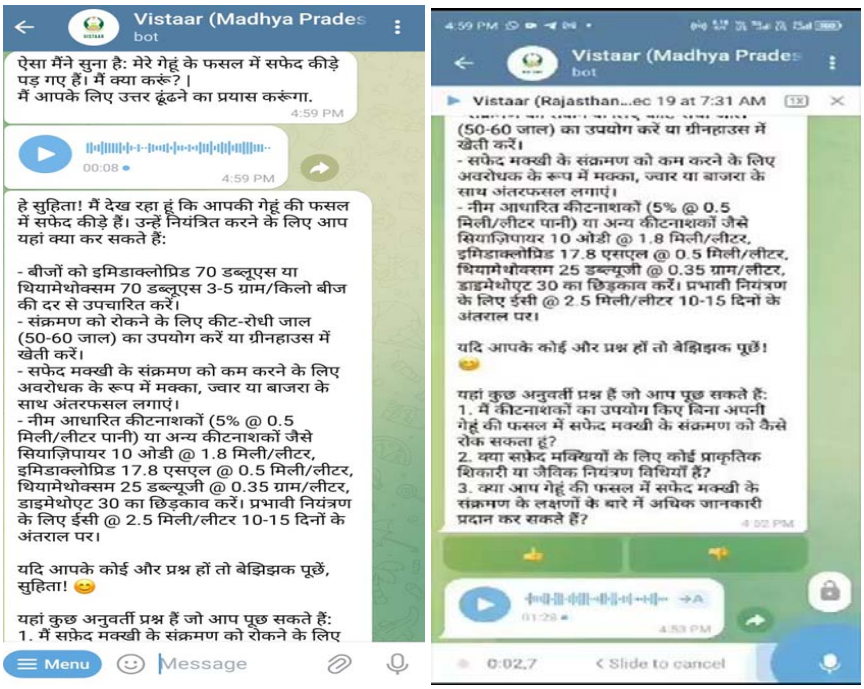

Fig. 3.5 & 3.6 Screenshots of VISTAAR BoT

Conclusion

VISTAAR is built with an aim to on-board millions of farmers across India. The platform will continue to evolve, integrating more data sources and expanding its service offerings to include everything from crop insurance to credit access. With its focus on inclusivity, scalability, and data-driven insights, VISTAAR is poised to revolutionize the Indian agriculture and offers a blueprint for how technology can create a more sustainable, profitable, and resilient agricultural ecosystem.

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Leveraging Online Platforms for Effective Data collection, Surveys and Visualization

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ABSTRACT

This chapter provides a comprehensive overview of online data collection, surveys, and visualization, highlighting key methodologies, tools, and best practices for effective research. The advent of online platforms has revolutionized data collection by offering greater reach, efficiency, and flexibility compared to traditional methods. We explore the principles of designing robust online surveys, emphasizing the importance of clear, relevant questions and pre-testing to ensure data quality.

The chapter delves into various data visualization techniques that enhance the interpretation and presentation of survey results. Interactive visualizations, such as dashboards and heat maps, are discussed for their role in making complex datasets accessible and actionable. Advanced graphical methods, including network diagrams and geospatial maps, are examined for their ability to reveal intricate patterns and relationships within the data.

Case studies from different sectors illustrate practical applications of online surveys and visualizations. Examples from public health, market research, education, and employee engagement demonstrate how these tools are used to address specific challenges and drive informed decision-making. The chapter also addresses the critical aspects of data quality, including validity, reliability, and the mitigation of biases. Methods for data cleaning and validation are discussed, alongside strategies for ensuring data security and privacy.

Overall, the chapter underscores the significance of integrating online data collection with sophisticated visualization techniques to enhance research outcomes. It provides a framework for understanding and implementing these tools effectively, offering insights into their application across various fields. As technology continues to advance, the chapter highlights the ongoing evolution in data collection and visualization practices, reinforcing their crucial role in modern research and decision-making.

Key words: *Online Data Collection, Survey Methodology, Data Visualization, Survey Design, Interactive Dashboards, Data Quality, Response Bias.*

Introduction

Online data collection refers to the process of gathering information from various digital sources through the internet. In today's data-driven world, the ability to collect, analyze, and interpret data is paramount for making informed decisions across various fields, including science, business, and policy-making. Online data collection methods have become increasingly popular due to their efficiency, cost-effectiveness, and the vast amount of data they can provide. Unlike traditional methods, which may involve face-to-face interviews or paper-based surveys, online data collection leverages digital platforms, enabling researchers to reach a broader audience and gather data more quickly and accurately. The evolution of online data collection has been closely tied to advances in technology and the widespread use of the internet. As of 2024, it is estimated that over 5 billion people use the internet, creating an unprecedented opportunity for data collection. This shift has not only changed how data is gathered but also who can collect it, democratizing the process and enabling a wider range of organizations and individuals to conduct research.

Relevance of Surveys in Data Collection

Surveys are one of the most common and effective methods of online data collection. They allow researchers to gather information directly from respondents, making them ideal for collecting subjective data such as opinions, preferences, and self-reported behaviors. Online surveys, in particular, have gained popularity due to their accessibility, scalability, and the ease with which they can be distributed and analyzed.

The relevance of surveys in data collection is underscored by their ability to collect large amounts of data quickly and cost-effectively. For instance, a well-designed online survey can reach thousands of respondents across different geographic locations in a matter of hours, something that would be impossible with traditional methods. Furthermore, online surveys can be easily customized and adapted to suit the needs of specific research objectives, allowing for a high degree of flexibility in data collection.

In addition to their practicality, online surveys also offer methodological advantages. They reduce the risk of interviewer bias, as respondents complete the surveys independently, and they allow for the inclusion of various question formats, such as multiple-choice, Likert scales, and open-ended questions.

This versatility makes surveys a powerful tool for collecting a wide range of data, from quantitative metrics to qualitative insights.

Importance of Data Visualization

Data visualization is a crucial component of the data collection and analysis process. It involves the graphical representation of data, enabling researchers and stakeholders to understand complex information quickly and intuitively. As the volume of data collected online continues to grow, the importance of effective data visualization has become increasingly apparent.

Visualization transforms raw data into visual formats such as charts, graphs, and maps, making it easier to identify patterns, trends, and outliers that might not be immediately apparent in tabular data. This capability is particularly important in online data collection, where the sheer volume of data can be overwhelming. By using visualization tools, researchers can present their findings in a way that is accessible and engaging, facilitating better decision-making and communication.

Moreover, data visualization is not just about aesthetics; it plays a critical role in the analytical process. Good visualization practices help to ensure that the data is interpreted correctly and that the insights derived from it are accurate and actionable. As such, understanding and applying the principles of data visualization is essential for anyone involved in online data collection and analysis.

The integration of data collection, surveys, and visualization represents a comprehensive approach to modern research. Each element plays a distinct yet interrelated role in the process, from gathering data to interpreting and communicating findings. This chapter will explore these components in detail, providing a thorough understanding of how they contribute to effective research and decision-making in the digital age.

Online Data Collection Methods

Web Scraping

Web scraping is a powerful method of online data collection that involves extracting large amounts of data from websites through automated tools. This technique is particularly useful for gathering publicly available data that is not easily accessible through traditional means, such as structured databases. Web scraping enables researchers to collect data at scale, allowing for the aggregation of information from multiple sources for comprehensive analysis. The process typically involves the use of programming languages like Python, along with libraries such as Beautiful Soup, Scrapy, and Selenium, to navigate through web pages and extract relevant information.

However, web scraping comes with its own set of challenges and ethical considerations. The legality of web scraping varies by jurisdiction and depends on the terms of service of the websites being scraped. For instance, scraping data from websites without permission can violate copyright laws or terms of use, leading to legal consequences. Furthermore, ethical concerns arise when scraping data that includes personal information, as this may infringe on privacy rights. As such, it is essential for researchers to be aware of and adhere to legal and ethical guidelines when conducting web scraping.

Despite these challenges, web scraping remains a valuable tool for collecting real-time data, particularly in fields such as market research, social science, and environmental monitoring. For example, it can be used to track changes in product prices, gather social media sentiment, or monitor environmental conditions through publicly available data sources.

APIs

Application Programming Interfaces (APIs) offer another efficient method for online data collection. APIs act as intermediaries that allow different software systems to communicate and exchange data, often in real-time. Many organizations provide public APIs that give access to their data, such as Twitter, Google, and Facebook, making it possible for researchers to collect data directly from these platforms without the need for web scraping.

The use of APIs in data collection has several advantages. APIs typically provide structured data in formats like JSON or XML, making it easier to process and analyze. Moreover, APIs often include mechanisms to handle large volumes of data and can be programmed to collect data continuously over time. This capability is particularly beneficial for longitudinal studies or projects that require real-time data collection.

However, API usage also presents certain limitations. Access to APIs may be restricted by usage limits, requiring researchers to manage their data collection within these constraints. Additionally, changes

to an API's structure or availability can disrupt data collection processes, necessitating ongoing maintenance and adaptation of the research methodology.

APIs are widely used in various research fields, including social network analysis, financial data monitoring, and health informatics. For instance, the Twitter API is commonly used to study social behaviors and trends, while the Google Analytics API allows businesses to track website performance and user behavior.

Online Surveys

Online surveys are one of the most prevalent methods of data collection on the internet, offering a direct approach to gathering information from participants. They are particularly useful for collecting self-reported data on attitudes, behaviors, and demographics. Platforms like Google Forms, SurveyMonkey, and Qualtrics have made it easier than ever to design and distribute surveys to a wide audience, enabling researchers to gather large datasets with minimal effort.

The effectiveness of online surveys is largely due to their flexibility and scalability. Researchers can design surveys with various question types, including multiple-choice, open-ended, and Likert scale questions, to gather both quantitative and qualitative data. Furthermore, online surveys can be distributed through multiple channels, such as email, social media, and websites, increasing their reach and response rates.

However, online surveys also face challenges related to sampling and response bias. Since participation is typically voluntary, there is a risk of self-selection bias, where certain groups may be overrepresented while others are underrepresented. Additionally, online surveys may suffer from low response rates, which can affect the generalizability of the results. To mitigate these issues, researchers must carefully design their surveys, select appropriate distribution methods, and consider using incentives to encourage participation.

Ethical Considerations in Online Data Collection

Ethics play a crucial role in online data collection, particularly when it involves personal or sensitive information. Researchers must adhere to ethical standards that protect the privacy and confidentiality of participants, as well as ensure that data collection methods are transparent and fair. Informed consent is a fundamental aspect of ethical data collection, requiring researchers to provide clear information about the purpose of the study, how the data will be used, and the rights of participants.

In addition to obtaining consent, researchers must also consider the ethical implications of their data collection methods. For instance, while web scraping may be legal in some contexts, it can still raise ethical concerns if it involves collecting data without the knowledge or consent of the data owners. Similarly, the use of APIs to collect data from social media platforms must be done with consideration of the privacy settings and preferences of users.

Adhering to ethical guidelines not only ensures the integrity of the research but also helps to build trust with participants and the broader public. Researchers must remain vigilant about ethical issues throughout the data collection process, from the initial design of the study to the final analysis and reporting of the results.

Designing Effective Online Surveys

Survey Design Principles

Designing effective online surveys requires careful consideration of various principles to ensure the collection of reliable and valid data. The primary objective of survey design is to create a tool that accurately captures the information needed for the research while minimizing bias and maximizing response rates. A well-designed survey must be clear, concise, and tailored to the target audience, ensuring that respondents can easily understand and complete it.

One fundamental principle in survey design is the use of simple and unambiguous language. Questions should be formulated to avoid confusion, leading respondents to provide accurate and relevant answers. Complex or technical jargon should be avoided unless the target audience is familiar with it. Additionally, survey designers should strive for brevity; long surveys may lead to respondent fatigue, resulting in incomplete responses or dropouts.

Another crucial aspect is the logical flow and structure of the survey. Questions should be organized in a coherent sequence that reflects the natural thought process of the respondents. Grouping similar questions together can help maintain the respondent's focus and prevent cognitive overload. Moreover, the

use of a consistent response scale across similar questions can reduce confusion and improve the reliability of the data collected.

Pre-testing, or piloting, the survey is another essential step in the design process. Conducting a pilot test with a small sample of the target population allows researchers to identify and address potential issues, such as ambiguous questions or technical problems with the survey platform. This step ensures that the final survey is both functional and effective in gathering the intended data.

Types of Questions

The types of questions used in an online survey significantly influence the quality and type of data collected. There are various question formats available, each with its own strengths and limitations. Understanding when and how to use these different formats is critical for effective survey design.

Closed-ended questions are the most commonly used in online surveys. These questions provide respondents with a predefined set of response options, such as multiple-choice questions, Likert scales, or rating scales. Closed-ended questions are advantageous because they are easy to analyze and can produce consistent, quantifiable data. For example, Likert scale questions are widely used to measure attitudes and perceptions, offering respondents a range of options from "strongly agree" to "strongly disagree".

Open-ended questions allow respondents to provide answers in their own words, offering richer qualitative data. These questions are particularly useful when exploring new topics or seeking detailed feedback that cannot be captured through closed-ended formats. However, open-ended questions can be more challenging to analyze, as responses may vary widely in content and length.

Matrix questions are another common format, where respondents are asked to evaluate multiple items using the same set of response options. This format is efficient for capturing data on several related variables but may lead to respondent fatigue if overused. Matrix questions are particularly useful in assessing attitudes or behaviors across different contexts or scenarios.

The choice of question type should align with the research objectives and the nature of the data being sought. A well-designed survey often includes a mix of question types to balance the need for structured, quantifiable data with the richness of qualitative insights.

Survey Distribution Channels

The success of an online survey depends not only on its design but also on its distribution strategy. Survey distribution channels determine how effectively the survey reaches the target audience and how likely it is to generate sufficient responses. There are several common channels for distributing online surveys, each with its advantages and challenges.

Email distribution is one of the most widely used methods. It allows researchers to send personalized invitations directly to potential respondents, increasing the likelihood of participation. Email surveys can also be easily tracked, enabling researchers to monitor response rates and send reminders as needed. However, the effectiveness of email distribution can be hindered by spam filters or low open rates.

Social media platforms, such as Facebook, Twitter, and LinkedIn, offer another powerful avenue for survey distribution. Social media can reach a broad and diverse audience quickly, making it particularly useful for surveys targeting specific communities or demographics. However, the public nature of social media responses can introduce bias, as respondents may be influenced by the opinions of others or the desire to present themselves in a certain way.

Website embedding is a method where the survey is embedded directly into a website or blog, allowing visitors to complete it while browsing. This method is particularly effective for targeting specific user groups, such as visitors to an organization's website. However, the response rate may be lower compared to more direct methods like email, as visitors may not be motivated to complete the survey.

Mobile surveys are designed specifically for smartphones and tablets, reflecting the increasing use of mobile devices for internet access. Mobile-friendly surveys must be optimized for small screens and touch interfaces, ensuring that they are easy to navigate and complete on a mobile device. Mobile surveys can reach respondents who are on the go, but they must be concise to prevent dropouts due to the limitations of mobile devices.

The choice of distribution channel should consider the target audience's preferences and behaviors, as well as the goals of the survey. A multi-channel approach, using a combination of email, social media, and mobile distribution, can help maximize reach and response rates.

Ethical Considerations in Survey Design

Ethical considerations are paramount in the design and administration of online surveys, particularly regarding issues of consent, privacy, and data security. Researchers must ensure that participants are fully informed about the purpose of the survey, how their data will be used, and their rights as participants, including the right to withdraw from the survey at any time.

Informed consent is a foundational ethical requirement, often facilitated through a clear and concise consent form at the beginning of the survey. This form should explain the nature of the research, any potential risks, and how the collected data will be stored and protected. Participants should also be informed about how long the data will be retained and whether it will be shared with third parties.

Data privacy and confidentiality are critical, especially when collecting sensitive or personal information. Survey data should be stored securely, using encryption and other security measures to protect against unauthorized access. Additionally, researchers should consider the implications of data anonymization, ensuring that individual respondents cannot be identified from their responses.

Ethical survey design also involves considering the potential burden on respondents. Surveys should be designed to minimize time and effort required to complete them, avoiding unnecessary questions or overly long questionnaires. Providing respondents with the ability to skip questions or exit the survey without penalty is another important ethical consideration.

By adhering to ethical standards in survey design, researchers can build trust with respondents, increase participation rates, and ensure the integrity of their data collection process.

Data Visualization Techniques in Online Surveys

Importance of Data Visualization

Data visualization is a critical aspect of online survey research, serving as a bridge between raw data and meaningful insights. Effective visualization techniques enable researchers to interpret complex data, identify patterns, and communicate findings clearly and persuasively to various stakeholders. Visualization is particularly important in the context of online surveys, where large datasets often require efficient methods for summarization and analysis. By converting data into visual formats, such as charts, graphs, and maps, researchers can make data more accessible and actionable, facilitating decision-making processes.

The primary goal of data visualization is to present data in a way that enhances comprehension while minimizing cognitive load. Good visualizations leverage the brain's ability to process visual information more effectively than text or numbers alone. For instance, a well-designed bar chart can immediately convey comparisons between different survey responses, while a heatmap can highlight areas of high activity or interest within a dataset. These visual tools not only improve data interpretation but also help in identifying trends, outliers, and relationships that might not be apparent from raw data alone.

Types of Visualizations

Selecting the appropriate type of visualization depends on the nature of the data and the specific insights the researcher aims to convey. Different types of visualizations are suited to different kinds of data and analytical purposes, making it essential to choose the right tool for the task.

Bar Charts are one of the most commonly used visualization types in survey research. They are particularly effective for comparing the frequency or proportion of categorical data, such as responses to a multiple-choice question. Bar charts can be presented either vertically or horizontally and are useful for illustrating differences across various groups or categories.

Pie Charts are another popular visualization tool, often used to represent the relative proportions of a whole. While pie charts can be visually appealing, they are less effective than bar charts when it comes to making precise comparisons, especially when the differences between categories are small. Therefore, pie charts should be used sparingly and only when the data is simple and the focus is on showing the part-to-whole relationships.

Line Charts are ideal for displaying trends over time or other continuous data. They are commonly used in longitudinal studies where tracking changes in variables across different time points is necessary. Line charts effectively show the direction and rate of change, making them a powerful tool for identifying trends and predicting future outcomes.

Scatter Plots are used to explore relationships between two continuous variables. They are particularly useful in identifying correlations, clusters, or outliers within the data. In survey research,

scatter plots can help in understanding the relationship between two survey variables, such as age and income, or satisfaction and engagement.

Heatmaps provide a way to visualize data through variations in color, often used to show the intensity of responses or the density of occurrences within a dataset. Heatmaps are particularly useful for large datasets where traditional charts may become cluttered or difficult to interpret. They are commonly used in survey research to display the distribution of responses across different categories or geographic areas.

Word Clouds are a form of text visualization that displays the frequency of words in a body of text, with more frequent words appearing larger and bolder. Word clouds are often used in qualitative analysis to highlight key themes or common responses in open-ended survey questions. However, they should be used with caution, as they may oversimplify complex data and ignore the context in which words are used.

Tools for Data Visualization

Several software tools are available for creating data visualizations, each offering different features and capabilities. The choice of tool depends on factors such as the complexity of the data, the desired level of customization, and the technical expertise of the researcher.

Microsoft Excel is one of the most widely used tools for creating basic charts and graphs. It offers a range of built-in templates for bar charts, pie charts, line charts, and more. Excel is user-friendly and accessible, making it a popular choice for quick and simple visualizations. However, its capabilities may be limited when dealing with large datasets or when advanced customization is required.

Tableau is a more advanced data visualization tool that allows for sophisticated and interactive visualizations. It is particularly well-suited for handling large datasets and offers a wide range of visualization options, including dashboards that can integrate multiple visualizations into a single interactive interface. Tableau's drag-and-drop functionality makes it accessible to users with varying levels of technical expertise.

R and Python are programming languages that offer extensive libraries for data visualization, such as ggplot2 for R and Matplotlib and Seaborn for Python. These tools are highly customizable and powerful, making them ideal for researchers who need precise control over their visualizations. However, they require a higher level of technical skill compared to tools like Excel or Tableau.

D3.js is a JavaScript library for producing dynamic, interactive data visualizations in web browsers. It is highly flexible and allows for the creation of complex, custom visualizations. D3.js is particularly useful for web-based applications but requires proficiency in JavaScript and web development.

The choice of visualization tool should align with the research objectives, the complexity of the data, and the technical skills of the researcher. In many cases, combining multiple tools may be the best approach, allowing for both quick insights and detailed, custom analyses.

Best Practices in Data Visualization

Creating effective data visualizations requires adherence to several best practices that ensure clarity, accuracy, and accessibility. One of the key principles is simplicity; visualizations should avoid unnecessary complexity and focus on conveying the core message. Overly complicated charts can confuse the audience and obscure important insights.

Another best practice is to ensure that visualizations are accurate and truthful. This involves using appropriate scales, avoiding misleading representations (such as truncated axes), and being transparent about data limitations. Misleading visualizations can result in incorrect interpretations and undermine the credibility of the research.

Accessibility is also an important consideration, particularly in ensuring that visualizations are interpretable by a wide audience, including those with visual impairments. This can be achieved by using color palettes that are distinguishable by those with color blindness, providing textual descriptions of visualizations, and ensuring that charts are clear when printed in black and white.

Lastly, context is critical in data visualization. Visualizations should be accompanied by appropriate labels, titles, and explanations that guide the viewer in understanding the data being presented. Providing context helps ensure that the audience can interpret the visualization correctly and appreciate its significance within the broader research.

Ethical Considerations in Online Data Collection and Surveys

Informed Consent in Online Surveys

In the realm of online surveys, obtaining informed consent is a fundamental ethical requirement. Informed consent ensures that participants are fully aware of the nature of the research, the procedures involved, the potential risks, and their rights as participants, including the right to withdraw at any point without penalty. Unlike traditional face-to-face interactions, online surveys often involve a degree of anonymity and distance that can complicate the process of obtaining informed consent. To address this challenge, researchers must provide clear, concise, and accessible information at the beginning of the survey, often in the form of a consent form that participants must agree to before proceeding.

The design of the consent process in online surveys must consider the potential for participants to overlook or misunderstand key information. This can be mitigated by using plain language, highlighting important details, and offering an option to contact the researcher with any questions or concerns. Additionally, it is crucial to ensure that consent is given freely, without any form of coercion or undue influence, which can be more challenging to monitor in an online environment.

Data Privacy and Confidentiality

Data privacy and confidentiality are paramount concerns in online data collection, particularly given the ease with which digital data can be accessed, shared, or compromised. Researchers must implement robust measures to protect the privacy of participants and the confidentiality of their data. This includes the use of secure data storage solutions, encryption of sensitive information, and strict access controls to ensure that only authorized personnel can view or manipulate the data.

Anonymization of data is a common practice to protect participants' identities, especially when dealing with sensitive topics. However, even anonymized data can sometimes be re-identified if it includes certain types of information or is combined with other datasets. Therefore, researchers must carefully consider what data is necessary to collect and avoid gathering any identifying information unless absolutely required for the study's objectives. Participants should be informed about how their data will be used, who will have access to it, and the measures in place to ensure its security.

Compliance with legal and regulatory requirements, such as the General Data Protection Regulation (GDPR) in Europe, is also essential for ensuring the ethical handling of online survey data. These regulations impose strict guidelines on data collection, storage, and processing, with significant penalties for non-compliance. Researchers conducting online surveys across different jurisdictions must be aware of the relevant laws and ensure that their data management practices align with these regulations.

Ethical Challenges in Survey Design

Ethical considerations in online surveys extend beyond data privacy and informed consent to encompass the design and administration of the survey itself. Researchers must be mindful of the potential for survey design to introduce bias, cause harm, or mislead participants. For example, the use of leading questions, which suggest a particular response, can compromise the integrity of the data and undermine the validity of the research findings. To avoid this, questions should be carefully crafted to be neutral and unbiased, allowing participants to provide responses that reflect their true opinions or experiences.

Another ethical concern is the potential for participant fatigue, especially in long or complex surveys. Fatigue can lead to careless responses, dropouts, or reduced data quality, which can skew the results and diminish the overall value of the research. Researchers must balance the need for comprehensive data collection with the consideration of participants' time and cognitive load, often by limiting the length of the survey or employing techniques to maintain engagement, such as progress indicators or motivational prompts.

Deception is another ethical issue that occasionally arises in online surveys, particularly in studies that require participants to be unaware of the true nature of the research until after data collection is complete. While deception can be justified in certain cases to avoid biasing responses, it must be carefully considered and justified by the potential benefits of the research. When deception is used, a debriefing process should be implemented at the end of the survey, explaining the true purpose of the study and offering participants the opportunity to withdraw their data if they feel uncomfortable.

Ensuring Cultural Sensitivity

In online surveys, especially those conducted across diverse populations or international contexts, cultural sensitivity is an important ethical consideration. Researchers must be aware of cultural differences

that may affect how questions are interpreted, how respondents engage with the survey, and the relevance of the survey content to different cultural groups. This involves not only translating surveys into different languages but also adapting questions to be culturally appropriate and understandable within different contexts.

Pre-testing or piloting surveys with a sample from the target population can help identify potential cultural issues before the survey is widely distributed. This process allows researchers to refine questions, adjust terminology, and ensure that the survey is respectful and relevant to all participants. Moreover, researchers should be transparent about the cultural context in which the survey was developed and the potential limitations this may impose on the generalizability of the findings.

Evaluating the Quality of Online Survey Data

Measurement Validity

Measurement validity is crucial in online surveys to ensure that the instruments used accurately capture the intended constructs. Validity refers to the extent to which a survey measures what it is supposed to measure. In online surveys, establishing validity involves several types, including content validity, criterion validity, and construct validity. Content validity ensures that the survey items comprehensively cover the domain of the construct. This is achieved through expert reviews and pilot testing to verify that the questions are relevant and representative of the construct being measured.

Criterion validity involves comparing survey responses with an external criterion known to measure the same construct. For example, a new survey instrument measuring job satisfaction should correlate well with established measures of job satisfaction. Construct validity examines whether the survey measures the theoretical construct it claims to measure by evaluating the relationships between survey responses and other variables. This can be assessed using statistical techniques such as factor analysis to confirm that the survey items align with the theoretical dimensions of the construct.

Reliability of Survey Instruments

Reliability refers to the consistency and stability of survey responses over time and across different contexts. It is essential for ensuring that the data collected from online surveys is dependable and replicable. Several types of reliability are pertinent to online surveys, including internal consistency, test-retest reliability, and inter-rater reliability.

Internal Consistency measures the extent to which survey items that are intended to measure the same construct yield similar responses. This can be assessed using Cronbach's alpha, which evaluates the average correlation between items within a scale. A high Cronbach's alpha indicates that the items are consistently measuring the same underlying construct.

Test-Retest Reliability assesses the stability of survey responses over time by administering the same survey to the same respondents at two different points in time. High correlation between the two sets of responses suggests that the survey is reliable and that responses are stable across time.

Inter-Rater Reliability is important when survey data involves subjective judgments by multiple raters. It assesses the degree of agreement among different raters. For example, in surveys where participants rate the quality of open-ended responses, ensuring high inter-rater reliability is crucial for consistent data interpretation.

Data Quality and Respondent Characteristics

The quality of data collected through online surveys can be influenced by various respondent characteristics, including motivation, attentiveness, and honesty. Respondent motivation and attentiveness are crucial for obtaining high-quality data. Surveys that are lengthy, poorly designed, or lack clear instructions can lead to respondent fatigue or disengagement, resulting in incomplete or inaccurate responses. Techniques such as incorporating engaging visuals, keeping surveys concise, and providing progress indicators can help maintain respondent attention and improve data quality.

Honesty in responses is another critical aspect of data quality. Social desirability bias, where respondents provide answers they believe are more socially acceptable rather than their true opinions, can skew results. To mitigate this, surveys should employ techniques such as anonymization and assuring confidentiality, which can help reduce the impact of social desirability bias. Additionally, including validity checks within the survey, such as consistency questions or attention checks, can help identify and address issues related to dishonest or inattentive responses.

Addressing Non-Response Bias

Non-response bias occurs when certain groups of respondents are less likely to complete the survey, potentially skewing the results. This can be addressed through various strategies, including improving survey design, sending reminders, and offering incentives to encourage participation. It is also important to analyze response patterns and implement adjustments to account for non-response bias, such as weighting responses to better represent the target population.

Imputation Methods can be employed to handle missing data, which is another aspect of managing non-response bias. Techniques such as multiple imputation or maximum likelihood estimation can provide estimates for missing responses and help ensure the validity and reliability of the data analysis.

Best Practices for Online Data Collection and Surveys

Designing Effective Online Surveys

Designing effective online surveys is crucial for maximizing response rates and ensuring data quality. Key principles in survey design include clarity, simplicity, and relevance. Clarity in question wording prevents misinterpretation and ensures that respondents understand what is being asked. This involves using straightforward language and avoiding jargon or ambiguous terms. Simplifying the survey structure by breaking complex questions into simpler components can improve respondent engagement and data accuracy.

Relevance pertains to ensuring that all survey items are directly related to the research objectives. Each question should contribute valuable information to the study, avoiding unnecessary or off-topic questions that could lead to respondent fatigue. Additionally, including skip patterns and branching logic can help tailor the survey to individual respondents, making it more relevant and engaging for them.

Pre-testing is an essential practice for refining survey instruments before full deployment. Conducting cognitive interviews or pilot tests with a small sample from the target population can help identify potential issues with question clarity, survey length, and overall design. This process allows researchers to make necessary adjustments to improve the survey's effectiveness and address any issues that might affect data quality.

Engaging and Retaining Respondents

Engaging and retaining respondents is critical for achieving high response rates and obtaining quality data. Several strategies can enhance respondent engagement and reduce dropout rates. **Personalization** of survey invitations and reminders can increase respondent motivation. Personalized messages that address participants by name and explain the importance of their individual responses can lead to higher participation rates.

Incentives are another effective tool for improving response rates. Providing small rewards or incentives for completing the survey can encourage participation and reduce non-response bias. However, the type and amount of incentive should be carefully considered to avoid introducing bias or affecting the validity of responses.

Maintaining **respondent confidentiality** and clearly communicating data protection measures also play a crucial role in retaining participants. Ensuring that respondents feel secure about how their data will be used and protected can foster trust and encourage honest responses. Additionally, keeping the survey length reasonable and providing progress indicators can help maintain respondent engagement throughout the survey process.

Leveraging Technology and Tools

Advancements in technology offer numerous tools and features to enhance online data collection and survey implementation. Utilizing **survey software** with built-in features such as automatic data entry, real-time analytics, and customizable templates can streamline the survey process and improve data management.

Mobile optimization is increasingly important as more respondents access surveys via smartphones and tablets. Ensuring that surveys are mobile-friendly and compatible with various devices can help reach a broader audience and improve response rates.

Real-time data collection and analysis tools allow researchers to monitor responses as they come in, providing the opportunity to address any issues promptly and make adjustments to the survey if necessary. These tools can also facilitate immediate feedback and iterative improvements to the survey based on early responses.

Ethical and Practical Considerations

Incorporating ethical practices into the design and implementation of online surveys is crucial for maintaining research integrity and protecting participants. Ensuring **informed consent** and **data confidentiality** are fundamental ethical requirements that must be adhered to throughout the research process.

Compliance with regulations such as the General Data Protection Regulation (GDPR) is also essential for legal and ethical adherence. Researchers must stay informed about relevant regulations and ensure that their data collection practices comply with these standards.

On a practical level, researchers should **prepare for technical issues** by having contingency plans in place. This includes ensuring that survey platforms are reliable, providing technical support for respondents, and having backup systems for data storage and management to prevent data loss.

Advanced Techniques in Data Visualization for Survey Results

Interactive Visualizations

Interactive visualizations are increasingly employed to enhance the analysis and presentation of survey data. These techniques allow users to engage with the data dynamically, facilitating a deeper understanding and exploration of the results. Interactive visualizations can include features such as drill-down capabilities, where users can click on a data point to view more detailed information, and filters that enable users to view specific subsets of data. This interactivity supports more nuanced analyses and can help identify patterns and trends that might not be apparent in static visualizations.

Tools and Platforms: Modern data visualization platforms, such as Tableau, Power BI, and D3.js, offer extensive support for creating interactive charts, graphs, and dashboards. These tools provide built-in functionalities for interactive elements like dropdown menus, sliders, and clickable charts, which can significantly enhance the user experience and the interpretability of survey data.

User Engagement: To maximize the effectiveness of interactive visualizations, it is essential to consider user experience and design principles. The visualizations should be intuitive and user-friendly, ensuring that users can easily navigate and interact with the data without extensive training. Additionally, incorporating responsive design ensures that visualizations function well across different devices and screen sizes, further enhancing accessibility and user engagement.

Advanced Graphical Techniques

Advanced graphical techniques, such as **heat maps, network diagrams**, and **geospatial maps,** provide powerful ways to visualize complex survey data. Each of these techniques offers unique advantages for representing different types of data and relationships.

Heat Maps are useful for visualizing data density or intensity across two dimensions. They use color gradients to represent varying levels of values, making them ideal for identifying patterns or anomalies in large datasets. For example, a heat map can illustrate the distribution of responses across different regions or time periods, highlighting areas with high or low response rates.

Network Diagrams are employed to visualize relationships and interactions between entities. They are particularly useful for surveys involving social networks or communication patterns. Network diagrams display nodes (entities) and edges (relationships), enabling the identification of key influencers or clusters within the data. This technique is beneficial for understanding complex interrelationships and the structure of networks.

Geospatial Maps integrate geographic information with survey data to visualize spatial patterns and distributions. By overlaying survey results onto geographic maps, researchers can examine how responses vary across different locations. This technique is valuable for studies that involve location-based data, such as regional differences in attitudes or behaviors.

Data Dashboards

Data dashboards provide a consolidated view of key survey metrics and visualizations in a single interface. They aggregate various data visualizations, such as charts, graphs, and tables, into a coherent and interactive dashboard that facilitates real-time monitoring and analysis. Dashboards allow users to quickly access and interpret key findings, track performance indicators, and make data-driven decisions.

Design Considerations: Effective dashboard design requires a balance between information density and clarity. It is crucial to prioritize the most relevant metrics and ensure that visualizations are clearly labeled and easily interpretable. Incorporating interactive elements, such as drill-down capabilities and filter options, can enhance the usability of dashboards and allow users to explore the data more thoroughly.

Integration with Data Sources: Modern dashboards can integrate with various data sources and real-time data feeds, providing up-to-date information and enabling dynamic updates as new survey responses are collected. This integration supports ongoing analysis and ensures that users have access to the most current data.

Case Studies and Applications

Case Study 1: Public Health Surveys

Public health organizations frequently utilize online data collection and visualization techniques to monitor health trends and evaluate interventions. For instance, the Centers for Disease Control and Prevention (CDC) uses online surveys to track vaccination rates and public health behaviors. The implementation of interactive dashboards enables real-time tracking of vaccination coverage across different regions, facilitating timely responses to emerging health issues (CDC, 2020). Visualization tools, such as heat maps and geographic information systems (GIS), allow public health officials to identify areas with low vaccination rates and target interventions more effectively.

Key Success Factors: The success of these surveys hinges on the ability to reach a broad audience quickly and gather actionable data. Interactive elements in dashboards, such as filtering by region or age group, enhance the granularity of insights and support data-driven decision-making. Additionally, the integration of real-time data feeds helps in monitoring trends and responding to public health emergencies swiftly (CDC, 2020).

Case Study 2: Market Research in Consumer Behavior

In the realm of market research, companies like Nielsen and Kantar employ online surveys and visualization tools to analyze consumer behavior and preferences. For example, Nielsen's use of interactive data visualizations allows clients to explore consumer purchasing patterns across different demographics and regions. By leveraging dashboards that integrate survey data with sales figures and social media analytics, businesses can derive comprehensive insights into consumer trends and preferences.

Challenges and Solutions: One significant challenge in market research surveys is ensuring the representativeness of the sample. Advanced sampling techniques and weighting adjustments are employed to address potential biases and improve the accuracy of survey results. Visualization tools play a crucial role in presenting these insights in a clear and actionable manner, facilitating better strategic decisions.

Case Study 3: Educational Assessments

Educational institutions and assessment agencies use online surveys to evaluate student performance and educational outcomes. For example, the National Assessment of Educational Progress (NAEP) utilizes online surveys to gather data on student achievement and educational practices across the United States. Data visualization techniques are employed to present assessment results in a way that highlights key trends and areas for improvement (NAEP, 2022).

Implementation and Impact: Effective visualization of educational data helps educators and policymakers understand performance trends and identify gaps in achievement. Dashboards that aggregate data across various dimensions, such as grade level and subject area, provide actionable insights for curriculum development and targeted interventions (NAEP, 2022). Interactive charts and graphs enable stakeholders to explore data in detail and make evidence-based decisions to enhance educational outcomes.

Case Study 4: Employee Engagement Surveys

Organizations frequently use online surveys to assess employee engagement and satisfaction. For instance, Gallup's employee engagement surveys leverage advanced visualization techniques to present survey results on employee morale, job satisfaction, and organizational culture. Interactive dashboards allow HR departments to explore engagement metrics by department, location, and demographic group, facilitating targeted interventions to improve workplace culture.

Effectiveness and Improvements: The effectiveness of these surveys is enhanced by the use of interactive visualizations that allow for detailed exploration of engagement factors. By providing HR professionals with tools to analyze and interpret survey data, organizations can implement strategies to address areas of concern and improve overall employee satisfaction.

Evaluating and Ensuring the Quality of Online Survey Data

Assessing Data Quality

Ensuring the quality of data collected through online surveys is critical for obtaining valid and reliable results. **Data validity** refers to the extent to which the survey measures what it intends to measure. This can be assessed by evaluating the clarity and relevance of the survey questions and ensuring that they align with the research objectives. Techniques such as **pre-testing** and **pilot studies** are essential for identifying potential issues and refining survey instruments before full deployment.

Data reliability, on the other hand, pertains to the consistency of the survey results over time or across different samples. To assess reliability, researchers can use **test-retest methods,** where the same survey is administered to the same group at different times, and **internal consistency measures**, such as Cronbach's alpha, to evaluate the consistency of responses across related items. High reliability indicates that the survey produces stable and dependable results.

Identifying and Addressing Common Biases

Online surveys are susceptible to various types of biases that can impact data quality. **Selection bias** occurs when certain groups are overrepresented or underrepresented in the sample, potentially skewing the results. Researchers can mitigate selection bias by employing **random sampling techniques** and using **weighting adjustments** to correct for overrepresented or underrepresented groups.

Response bias can arise when respondents provide inaccurate or socially desirable answers rather than truthful ones. Techniques to reduce response bias include **ensuring anonymity** and using **neutral question wording** to avoid leading questions that may influence responses. Additionally, employing **data validation techniques,** such as cross-checking responses and using consistency checks, helps identify and address discrepancies in the data.

Non-response bias occurs when certain individuals do not respond to the survey, potentially leading to biased results. Strategies to minimize non-response bias include **follow-up reminders**, offering **incentives**, and designing the survey to be engaging and accessible.

Data Cleaning and Validation

Data cleaning is an essential step in ensuring the integrity of survey data. This process involves identifying and correcting errors or inconsistencies in the data, such as **missing values, duplicate responses,** and **outliers**. Techniques for data cleaning include **imputation methods** for handling missing data, and **statistical tests** to identify and address outliers.

Data validation involves verifying the accuracy and completeness of the data through **cross-referencing** with other data sources and **performing consistency checks.** This step ensures that the survey results are accurate and reliable, providing a solid foundation for analysis and interpretation.

Ensuring Data Security and Privacy

Maintaining the **security and privacy** of survey data is crucial for protecting respondent confidentiality and complying with ethical standards. Researchers must implement **data encryption** and **access controls** to safeguard data from unauthorized access. Additionally, adhering to **data protection regulations**, such as the GDPR, ensures that data collection and storage practices comply with legal requirements.

Informed consent should be obtained from all participants, clearly explaining how their data will be used and protected. This practice helps build trust with respondents and ensures ethical research conduct.

Conclusion

In the rapidly evolving landscape of data collection and analysis, online surveys have become a pivotal tool for researchers and practitioners across various fields. This chapter has elucidated the multifaceted nature of online data collection, surveys, and visualization, offering a comprehensive examination of the methodologies, technologies, and best practices involved.

Online Data Collection represents a significant advancement in survey research, offering unprecedented reach and efficiency. The flexibility of digital platforms allows researchers to gather data from diverse populations with greater ease than traditional methods. The effectiveness of online data collection, however, depends on meticulous design and deployment strategies to mitigate common issues such as response bias and non-response bias. By implementing robust sampling techniques and ensuring clarity and relevance in survey questions, researchers can enhance the reliability and validity of their data.

Survey Design plays a crucial role in ensuring the quality of data collected. Employing systematic approaches to survey construction—such as adhering to established principles for question design and employing pre-tests—can significantly improve the accuracy of the responses. The integration of advanced tools and platforms facilitates the creation of surveys that are both user-friendly and capable of capturing complex data effectively. Additionally, the ability to pre-test surveys and pilot them with target populations can help refine questions and structure, leading to more precise and actionable results.

Data Visualization has emerged as a powerful means of interpreting and presenting survey data. Through various visualization techniques, including interactive dashboards, heat maps, and network diagrams, researchers can translate complex datasets into intuitive and insightful visual representations. This enables stakeholders to explore data dynamically, identify trends, and make informed decisions. Advanced graphical techniques and interactive elements enhance the depth of analysis and the clarity of communication, facilitating a better understanding of survey results.

Ensuring Data Quality is fundamental to the success of any survey-based research. The chapter discussed various methods for assessing data validity and reliability, addressing common biases, and performing data cleaning and validation. By adopting rigorous quality control practices and employing advanced statistical techniques, researchers can ensure that their findings are both accurate and meaningful. Furthermore, safeguarding data security and privacy remains a critical consideration, underscoring the ethical responsibilities associated with data collection.

In summary, the interplay between online data collection, effective survey design, and advanced data visualization techniques forms the cornerstone of modern survey research. The insights gained from this chapter underscore the importance of leveraging these tools and methodologies to enhance the quality and utility of survey data. As technology continues to evolve, ongoing advancements in data collection and visualization will further enrich our ability to analyze and interpret complex information, driving progress across diverse fields of inquiry.

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Creating Effective Online Content: Guide for Veterinary Extension Professionals

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ABSTRACT

This chapter provides a comprehensive guide to creating effective online content for veterinary extension professionals, focusing on strategies that enhance the relevance, engagement, and educational impact of digital materials. The chapter begins by emphasizing the importance of understanding the target audience's needs and characteristics, which is crucial for developing content that addresses specific challenges and gaps in veterinary practice. It highlights the necessity of aligning educational objectives with the professional experiences and knowledge levels of veterinary practitioners. Organizational strategies are explored, including the use of clear, structured content and the incorporation of multimedia elements such as videos, infographics, and interactive diagrams. These approaches help to present complex information in an accessible manner and cater to diverse learning styles. The chapter also addresses the role of interactive components, such as quizzes and discussion forums, in promoting active learning and engagement. These elements are essential for reinforcing knowledge, facilitating practical application, and fostering a collaborative learning environment. Assessment and feedback mechanisms are discussed as critical components for measuring learning outcomes and guiding content improvement. The chapter outlines how formative assessments and timely feedback can support learners in tracking their progress and addressing areas of difficulty, thereby enhancing the overall effectiveness of online content. Looking forward, the chapter examines emerging technologies and trends, such as artificial intelligence, virtual reality, and gamification, which offer new opportunities for creating immersive and personalized learning experiences. The integration of these advancements can further enhance engagement and educational impact.

In nutshell, this chapter provides valuable insights and practical recommendations for designing and delivering online content tailored to the needs of veterinary extension professionals. It underscores the importance of a multifaceted approach that includes understanding the audience, organizing content effectively, incorporating interactive elements, and leveraging technological innovations to support ongoing professional development.

Key words: *Online content development, veterinary extension, instructional strategies, multimedia integration, interactive learning, assessment and feedback, emerging technologies, professional development.*

Introduction

The advent of digital technology has profoundly transformed the landscape of veterinary extension services, enabling more efficient dissemination of information and broader engagement with target audiences. In the context of veterinary extension, online content plays a pivotal role in educating professionals, farmers, and animal health practitioners, providing them with timely and relevant information. This section introduces the significance of creating effective online content tailored specifically for veterinary extension professionals, who are crucial in bridging the gap between scientific research and practical application in the field.

With the growing reliance on digital platforms, veterinary extension professionals must adapt their communication strategies to meet the evolving needs of their audience. Traditional methods of information dissemination, such as face-to-face meetings and printed materials, are increasingly complemented or even replaced by online content. This shift is driven by the need for immediacy, accessibility, and the ability to reach a geographically dispersed audience. As such, developing a robust online content strategy is essential for maximizing the impact of veterinary extension services.

The primary objective of this chapter is to explore the key elements of effective online content creation within the context of veterinary extension. This includes understanding the specific needs and preferences of the target audience, selecting appropriate content formats, and leveraging digital tools to enhance the delivery and accessibility of information. Furthermore, the chapter will address the importance of maintaining scientific rigor while ensuring the content remains engaging and accessible to non-expert audiences.

In today's digital age, the success of veterinary extension services hinges on the ability to communicate complex scientific information in a clear, concise, and engaging manner. This chapter seeks to equip veterinary extension professionals with the knowledge and tools necessary to create impactful online content that drives positive outcomes in animal health and welfare. By understanding the principles

of effective online communication, extension professionals can enhance their outreach efforts, foster greater collaboration, and ultimately contribute to the advancement of the veterinary field.

Understanding the Audience: Veterinary Professionals

Creating effective online content for veterinary extension professionals begins with a deep understanding of the audience. Veterinary extension professionals serve as critical intermediaries between scientific research and field-level application, making it essential that content is tailored to their specific needs, expertise, and preferences. To achieve this, a comprehensive audience analysis is necessary, encompassing demographic factors, professional roles, and content consumption behaviours.

Veterinary extension professionals are typically well-educated, with a strong background in veterinary science, animal husbandry, and agricultural practice. However, their roles can vary significantly, from direct farm advisory services to research dissemination and policy development. This diversity necessitates content that is both broad in scope to appeal to various sub-groups and specific enough to address particular professional needs. For instance, while one segment of the audience may require detailed technical guides on livestock disease management, another might benefit more from policy briefs or summaries of recent research finding.

Digital literacy is another critical factor in audience profiling. While many veterinary extension professionals are comfortable with basic online tools, there is a wide variation in familiarity with advanced digital platforms and multimedia content. Understanding this spectrum of digital skills is crucial for developing content that is both accessible and engaging. For example, interactive dashboards or data visualizations may be highly effective for some users, but overwhelming for others who might prefer text-based resources or static images.

Moreover, the context in which veterinary extension professionals' access online content must be considered. Many professionals work in rural or resource-limited settings where internet connectivity may be unreliable. This underscores the importance of optimizing content for low-bandwidth environments and ensuring that it can be easily downloaded or accessed offline. Additionally, content should be mobile-friendly, as many professionals may rely on smartphones or tablets to access information in the field.

Understanding content preferences is also key. Research indicates that veterinary extension professionals value content that is evidence-based, practical, and directly applicable to their work. They are often pressed for time, making concise, well-organized content more effective than lengthy, detailed reports. The use of visuals, case studies, and real-world examples can also enhance engagement by illustrating how the content applies in practical settings.

Understanding Livestock Farmers as an Audience

In the context of creating effective online content for veterinary extension, understanding the specific needs and characteristics of livestock farmers is critical. Livestock farmers represent a diverse audience with varying levels of education, technological access, and experience in animal husbandry. The effectiveness of online educational content depends on its ability to resonate with this diverse audience, addressing their specific challenges and aligning with their day-to-day practices.

Firstly, it is essential to recognize that livestock farmers often have a wealth of practical experience but may lack formal veterinary education. This disparity necessitates the development of content that is both scientifically accurate and easily comprehensible. Simplifying complex veterinary concepts without sacrificing accuracy is a delicate balance. Content should be presented in a manner that respects the farmers' knowledge while providing them with actionable insights that can be readily implemented in their operations. For instance, instructional videos demonstrating proper vaccination techniques or the management of common livestock diseases can be invaluable, offering visual and practical guidance that text-based content might not fully convey.

Furthermore, the socioeconomic and geographical diversity among livestock farmers must be considered. Farmers in remote or rural areas may have limited access to high-speed internet, making it crucial to optimize online content for low-bandwidth environments. Providing downloadable resources, such as PDF guides or offline video content, can ensure that all farmers, regardless of their internet access, can benefit from the educational materials. Additionally, recognizing the cultural and language differences among livestock farmers is vital. Content should be translated and localized to reflect the linguistic and cultural contexts of different farming communities, thereby enhancing its relevance and accessibility.

Another important aspect of understanding the audience is acknowledging the varied technological literacy among livestock farmers. While some may be adept at using smartphones and computers, others may have limited experience with digital platforms. To bridge this gap, online content should include

intuitive interfaces and straightforward navigation. Providing introductory tutorials on how to access and utilize the online resources can empower farmers who may be less familiar with technology, ensuring that they can fully engage with the content.

Moreover, livestock farmers often operate within tight schedules and face time constraints due to the demanding nature of their work. Therefore, the online content should be designed for flexibility, allowing farmers to access and absorb information at their own pace. Short, focused modules that can be completed in brief sessions are likely to be more effective than lengthy courses. Additionally, integrating mobile-friendly content that can be accessed on-the-go allows farmers to engage with educational material during their daily routines, such as while checking on livestock or performing other farm-related tasks.

Lastly, it is important to consider the social and community dynamics that influence livestock farmers' decision-making processes. Farmers often rely on peer networks and community leaders for advice and validation of new practices. Incorporating social features into online content, such as discussion forums or community boards, can facilitate peer-to-peer learning and encourage the sharing of experiences. Additionally, involving respected local veterinarians or agricultural experts in the content delivery can lend credibility and increase the likelihood of adoption of new practices by farmers.

By thoroughly understanding the specific needs, challenges, and contexts of livestock farmers, veterinary extension professionals can create online content that is not only educational but also practical and actionable. This approach ensures that the content is relevant and accessible, ultimately supporting livestock farmers in improving their practices and contributing to the health and productivity of their herds.

Content Development and Creation for Veterinary Professionals

Content development and creation for veterinary extension professionals is a meticulous process that requires a blend of scientific accuracy, clarity, and engagement. This section discusses the key steps in content development, including research, drafting, content structure, language use, and the integration of multimedia elements.

The content development process begins with thorough research. Given the scientific nature of veterinary extension, it is imperative that all content is rooted in evidence-based information. This involves reviewing the latest scientific literature, consulting experts in the field, and ensuring that all data presented is accurate and up-to-date. Research should be comprehensive, covering a range of sources including peer-reviewed journals, industry reports, and case studies. The credibility of the sources used is critical, as the target audience relies on this content to inform their professional practices.

Once the research is complete, the drafting phase begins. Drafting involves organizing the information in a logical and coherent manner. The content should be structured to facilitate easy understanding, with a clear introduction, body, and conclusion. For complex topics, it may be beneficial to break the content into subsections, each focusing on a specific aspect of the subject matter. This approach helps in maintaining the reader's engagement and allows them to digest information in manageable chunks.

The language used in content creation should be precise and tailored to the audience's level of expertise. For veterinary extension professionals, this means using technical terms and industry jargon appropriately, without oversimplifying the content. However, clarity should not be compromised; complex concepts should be explained in a way that is understandable without diluting the scientific rigor. Additionally, the tone should be formal and professional, reflecting the seriousness of the subject matter.

The structure of the content is another critical aspect. It should follow a logical flow, guiding the reader through the material in a way that builds understanding progressively. Headings and subheadings can be used to break up the text and make it easier to navigate. Lists, bullet points, and tables can also be useful for presenting complex information in a more accessible format. For example, a table comparing different livestock disease management strategies can quickly convey critical differences without overwhelming the reader with text.

Incorporating multimedia elements is increasingly important in online content. Visuals such as diagrams, infographics, and videos can enhance understanding, particularly for complex or technical subjects. These elements should be used to complement the text, not replace it, ensuring that they add value to the content rather than distract from it. For instance, an infographic illustrating the life cycle of a parasite can make the concept more tangible and easier to grasp for the audience.

Interactive content, such as quizzes or decision-making simulations, can also be an effective way to engage users and reinforce learning. These tools provide an opportunity for the audience to apply what they have learned in a practical context, enhancing retention and comprehension. However, these elements should be designed carefully to ensure they are aligned with the learning objectives and do not detract from the core content.

Content Creation for Livestock farmers

When developing content for livestock farmers, it is crucial to recognize the diversity within this audience in terms of farm size, species managed, and varying levels of technological literacy. This variability necessitates a tailored approach that addresses the specific needs and constraints of different farming systems. Content must be both accessible and directly applicable to the everyday challenges faced by livestock farmers, ensuring that the information provided is practical, actionable, and relevant to their unique contexts.

A critical aspect of content development is the incorporation of region-specific information. Livestock farming practices vary significantly depending on geographical location, climate, and available resources. Therefore, content that resonates with farmers in a particular region must consider local environmental conditions, common livestock breeds, and prevalent diseases. For instance, a module on herd management for dairy farmers in tropical climates should address heat stress management, while content for farmers in colder regions might focus on preventing frostbite and ensuring adequate shelter.

Moreover, the creation of content for livestock farmers should emphasize the economic aspects of livestock management. Farmers are often concerned with maximizing productivity while minimizing costs. Educational materials that provide clear guidelines on cost-effective practices, such as feed efficiency, breeding strategies, and disease prevention, can greatly enhance the practical value of the content. Additionally, integrating case studies and testimonials from successful farmers can offer real-world examples of how these practices can be implemented and the tangible benefits they bring.

The format and delivery of content are also paramount. Given that many livestock farmers have limited time due to the demands of their operations, content should be concise and presented in formats that can be easily accessed during their daily routines. Short video tutorials, mobile-friendly infographics, and podcasts are examples of formats that align with the needs of farmers who may prefer to consume content while working. These formats not only accommodate the farmers' busy schedules but also cater to varying levels of literacy and technology access.

Interactive elements, such as decision-making tools and virtual farm simulations, can further enhance engagement by allowing farmers to apply what they have learned in a risk-free environment. For example, a simulation tool that allows farmers to experiment with different feeding strategies and observe the potential outcomes can provide valuable insights without the risk of financial loss. These tools make learning more dynamic and can increase the likelihood that farmers will implement the practices in their own operations.

Furthermore, the inclusion of multilingual content is essential for reaching a broader audience of livestock farmers, especially in regions with diverse linguistic backgrounds. Providing content in multiple languages ensures that non-native speakers have equal access to educational resources, thereby increasing the overall impact of the extension programs. Translating key materials and offering subtitles or voiceovers in local languages can significantly enhance comprehension and retention.

Content Delivery and Distribution Channels

Content delivery and distribution are critical components in ensuring that online content effectively reaches veterinary extension professionals. This section explores various methods of content dissemination, considering both traditional and emerging digital channels. It emphasizes the importance of selecting the right platforms to maximize reach, engagement, and impact.

The choice of distribution channels should be informed by the target audience's preferences and behaviors. Veterinary extension professionals typically access content through a variety of platforms, including email newsletters, professional networks, webinars, social media, and dedicated educational websites. Understanding which channels are most frequented by the audience allows for more strategic content dissemination. For example, it is observed that webinars and online forums were particularly effective for disseminating complex, technical content in the veterinary field.

Email remains one of the most reliable and widely used channels for content distribution. It allows for direct communication with the audience, providing them with timely updates and access to new content. The effectiveness of email as a distribution channel can be enhanced through segmentation, where content is tailored to specific sub-groups within the audience based on their interests or professional need. For instance, a newsletter focusing on dairy cattle might be more relevant to some professionals than one discussing poultry.

Webinars and online courses are also highly effective for content delivery, particularly for in-depth training or complex topics that require interaction. These platforms offer the opportunity for real-time engagement, where participants can ask questions and discuss the content with experts and peer.

Interactive webinars significantly improve knowledge retention among veterinary professionals, particularly when combined with supplementary materials such as slides or reading lists.

Social media platforms like LinkedIn, Twitter, and specialized forums provide avenues for broader content dissemination and engagement. Social media enables the rapid sharing of information and facilitates discussions among professionals from different geographic location. However, the choice of platform should be aligned with the content type and audience preferences. For example, LinkedIn is more suitable for sharing professional articles and case studies, while Twitter might be used for quick updates or links to full articles.

Educational websites and learning management systems (LMS) are essential for hosting and organizing content. These platforms provide a centralized location where professionals can access a wide range of resources, including articles, videos, and interactive tools. The use of LMS allows for tracking of user engagement and progress, offering insights into the effectiveness of the content and areas where further support might be needed. For veterinary extension professionals, such systems can host modules on specific topics like disease management, thereby providing a comprehensive learning experience.

Another emerging channel is mobile applications, which offer on-the-go access to content. Apps can be particularly useful for field veterinarians who require quick access to information while on-site. It is also crucial to consider the format in which content is delivered. Text-based articles, while informative, may not always be the most engaging format. Incorporating multimedia elements like videos, podcasts, and infographics can make the content more appealing and easier to digest. These formats cater to different learning styles and can help in reinforcing key messages.\

Content Delivery to Livestock Farmers

When creating and delivering online content for livestock farmers, the selection of appropriate delivery and distribution channels is paramount. Livestock farmers often have varying degrees of access to technology, and their schedules may limit the time they can dedicate to online learning. Therefore, the content delivery strategies must be flexible, accessible, and practical to meet their unique needs.

One effective channel is mobile technology, particularly through SMS and mobile-friendly platforms. Many livestock farmers may not have regular access to computers, but mobile phones are ubiquitous. Educational content delivered via SMS or through mobile applications can provide timely, concise, and actionable information that farmers can access on-the-go. This method is particularly effective for delivering updates on animal health, market prices, and weather forecasts, which are critical for decision-making in livestock management.

Another essential channel is social media platforms, such as WhatsApp, Facebook, and YouTube. These platforms are increasingly popular among livestock farmers for information sharing and community support. WhatsApp groups, for example, can facilitate real-time communication between farmers and extension professionals, allowing for quick dissemination of information and collective problem-solving. Facebook pages and groups can serve as platforms for broader outreach, where educational videos, infographics, and articles can be shared widely. YouTube, with its visual and auditory appeal, is especially useful for demonstrating best practices in livestock management, such as animal handling, vaccination procedures, and feed preparation.

Webinars and online training sessions offer another avenue for content delivery. These formats can provide in-depth learning experiences, allowing livestock farmers to engage with experts in real time. However, it is crucial to consider the timing and length of these sessions, as farmers may have limited availability due to their daily responsibilities. Offering recordings of webinars can help accommodate those who cannot attend live sessions, ensuring that all interested farmers can access the information at their convenience.

Furthermore, podcasts have emerged as a valuable tool for reaching livestock farmers, especially those with limited internet bandwidth or who prefer auditory learning. Podcasts can be accessed during tasks that do not require full attention, such as driving or feeding animals, making them an efficient way to disseminate knowledge on topics like animal health, breeding techniques, and farm management practices. Importantly, Local extension agents play a crucial role in content distribution, particularly in remote or underserved areas where internet access may be unreliable. By equipping extension agents with online resources, such as digital guides and training materials, they can act as intermediaries, delivering content in person or through offline channels. This approach ensures that even those with limited digital access can benefit from the educational content created.

Audience Engagement and Interaction Strategies

Engagement is a critical factor in the success of online content for veterinary extension professionals. Effective engagement strategies can enhance learning, promote collaboration, and lead to better outcomes in professional practice. This section examines various methods to foster audience engagement and interaction, including personalization, interactive content, community building, and the use of feedback mechanisms.

Personalization is a powerful tool for increasing engagement. By tailoring content to meet the specific needs and preferences of veterinary professionals, it is possible to make the material more relevant and appealing. Personalized content can be based on factors such as the user's area of specialization, geographic location, or professional experience. For example, a veterinarian specializing in small animals may be more interested in content related to companion animal health, while a large animal practitioner may prefer information on livestock management.

Interactive content is another effective strategy for engaging audiences. Interactive elements, such as quizzes, case studies, and simulations, allow users to apply their knowledge and skills in practical scenarios. These activities not only make learning more engaging but also help to reinforce key concepts. Moreover, interactive content significantly improves knowledge retention among veterinary professionals, compared to passive learning methods like reading or watching videos.

Community building is also crucial for engagement. Online forums, social media groups, and professional networks provide platforms for veterinary professionals to connect, share experiences, and collaborate on solving problems. These communities can be facilitated by content creators, who can encourage discussions, organize virtual events, and share user-generated content. Such interactions foster a sense of belonging and encourage ongoing engagement with the content.

The use of feedback mechanisms is essential for maintaining and improving engagement. Feedback can be gathered through surveys, polls, and comment sections, providing valuable insights into what content resonates with the audience and what areas need improvement. This feedback can be used to refine content, address knowledge gaps, and ensure that the material remains relevant and useful. Additionally, by responding to feedback and adjusting based on user input, content creators demonstrate their commitment to meeting the needs of their audience.

Gamification is an emerging strategy that can enhance engagement by making learning more enjoyable. Incorporating elements such as points, badges, and leaderboards into online content can motivate veterinary professionals to participate more actively and consistently. For instance, awarding points for completing quizzes or participating in discussions can create a competitive but supportive learning environment.

Moreover, the use of multimedia content—such as videos, infographics, and podcasts—can cater to different learning styles and keep the audience engaged. Multimedia content is often more dynamic and visually appealing than text-based content, which can help maintain the audience's interest. Similarly, veterinary professionals who engaged with multimedia content reported higher levels of satisfaction and a greater likelihood of applying what they learned in practice.

Evaluating and Improving Online Content Effectiveness

Evaluating the effectiveness of online content for veterinary extension professionals is a critical step in ensuring that the educational objectives are met and that the content is valuable to the target audience. This section explores various methodologies and tools used for assessing the impact of online educational resources and provides strategies for continuous improvement based on evaluation results.

One of the primary methods for evaluating online content effectiveness is through the analysis of user engagement metrics. These metrics include page views, time spent on content, click-through rates, and the completion rates of interactive activities such as quizzes or survey. High engagement levels typically indicate that the content is resonating with the audience, while low engagement may signal that adjustments are needed. For instance, if veterinary professionals are spending minimal time on key sections, this could suggest that the material is either too difficult, not engaging, or not relevant.

In addition to engagement metrics, feedback collected directly from users is invaluable. Surveys, interviews, and focus groups with veterinary professionals can provide insights into their experiences with the content, the challenges they face, and areas where they feel improvements are necessary. This qualitative data complements quantitative engagement metrics and provides a more nuanced understanding of content effectiveness. For example, a survey might reveal that while a video tutorial is popular, it could benefit from more detailed case studies or slower pacing.

Another key aspect of evaluation is the assessment of learning outcomes. Pre- and post-assessment tools, such as quizzes or exams, can measure the knowledge gained by users after interacting with the content. By comparing results before and after exposure to the material, educators can gauge the content's effectiveness in conveying the intended knowledge. If significant learning gains are not observed, it may indicate that the content needs to be revised or supplemented with additional resources.

Continuous improvement of online content is achieved by integrating evaluation results into the content development process. This iterative approach, often referred to as the Plan-Do-Check-Act (PDCA) cycle, involves planning changes based on evaluation data, implementing these changes, checking the results, and then refining the content further. For instance, if feedback indicates that users find a particular module too lengthy, content creators might break it into shorter, more digestible segments.

Technological tools also play a significant role in evaluating and improving online content. Learning management systems (LMS) offer analytics features that can track user progress, identify areas where users struggle, and highlight content that may require revision. Additionally, A/B testing—where two versions of the same content are compared to see which performs better—can provide insights into which approaches are most effective. For example, one version of a training video might include interactive questions throughout, while another does not; by comparing the two, content creators can determine which method leads to better engagement and retention.

Finally, peer review and collaboration with other experts in veterinary education can enhance the quality of online content. Involving peers in the review process allows for the identification of gaps or weaknesses that may not be apparent to the original content creators. This collaborative approach not only improves the content but also fosters a culture of continuous learning and professional development among veterinary extension professionals.

In summary, evaluating and improving the effectiveness of online content for veterinary extension professionals requires a multifaceted approach, combining quantitative metrics, qualitative feedback, learning assessments, and iterative development. By rigorously assessing and refining content, educators can ensure that their materials remain relevant, engaging, and impactful for their audience.

Ethical Considerations in Creating Online Content

Ethical considerations are paramount in the creation of online content for veterinary extension professionals, as they ensure the integrity and credibility of the information provided. This section discusses key ethical issues, including accuracy and reliability of information, consent and privacy, and the responsible use of data.

Accuracy and reliability are fundamental to maintaining trust in online content. Veterinary extension professionals rely on accurate information to make informed decisions and provide high-quality care. Therefore, content creators must ensure that all information presented is evidence-based and up-to-date. This involves rigorous fact-checking, referencing credible sources, and regularly updating content to reflect the latest research and best practices. For instance, presenting outdated treatment guidelines or unverified research could lead to misinformation and potentially harm veterinary practice.

Consent and privacy are also critical ethical concerns, particularly when involving case studies or personal testimonials. Content creators must obtain explicit consent from individuals whose information is used, ensuring that their privacy is respected and protected. This includes anonymizing data where necessary and being transparent about how personal information will be used. Additionally, adhering to data protection regulations such as GDPR or HIPAA is essential in safeguarding user information. Content creators should also be aware of the ethical implications of sharing sensitive information and strive to balance transparency with confidentiality.

The responsible use of data extends to how data collected from users is handled and reported. Content creators should ensure that data is used in a manner that respects user rights and avoids misuse. This involves clear communication about data collection practices, providing users with options to opt-out, and ensuring that data is stored securely. Moreover, the ethical use of data includes avoiding manipulation or misrepresentation of data to achieve a particular agenda. Content creators should strive for objectivity and avoid biases that could skew the interpretation of data.

Another important ethical consideration is the potential impact of the content on diverse audiences. Content should be inclusive and accessible, avoiding language or imagery that could be discriminatory or offensive to any group. This includes considering the cultural, socio-economic, and professional diversity of the target audience when developing content. Ethical content creation involves being mindful of these factors to ensure that all professionals feel represented and respected.

Lastly, the ethical principle of beneficence requires that online content aims to provide tangible benefits to users and contribute positively to the field of veterinary practice. Content should be designed with the goal of enhancing professional knowledge, skills, and overall well-being. Content creators have a responsibility to ensure that their work supports the professional growth of veterinary extension professionals and upholds the values of the veterinary community.

Leveraging Multimedia and Interactive Tools

The use of multimedia and interactive tools in online content creation plays a crucial role in enhancing engagement, comprehension, and retention among veterinary extension professionals. This section examines how various multimedia elements and interactive features can be effectively integrated into online content to support learning objectives and improve educational outcomes.

Multimedia elements such as videos, audio recordings, and infographics are essential for creating dynamic and engaging online content. Videos, for instance, can demonstrate complex procedures, present case studies, or provide expert interviews, offering a more immersive learning experience compared to text alone. High-quality video content can convey detailed visual information and facilitate understanding through demonstrations, which are particularly valuable in veterinary education where practical skills are critical. Additionally, audio recordings, including podcasts or expert commentaries, provide flexibility for learners to engage with content in various settings, enhancing accessibility and convenience.

Infographics serve as effective tools for summarizing and visualizing data, making complex information more digestible. They can highlight key statistics, illustrate processes, or compare different options in a visually appealing format. By incorporating infographics, content creators can enhance learners' ability to grasp and retain essential information quickly, which is particularly useful in conveying intricate concepts or summarizing research findings.

Interactive tools, such as quizzes, simulations, and interactive diagrams, further enhance the learning experience by actively engaging users. Quizzes can be used to reinforce knowledge, provide instant feedback, and assess learners' understanding of the material. Simulations, on the other hand, allow learners to practice skills in a controlled environment, offering a hands-on approach to learning without the risks associated with real-world applications. Interactive diagrams enable users to explore content at their own pace, providing a more personalized learning experience and allowing for deeper exploration of specific topics.

Gamification, the integration of game elements such as points, badges, and leaderboards, is another effective strategy for increasing engagement and motivation. By incorporating game-like features into educational content, creators can create a more enjoyable and competitive learning environment, which can enhance learner participation and persistence. For example, veterinary extension professionals could engage in scenario-based simulations or case study challenges that reward successful outcomes and encourage continued interaction with the content.

Moreover, adaptive learning technologies, which use algorithms to tailor content based on individual learner progress and performance, offer a customized educational experience. These technologies adjust the difficulty and type of content presented based on learners' responses, ensuring that they receive the appropriate level of challenge and support.

Incorporating multimedia and interactive tools requires careful planning to ensure that these elements align with the educational objectives and enhance the overall learning experience. Content creators should consider the specific needs of their audience, the nature of the material, and the technical capabilities of the platform to maximize the effectiveness of these tools. Therefore, leveraging multimedia and interactive tools in online content creation enhances engagement, understanding, and retention. By integrating videos, audio recordings, infographics, quizzes, simulations, and gamification elements, content creators can provide a richer and more effective learning experience for veterinary extension professionals.

Measuring and Evaluating Online Content Effectiveness

Assessing the effectiveness of online content is crucial for ensuring that it meets educational goals and provides value to veterinary extension professionals. This section explores methodologies for measuring and evaluating online content, focusing on metrics for engagement, learning outcomes, and user feedback.

One primary method for evaluating online content is through the analysis of engagement metrics. These metrics include measures such as page views, time spent on content, and interaction rates. For instance, high engagement levels can indicate that the content is relevant and appealing to the audience.

Tools such as Google Analytics provide detailed insights into how users interact with content, enabling creators to identify which sections are most engaging and which may require improvement. Engagement metrics also help in understanding user behavior and preferences, which can guide the development of future content.

Learning outcomes are another critical aspect of content evaluation. Assessments such as quizzes, tests, and practical exercises can be used to measure the extent to which learners have absorbed and applied the information provided. For example, pre- and post-assessment comparisons can reveal whether learners have gained knowledge and skills from the content. Additionally, analyzing assessment results can help in identifying content areas where learners may struggle, allowing for targeted revisions and enhancements. Incorporating formative assessments throughout the learning process can provide ongoing feedback and support continuous improvement.

User feedback is essential for a comprehensive evaluation of online content. Collecting feedback through surveys, interviews, and focus groups provides direct insights into users' perceptions and experiences. Feedback can reveal strengths and weaknesses in content delivery, usability, and relevance. For instance, survey responses can highlight areas where users found the content particularly useful or challenging, guiding future content adjustments. Additionally, qualitative feedback from interviews can provide in-depth understanding of user needs and preferences, informing more personalized and effective content development.

Another important aspect of evaluation is the use of benchmarking and comparative analysis. By comparing content effectiveness against established standards or similar content from other sources, creators can assess how their content performs relative to industry norms. Benchmarking can help in setting realistic goals and measuring progress over time, ensuring that content remains competitive and relevant.

Incorporating analytics tools, assessment methods, and user feedback into a comprehensive evaluation strategy enables creators to refine and optimize online content continuously. By focusing on engagement metrics, learning outcomes, user feedback, and benchmarking, content creators can ensure that their materials effectively support the professional development of veterinary extension professionals.

Ensuring Accessibility and Inclusivity in Online Content

Ensuring accessibility and inclusivity is fundamental in creating online content that serves all veterinary extension professionals effectively. This section discusses strategies for designing online content that accommodates diverse learners, including those with disabilities and varying levels of technological proficiency.

Accessibility in online content involves designing materials that can be used by individuals with a range of abilities and disabilities. The Web Content Accessibility Guidelines (WCAG) provide a comprehensive framework for achieving accessibility standards. These guidelines cover key areas such as text readability, multimedia accessibility, and navigational ease. For instance, ensuring that all video content has accurate captions and that all images have descriptive alt text is essential for users with visual or hearing impairments. Additionally, providing alternative text for visual content allows screen readers to convey information to users who are visually impaired, enhancing their ability to interact with the content.

Inclusive design also involves considering the needs of users with varying levels of technological proficiency. Content should be designed to be intuitive and user-friendly, minimizing the need for advanced technical skills. This includes using clear and simple language, providing straightforward navigation, and ensuring compatibility with various devices and browsers. Interactive elements should be easy to use, and instructional materials should be available in multiple formats, such as text, audio, and video, to accommodate different learning preferences and needs.

Additionally, culturally responsive design is crucial for inclusivity. Online content should respect and reflect the diverse backgrounds of its audience. This involves using culturally appropriate language, images, and examples that resonate with a global audience. By incorporating diverse perspectives and addressing cultural sensitivities, content creators can foster a more inclusive learning environment that acknowledges and values the experiences of all users.

Usability testing is an effective method for identifying and addressing accessibility and inclusivity issues. Involving users with disabilities and varying levels of technological experience in the testing process can provide valuable insights into potential barriers and areas for improvement. Feedback from these users can guide adjustments to content design, ensuring that it meets accessibility standards and is inclusive of all learners.

Integrating Interactive Elements for Enhanced Learning

Interactive elements play a critical role in enhancing the effectiveness of online content by engaging learners more deeply and facilitating active participation. This section examines the integration of interactive elements in online content and their impact on learner engagement and knowledge retention.

Interactive elements, such as quizzes, simulations, and discussion forums, can significantly enhance learner engagement by providing opportunities for active involvement. Quizzes and self-assessment tools allow learners to test their understanding and receive immediate feedback, which can reinforce learning and highlight areas needing further attention. Simulations, on the other hand, offer practical, hands-on experience in a controlled environment, enabling learners to apply theoretical knowledge to real-world scenarios. These elements not only make the learning process more dynamic but also cater to different learning styles, promoting a deeper understanding of the material.

Discussion forums and peer interactions are essential for fostering a collaborative learning environment. They allow learners to share insights, ask questions, and engage in critical thinking, which can enhance comprehension and retention. Facilitators can use these forums to guide discussions, provide additional resources, and address common misconceptions. The social aspect of learning through interaction with peers can also increase motivation and create a sense of community among learners.

Another important interactive element is the use of gamification techniques, such as badges, leaderboards, and reward systems. Gamification can increase motivation and engagement by incorporating game-like elements into the learning experience. For example, earning badges for completing modules or achieving high scores on quizzes can provide learners with tangible incentives and recognition for their progress. However, it is essential to design these elements thoughtfully to ensure they align with educational objectives and do not detract from the learning experience.

Effective integration of interactive elements requires careful planning and alignment with the content's educational goals. It is crucial to ensure that these elements are not merely add-ons but are designed to complement and enhance the learning experience. Evaluating the effectiveness of interactive elements through user feedback and performance data can provide insights into their impact on learner engagement and outcomes, guiding continuous improvement in content design.

Future Trends in Online Content for Veterinary Extension

The evolution of online content for veterinary extension is shaped by emerging technologies and evolving educational practices. This section explores key future trends that are likely to impact how veterinary extension professionals engage with online content and how they apply it in their practice.

One prominent trend is the increased use of artificial intelligence (AI) and machine learning in online education. AI technologies are enhancing personalized learning experiences by adapting content and recommendations based on individual learner behaviors and needs. For instance, AI-driven platforms can provide tailored learning pathways and instant feedback, optimizing the educational experience for each user. This personalization can be particularly beneficial in veterinary extension, where professionals may have varying levels of prior knowledge and expertise.

Virtual reality (VR) and augmented reality (AR) are also transforming online content by offering immersive learning experiences. VR simulations allow veterinary professionals to practice surgical procedures or interact with virtual animals in a controlled environment, enhancing practical skills and experiential learning. AR can overlay digital information onto the real world, providing contextual support and interactive learning opportunities during fieldwork. These technologies are expected to make complex concepts more accessible and engaging, thus improving learning outcomes.

Gamification, which incorporates game-design elements into educational content, continues to gain traction. Future online content will likely see more sophisticated gamification strategies, such as adaptive learning games and scenario-based simulations, which can increase motivation and engagement. These approaches not only make learning more interactive but also help reinforce critical skills and knowledge through experiential learning.

The integration of big data and analytics in online content development is another significant trend. By leveraging data on learner interactions and performance, educational platforms can identify trends and areas for improvement, leading to more effective and targeted content. This data-driven approach enables the continuous refinement of educational materials and ensures that they meet the evolving needs of veterinary professionals.

Additionally, the rise of collaborative online tools and social learning platforms is expected to enhance peer-to-peer learning and knowledge sharing. Platforms that facilitate real-time collaboration and discussion among veterinary professionals can support continuous professional development and foster a

sense of community. These tools enable practitioners to share experiences, discuss challenges, and collectively solve problems, contributing to a more dynamic and supportive learning environment.

In summary, future trends in online content for veterinary extension include the integration of AI and machine learning for personalized learning, the use of VR and AR for immersive experiences, advanced gamification techniques, the application of big data and analytics, and enhanced collaborative tools. These trends promise to enhance the effectiveness and engagement of online learning for veterinary professionals.

Conclusion

Creating effective online content for veterinary extension professionals involves a multifaceted approach that integrates various instructional strategies, technological tools, and engagement techniques. Throughout this chapter, we have explored critical elements and best practices that contribute to the development of high-quality, impactful online educational materials.

Firstly, the foundation of effective online content lies in understanding the target audience's needs and characteristics. By conducting thorough needs assessments and aligning content with the specific demands and knowledge levels of veterinary professionals, content creators can ensure that the material is relevant and engaging. This alignment not only enhances the learning experience but also ensures that the content addresses real-world challenges and gaps in knowledge.

Secondly, the organization and presentation of online content are pivotal in facilitating learning. Structuring content logically and incorporating clear, concise language helps learners navigate complex information more easily. Additionally, employing multimedia elements—such as videos, infographics, and interactive diagrams—can aid in illustrating key concepts and maintaining learner interest. These elements cater to different learning styles and help make abstract concepts more tangible. Interactive components, such as quizzes, simulations, and discussion forums, play a crucial role in reinforcing learning and promoting active engagement. By providing opportunities for learners to apply their knowledge, test their understanding, and interact with peers, content creators can enhance the effectiveness of the educational experience. These interactive elements not only support knowledge retention but also foster a collaborative learning environment.

Thirdly, assessment and feedback mechanisms are integral to measuring learning outcomes and guiding improvement. Implementing formative assessments and providing timely, constructive feedback enables learners to track their progress and address areas of difficulty. This iterative process helps in refining the content and improving its alignment with educational objectives. Looking to the future, the integration of emerging technologies and innovative practices will continue to shape the landscape of online education for veterinary extension professionals. Advances in artificial intelligence, virtual reality, and gamification offer new avenues for creating immersive and personalized learning experiences. By staying abreast of these trends and incorporating them thoughtfully into online content, educators can further enhance engagement and effectiveness.

Finally, the creation of effective online content for veterinary extension professionals requires a comprehensive approach that includes understanding audience needs, organizing content effectively, integrating interactive elements, and utilizing advanced technologies. By adhering to these principles and continuously evaluating and refining their approaches, educators can develop online content that not only meets the educational needs of veterinary professionals but also supports their ongoing professional development and practice.

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New Media and Conventional Media

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ABSTRACT

This chapter explores the evolving landscape of media in agricultural communication, focusing on the roles of folk media, conventional media, and new media technologies. With its deep cultural roots, folk media plays a vital role in rural development by engaging audiences through participatory methods and aligning with local traditions. Conventional media, including print, radio, and television, remain crucial for reaching wide audiences and providing structured, credible information, despite challenges such as high costs, limited interactivity, and geographical limitations. The new media, including social media platforms, blogs, microblogs, and mobile applications, which are reshaping how agricultural information is shared and accessed. These digital tools facilitate real-time, interactive communication, overcoming many of the limitations of traditional media. They enable farmers to access timely updates, share experiences, and engage with broader networks, thus enhancing decision-making and productivity. Furthermore, advanced technologies such as augmented reality, virtual reality, and AI-driven chatbots like Kissan GPT are emerging as powerful tools in agricultural extension, offering personalized advice and immersive learning experiences. In conclusion, the integration of folk, conventional, and new media offers a comprehensive approach to agricultural communication, each playing a complementary role in addressing the diverse needs of farmers. This hybrid approach is essential for fostering sustainable agricultural development, particularly in rural and underserved areas.

Key words: *Conventional Media, Digital Tools, Folk Media, New Media*

Introduction

Media refers to the various channels, tools, or platforms used to store, deliver, and communicate information or content to a wide audience. Throughout history, various media and channels have been employed to convey information. Over time, these forms of media have undergone significant evolution. In earlier periods, traditional forms of media predominated. The advent of the digital revolution has marked the beginning of the Information Age, characterized by the growing economic, social, and technological significance of information. Consequently, new forms of media have emerged and continue to evolve, enabling the timely and effective dissemination of information.

Types of media

1. **Traditional media:** Traditional media (old media) are non-digital methods of communication practices by a particular community for example folk media.
2. **Conventional media:** Conventional media are the group of media that are associated with all forms of communication used before the emergence of the Internet. Conventional media include print media (newspapers, magazines, brochures), broadcast media (radio, television), and interpersonal communication methods (meetings, workshops).
3. **New media or modern media or digital media:** It encompasses methods that primarily involve the Internet in some capacity. New media is a hybrid form of media, similar to the internet, that combines the functional properties of mass media and interpersonal communication. New media includes email, web browser, online communication, digital newspapers, e-books, e-learning etc.

Evolution of media forms

The evolution from traditional and conventional media to new media has significantly transformed how information is disseminated and consumed. Throughout various historical periods, different types of media have been developed and utilized.

1. **Prehistoric age/pre-industrial age (before 1700):** Before the existence of written and recorded history, there was the Stone Age and Metal Age. People discovered fire, developed paper from plants, and forged weapons or tools with stone, bronze, copper and iron. Prehistoric humans learned to etch on cave walls, drawing scenes from their surroundings, such as animals and nature.
2. **Industrial age (1700s to 1930s):** During this era people used the power of steam, machine tools, and established iron production to manufacture various products including books through the printing press for different means of communication.
3. **Electronic age (1930s to 1980s):** The invention of the transistor marked the beginning of the electronic age. With transistors, people unlocked new possibilities, leading to the creation of the transistor radio, electronic circuits, and early computers. This era revolutionized long-distance communication, making it more efficient than ever before for example Transistor Radio, Television

(1941), Large electronic computers, Mainframe computers - i.e. IBM 704 (1960), OHP, LCD projectors etc.

4. **Information age (1900s to 2000s):** The Internet facilitated more rapid communication and enabled the development of social networks. People advanced the use of microelectronics with the invention of personal computers, mobile devices, and wearable technology. Moreover, voice, image, sound and data are digitalized. We are now living in the information age.

Traditional media

Folk media of communication

Folk media of communication are defined as forms of expression that use vocal, verbal-musical, and visual folk art, passed down through generations within a society or group of societies. These indigenous modes have long served as essential tools for communication, deeply embedded in the socio-cultural fabric of communities.

Types of Folk Media

S.N.	Type of folk media	Description with examples	Image
1	**Folk theatre**	It is a mix of elements from music, dance, epic and ballad recitation, graphic arts, religion, and festival culture. Eg. Ankia naat, Ramlila, Raslila, Jatra, Bhand etc.	
2	**Puppetry**	There are four types of puppetries mainly: - String puppets, Rod puppets, Glove puppets and Shadow puppets, which are found in different parts of India. Utilization of puppetry can be done for mass communication purposes for social awareness.	
3	**Folk music**	Folk music is a type of music which traditionally passed down from generation to generation, often orally. It uses traditional instruments and has a connection to a particular culture. Eg. Bihu, Garba, Maand, Laman etc	
4	**Folk dances, fairs and festivals**	Indian folk dances, which typically consist of a few simple steps, are performed throughout the world to celebrate a new season, childbirth, weddings, festivals, and other social occasions. Eg. Kajri, Dandiya Raas, Pavri Nach, Bhangra etc.	

Role of folk Media

Folk media have proven highly effective in communicating developmental information and messages for rural development.

Advantages of folk media:

i. Folk media involves substantial participation of the audience.
ii. It attracts and sustain the audience's interest as they contain the entertainment elements.
iii. It creates greater confidence and arouses motivation to change because the communication takes place within the cultural pattern of rural society.
iv. The folk media will be more effective in rural areas which have the problems of illiteracy, resistance to change and inadequate spread of mass media.
v. Folk and modern media can be integrated, complementing each other for effective communication for rural development.

Conventional media

Print media communication: Print media is one of the oldest and basic form of mass communication. It includes newspapers and magazines, newsletters, posters and banners, flyers, journals, and other farm publications. Print media in agricultural extension has both advantages and limitations. The advantage includes it offers high outreach and is effective in creating awareness among farmers. However, the limitations include limited space for detailed agricultural content, challenges for illiterate farmers, and the risk of losing value if the content is not properly prepared.

ICAR Publication for farmers

- Indian Farming magazine
- ICAR NEWs
- ICAR Reports
- *Kheti, Phalphul*, and *Krishi Chayanika* magazine

Ministry of Agriculture Publication

- Intensive farming
- *Unnat Kheti*
- *Krishi Vistar Samiksha*

Agriculture universities publication

Farm digest, Parvatiy kheti, Changi kheti, Krishi sansar, Adike patrike, Krishi lok etc developed by various state universities.

Community Radio for communication: Community radio is a platform where local people create and broadcast programs in their local language and take part in running the station. Community radio can significantly disseminate information to rural illiterate and semi-literate farmers as it is affordable and accessible.

Many community radio stations are serving the needs of Indian farmers.

Sangham Radio: It is established in Andhra Pradesh, and is owned, managed, and operated entirely by women from rural marginalised communities (Dalit caste). The station's broadcast reaches a 25 km radius, covering 100 villages. The programme broadcast content includes news and views of local people, news and reports on farming tools of agriculture, folk songs, success stories etc.

Krishi Community Radio: It was founded in 2007 by the UAS, Dharwad covers a 15-20 km area around the University. It is dedicated to supporting agriculture and the rural community.

Sharada Krishi Vahini: Launched in 2011 by Krishi Vigyan Kendra, Baramati. It provides the latest information in the field of agriculture to the farming community in and around 25 km from Krishi Vigyan Kendra, Baramati.

Other community radios are Vasundhara Krishi Vahini, Radio Adan, Pantnagar Janvani, TANU e-Community radio, Kisan Vani etc.

Radio for communication: Radio is an electronic audio medium for broadcasting information quickly. Among other mass media, it is considered a cheap source of sending useful and practical information to the farmers.

- Radio is a Cosmopolite media
- It is widely dispersed among rural people
- Operated at low cost
- Penetrated deep into rural people life

Radio programmes

Farm School on AIR: The Farm and Home unit of All India Radio (AIR) launched the "Farm School on AIR" program to effectively disseminate new farming technologies to farmers. Broadcasted programmes like *Krishi Jagat* and *Suno Kisano*.

Kisan Vani: Launched in 2004, the Kisan Vani Programme is now broadcast across all of AIR's Local Radio Stations (LRS) and several primary stations nationwide. The primary objective of the *Kisan Vani* Programme is to educate farmers on a range of topics, including the diffusion of innovation, the lab-to-land approach, modern and scientific agricultural techniques etc.

Gyan Vani: Gyan Vani (operating by Indra Gandhi National Open University, IGNOU) is an educational FM radio station operating in multiple cities across India. The centre is committed for the creation, distribution, and transmission of educational materials.

Television for communication: Television is an electronic audio-visual medium which provides pictures with synchronised sound.

- Cosmopolite media
- Create instant awareness
- Multimedia equipment creates interest among users

Television channels: Television channels can play a significant role in disseminating agricultural information to farmers.

Krishi Darshan is a television program which telecasted on DD National and DD Kisan TV Channels. Currently broadcasted to 80 villages near Delhi region. This programme aims to disseminate agricultural information to rural farmers.

DD Kisan is an agricultural television channel established by the Government of India and managed by the Ministry of Information and Broadcasting. It was launched on May 26, 2015, as the flagship channel of Doordarshan. The channel focuses on agriculture and related fields, providing farmers with real-time information on modern farming practices, water conservation, organic farming, and other essential topics.

Kisan TV: It is a part of Prasar Bharati network. Kisan TV broadcasts content specifically aimed at farmers, including agricultural tips, market trends, and government schemes.

AgriJunction: This channel provides farmers with educational content on various aspects of agriculture, including crop management, pest control, and new technologies.

Shramajeevi TV: Shramajeevi Television Private Limited is a visual media (TV) company dedicated to content making on various aspects of agriculture and allied sectors. It prepared Agricultural documentaries, short films, corporate films, TV commercials, Testimonials, Jingles etc. in Kannada, English, Hindi, and other languages of India.

Kissan Call Center: Ministry of Agriculture launched the scheme Kisan Call Centres (KCCs) on January 21, 2004 in order to harness the potential of ICT in Agriculture. The main aim is to answer farmers' queries on a phone call in their own language. A countrywide common eleven-digit Toll Free number 1800-180-1551 has been allotted for Kisan Call Centre.

Strengths of traditional media

1. **Credibility and Trust:** Conventional media outlets especially established newspapers and television channels, are often perceived as more credible due to their rigorous editorial standards and long-standing reputation.
2. **Wide Reach:** Television and radio, in particular, can reach remote and rural areas where internet connectivity might be sparse.
3. **Structured Content:** Traditional media formats often provide well-structured and comprehensive content, making it easier for audiences to follow and understand complex information.
4. **Cultural Relevance:** Traditional media, especially folk media, often align with local customs, languages, and traditions, making them more relatable and effective in communicating messages.
5. **Simplicity and Accessibility**: Traditional media formats, such as radio and print, are easy to use and accessible to people with varying levels of literacy and technical skills.
6. **Longevity and Familiarity:** Many traditional media have been in use for decades, leading to familiarity and comfort among audiences who may be resistant to new forms of media.
7. **Community Engagement:** Folk media, in particular, can engage communities through participatory and interactive formats, fostering a sense of ownership and involvement in the development process.
8. **Non-Digital Dependency:** Traditional media do not rely on electricity or internet connectivity, making them especially valuable in areas with limited infrastructure.

Challenges for conventional media

1. **Limited Interactivity:** Conventional media are generally one-way communication channels, limiting audience engagement and feedback.
2. **High Costs:** Producing and disseminating content via traditional media can be expensive, particularly for small-scale extension programs.
3. **Slow Adaptation:** Conventional media might struggle to adapt quickly to emerging issues or incorporate real-time updates compared to new media.
4. **Limited Reach in Digital Age**: As more people turn to digital platforms for information, traditional media may struggle to maintain their audience, particularly among younger, tech-savvy generations.
5. **Rigidity in Content Delivery**: Traditional media often follow a fixed schedule or format, which may not be flexible enough to address rapidly changing situations or provide timely updates.
6. **Language and Literacy Barriers**: Print media and some broadcast formats may not be accessible to individuals with low literacy levels or those who speak languages not covered by the media outlet.
7. **Geographical Limitations**: While traditional media can reach large audiences, they may still struggle to penetrate very remote or isolated areas where infrastructure for broadcasting or distribution is lacking.

New Media in Extension

New media includes digital technologies and platforms that enable interactive, real-time communication and the creation of user-generated content. It refers to communication technologies that facilitate or improve interactions between users, as well as between users and content. The term "new media" gained popularity in the mid-1990s, largely due to the rise of interactive CD-ROMs used for entertainment and educational purposes. These technologies, often associated with Web 2.0, encompass various web-based communication tools, including blogs, wikis, online social networks, virtual worlds, and other social media platforms. According to Neuman “We are experiencing the development of a globally interconnected network that integrates audio, video, and electronic text communications, blurring the lines between interpersonal and mass communication, as well as between public and private communication”. He believes that new media will:

- Redefine the significance of geographic distance.
- Significantly expand the volume of communication.
- Enable much faster communication.
- Create opportunities for interactive communication.
- Allow previously distinct forms of communication to overlap and interconnect.

Definitions of new media

New media as a distribution platform: New media refers to cultural objects that utilize digital computer technology for their distribution and display. Examples include the Internet, websites, computer-based multimedia, and Blu-ray discs.

New media as the mix between existing cultural conventions and the conventions of software: New media is a blend of traditional cultural methods for representing, accessing, and handling information with newer digital methods. The computer is mainly used as a tool rather than making key creative decisions.

New media as faster execution of algorithms previously executed manually or through other technologies: Computers greatly speed up processes, allowing for new forms of representation and media art that weren't possible before.

New media as metamedia: Metamedia coincides with postmodernism in that they both rework old work rather than create new work. New media avant-garde is about new ways of accessing and manipulating information (e.g. hypermedia, databases, search engines, etc.). Meta-media is an example of how quantity can change into quality as new media technology and manipulation techniques can recode modernist aesthetics into very different postmodern aesthetics.

New media as a tool for social change: Social movements have widely used new media to educate, organize, share cultural products, communicate, build coalitions, and more.

New Media in agriculture and allied sectors

1. **Web browsers:** A web browser is an application designed to access websites on the Internet. It serves as software that enables users to view content on the World Wide Web. Essentially, a web browser functions as a translator, retrieving information from web servers and presenting it to the user as a web page. Eg. Mosaic, Internet Explorer, Safari, Firefox, Chrome, Edge etc.

2. **Social networks/social media:** social media are interactive technologies that enable users to create, share, and aggregate content such as ideas, interests, and other forms of expression within virtual communities and networks.
    - Social media also refers to the content: user-generated information, opinion, video, audio, and multimedia that are shared and discussed over digital networks.
    - Popular social media platforms with over 100 million registered users include Twitter, Facebook, WeChat, ShareChat, Instagram, Pinterest, QZone, Weibo, VK, Tumblr, Baidu Tieba, Threads, and LinkedIn.
    - These tools are empowering agricultural professionals, transforming agricultural organisations and connecting farmers.

Social media use for social networking services: Social Networking services are used for networking with friends and colleagues. Popular platforms are Facebook, Google Plus and LinkedIn. These networks are used in the agriculture sector by National Centre for Management of Agricultural Extension (MANGAGE), Agricultural Extension in South Asia (AESA), Global Forum for Rural Advisory Services (GFRAS), and Consultative Group on International Agricultural Research (CGIAR).

Use of Social Media in Agriculture:

- Share agriculture information and message
- Post video and photos of field activities, demonstrations and uses of new technology
- Share success stories of progressive farmers
- Advertise events like farmers' fairs, exhibitions, campaigns, seminars etc.
- Create awareness of government schemes
- Sent alerts in emergencies such as pest attacks, flood etc.
- Promotes the farm products and create a marketing channel

3. **Blogs:** A blog (weblog) is an informational website made up of separate, often informal diary-style text entries called posts. These posts are usually displayed in reverse chronological order, with the most recent post appearing at the top of the page.
   Blogging is an easy way to communicate knowledge. It is also called an online diary.

Features:

- A typical blog integrates text, digital images, and links to other blogs, web pages, and media related to its topic.
- Entries in blogs generally appear in reverse chronological order.
- After logging into the blog individuals can follow other blogs and post comments.
- Blog can have single or multiple authors.
- Most blogs are primarily text-based, some specialize in other formats, such as art (art blogs), photographs (photoblogs), videos (video blogs or vlogs), music (MP3 blogs), and audio (podcasts).
- In education, blogs used as instructional resources are known as edublogs.
- Microblogging, a variant of blogging, involves very short posts.

Blogging creation: Some free blogging platforms are available, such as Blogger (www.blogger.com) and WordPress (www.wordpress.com). These platforms enable users to create, edit, and publish posts, photos, and videos with ease. From a single account, a blogger creates up to 100 blogs.

International Institute for Environment and Development (IIED), IFPRI and AESA are the organisations that use blogging websites for communicate the latest information and opinions about agriculture topics.

Use of Blogs in Agriculture

- Express the opinion of various stakeholders
- Share new initiatives, technologies, and practices in agriculture and allied sectors
- Allow interaction between author and reader
- Share information quickly.

4. **Microblogs:** Microblogging is a type of blogging where users can post short text updates, typically limited to 140 characters or less. Microblogging involves short blog posts meant for quick, direct interactions with audiences. These brief updates are typically shared on social media platforms like Twitter or Instagram and can include various content formats such as audio, text, images, or video.

Various Organizations are using microblogging to share resources, ask questions, and enhance the visibility of their programs and projects.

@icarindia https://twitter.com/icarindia is the Twitter handle of the Indian Council of Agricultural Research (ICAR), Ministry of Agriculture, Govt. of India.

AgChat: Twitter discussion group created by AgChat Foundation's in 2009. It serves as a platform for facilitating industry discussions between farmers and agribusinesses. While originating in the USA, AgChat has since expanded its reach to the UK, Australia, New Zealand, and Ireland.

5. **Media sharing sites:** These sites allow users to share videos, photographs and audio among users.
    i. **Video sharing:**
        a. **YouTube:** YouTube (http://www.youtube.com) is a video-sharing website where users can watch, upload, and share short videos and multimedia presentations. YouTube helps disseminate information through engaging visual content and provides a platform for showcasing various adaptive techniques.
        b. **Agtube platform:** Agtube is a platform where you can upload and share video clips in any language. It is an initiative by Access Agriculture, an international NGO that promotes the use of training videos to assist farmers, pastoralists, and rural businesses in enhancing their profits and livelihoods. Agtube enables individuals and local communities to share their experiences and local innovations, inspiring others both within their country and globally.
        c. **Digital Green:** Digital Green (https://www.youtube.com/user/digitalgreenorg) creates and shares videos to promote the adoption of locally relevant agricultural practices across rural communities. These 8 to 10 minute documentaries, developed in collaboration with partners and village communities, are tailored to local content, languages, and dialects. The videos are accessible on the Digital Green website and YouTube.
    ii. **Photo sharing:** Photo sharing sites like Flickr, Instagram, Pinterest can help organise and share photos and images easily and also receive comments from others.
    iii. **Audio Sharing:** You can upload and share music and audio with others. Podcasting involves using the Internet to make digital recordings available for download. Sound Cloud, and Podomatic are popular sound platforms for audio sharing.
6. **Messaging platforms:** A Messaging platform allows the exchange of messages for communication. Several platforms, including WhatsApp, Telegram, and Facebook Messenger, are available for messaging. Eg. Sethkari Mitra (Farmers friend) a WhatsApp group in Maharashtra, for sharing information on agriculture, Animal husbandry and the marketing of produce.
7. **Cloud storage:** These applications can be used to store and share files, photos, and other documents in the cloud (remote servers where data is kept). User can access and view these files from any internet-connected mobile phone, tablet, or computer. Popular storage devices are Google Drive, One Drive, and Drop Box which give free storage space of 15GB, 5GB, 2GB respectively.
8. **Mobile Apps:** Mobile-based applications provide farmers, students, and agricultural entrepreneurs with quick and easy access to information. Numerous mobile apps have been developed by various government and private organizations, such as the IVRI-Dairy Manager app, IVRI-Parasitic Management Guide, Kisan Suvidha, Pusa Krishi etc.

    Uses of Mobile Apps:
    - Farmers can effectively monitor and manage the herd efficiently.
    - They get advisories through audio and video messaging services.
    - Farmer gets price, quality and quantity of arrival of various animal products at different markets.
    - Access to information on management of the farm.
    - Get information about government policies and services.
9. **E-learning platform:** An electronic learning platform is an all-in-one online system that provides educators and learners with tools, resources, and information to enhance and manage education effectively. Eg Massive Open Online Courses (MOOC) platform

Farmer e-world platform: Generated by ICAR to provide advisory support to the farmers in terms of short-term training programmes on agriculture, horticulture, home science, fisheries, dairy, veterinary and animal husbandry etc.

MOOCs Providers: Canvas, Coursera, edx, Khan Academy, Udacity, Swayam, National Academy of agriculture Research Management (NAARM), MAGANGE, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) etc.

10. **Expert System:** It is also defined as a system that uses human knowledge stored in a computer system to solve problems that typically require human expertise. eg. Rice, wheat, tobacco expert systems etc.

Nowadays, expert systems in agriculture are increasingly used for diagnosing and managing economically significant pest issues, such as diseases and insects affecting crop plants.

Features

- Expert systems typically have three components viz., knowledge base, inference engine (Heart of expert system) and user interface.
- Expert system has three functions:
  - Crop doctor (Main function): Diagnose disease
  - Decision Support System
  - Information management

11. **Digital Ecosystem for Agriculture and Rural Livelihood (DEAL):** A system has been developed by Media Lab Asia in association with IIT Kanpur to provide a multimedia platform for the creation, sharing and dissemination of agricultural information among farmers and experts. This portal provides agricultural-related information in various categories organized hierarchically.
12. **AKMS (Agriculture Knowledge Management System):** It is a comprehensive platform designed to deliver valuable information to farmers. AKMS aims to provide farmers with timely, relevant, and actionable agricultural information to enhance their farming practices and decision-making.
13. **Big Data:** Big data encompasses a large volume of structured and unstructured information that can be analyzed to uncover valuable insights and create predictive models, enhancing decision-making processes.

Features:

- Big data is characterized by some unique features (5V)– volume, variety, velocity, variability, and veracity.
- The primary aim is to assist farmers, agriculturalists, and scientists in adopting effective farming practices.
- Big data applications in agriculture integrate technology and analytics to enhance decision-making.
- This involves the collection, compilation, and timely processing of new data, enabling scientists and farmers to make more informed choices.

14. **Augmented Reality:** A technology that overlays computer-generated images onto a user's view of the real world, creating a combined visual experience. Augmented reality is an interactive experience that blends the real world with computer-generated 3D content. Farmers can evaluate land fertility to determine the best crop to plant. Augmented reality (AR) can enhance this fertility assessment process. AR can help new farmers become familiar with agricultural equipment without needing to operate it directly.
15. **Virtual Reality:** Virtual reality creates a simulated experience by using 3D near-eye displays and pose-tracking technology to immerse users in a virtual environment. From immersive educational experiences that place you at the centre of agriculture, to pest control and specialized VR training in Vertical Farming, where essential skills are honed, and engaging virtual farm tours that take you straight to the fields.
16. **Kissan GPT/Chatbots:** Kissan GPT is an AI-driven chatbot designed to offer agricultural information and advisory services to farmers. It Utilizing the GPT-3.5 architecture and natural language processing to communicate with farmers in their preferred languages. These are accessible through multiple platforms, such as WhatsApp, Facebook Messenger, and SMS.
    - Through chat interface they can engage in conversations, respond to inquiries, provide information, and perform various tasks.
    - Kissan GPT offers a range of uses for farmers, including agriculture advice, weather updates, market information, farming techniques etc.
    - It provides timely and personalized recommendations to farmers.

AI-Powered Agriculture Chatbots: Here are some AI chatbots for agriculture:

- **Ama Krush AI:** First AI chatbot designed for agriculture in India. It assists farmers through government programmes, credit products, and agronomic techniques.
- **Kissan GPT:** Boosts the profitability of Indian farmers. Provide advices on how to manage soil, insect control, and crop cultivation.
- **Krushi - The Farmer Chatbot:** Assists farmers in making informed judgements about their crops.
- **PM Kisan AI-Chatbot (Kisan-e-Mitra):** The AI chatbot for the Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) programme was introduced by the Indian government.
- **Dairy Shria**: It is a modern educational platform created to support people in dairy farming. It was developed through a partnership between ICAR-IVRI, Izatnagar, and ICAR-IASRI, New Delhi. This chatbot uses advanced language processing and machine learning to give users real-time, useful information to dairy farmers.

Strength of new media

1. **Interactivity:** New media platforms enable users to actively engage with content, participate in discussions, and provide feedback, fostering a more interactive and dynamic communication environment.
2. **Accessibility:** Digital media can be accessed from virtually anywhere with an internet connection, allowing for widespread dissemination of information and resources.
3. **Real-Time Communication:** New media facilitates instantaneous communication and updates, enabling users to receive and share information in real time.
4. **Personalization:** Advanced algorithms and user preferences enable the tailoring of content to individual interests and needs, enhancing relevance and engagement.
5. **Cost-Effectiveness:** Digital platforms often reduce the costs associated with content creation and distribution compared to traditional media, making it more accessible for a wide range of users and organizations.
6. **Global Reach:** New media allows for the dissemination of information on a global scale, connecting people across different regions and cultures.
7. **Multimedia Integration:** New media integrates various forms of content, including text, audio, video, and interactive elements, providing a richer and more engaging user experience.
8. **User-Generated Content:** Platforms such as social media and blogs empower users to create and share their own content, contributing to a diverse and dynamic media landscape.

Challenges for new media

1. **Digital Divide:**
   Access to Technology: Not all farmers have access to smartphones, computers, or reliable internet, especially in remote or underdeveloped areas.
   Literacy and Digital Skills: Some farmers may lack the literacy or technical skills needed to effectively use new media platforms.
2. **Information Overload:**
   Volume of Information: Farmers can be overwhelmed by the sheer amount of information available online, making it difficult to discern what is relevant or credible.
   Quality and Accuracy: The rise of misinformation and unverified content on social media can lead to farmers adopting poor practices or making decisions based on inaccurate data.
3. **Data Privacy and Security:**
   Personal Data Vulnerability: Farmers may unknowingly share personal or sensitive information on online platforms, making them vulnerable to cyber threats.
   Trust Issues: Concerns about how data is collected, stored, and used by digital platforms can lead to mistrust and reluctance to engage with new media.
4. **Language Barriers:** Many new media platforms may not offer content in the local languages or dialects spoken by farmers, limiting their accessibility.
5. **Cost Implications:** The cost of purchasing devices and data plans can be prohibitive for some farmers. Further, ongoing expenses related to device maintenance, software updates, and data usage can be a burden.
6. **Limited Interaction:** Traditional extension services often rely on personal interactions, which can be more effective in building trust and understanding. New media lacks the personal touch, making it harder to establish strong relationships.

7. **Generational Gaps:** Older farmers may be resistant to adopting new technologies and may prefer traditional methods of receiving information.
8. **Infrastructure Challenges:** In rural areas, internet connectivity may be unreliable or slow, affecting the ability to access real-time information. Also, frequent power outages or lack of access to electricity can hinder the use of digital devices.
9. **Sustainability and Scalability:** Many digital initiatives in agriculture are short-lived so making it difficult to maintain consistent support for farmers.

Future recommendations for efficient use of media

Embracing Convergence: The convergence of conventional and new media offers a promising pathway for extension services. Developing integrated communication strategies that leverage the strengths of both media types can enhance information dissemination, engagement, and impact.

Fostering Digital Literacy: Enhancing digital literacy among target audiences ensures that the benefits of new media are fully realized. Extension programs should include components that educate users on navigating and utilizing digital platforms effectively and safely.

Ensuring Inclusivity: Efforts must be made to bridge the digital divide, ensuring that remote and underserved communities have access to both conventional and new media resources. Investing in infrastructure and training can mitigate disparities and promote inclusive communication.

Inclusive role of extension officials: Extension agencies should create awareness and organize in-service training for the staff on skill acquisition and importance of new media use in sourcing and disseminating innovation. This will encourage extension agents to increase their extent of new media use.

Digital ecosystem: It is necessary that access to Internet facilities be provided with other supporting amenities such as a constant supply of electricity, regular upgrading of Internet skills, software and hardware. This could re-orientate and prompt extension agents' interest in the better use of new media.

Greater participation: The need for community enrolment mainly by NGOs or Public-Private Community partnership for the need of using the new media to source for agricultural information.

Content centric approach: Provide broadband connectivity and a content centric development approach particularly in the rural areas.

Interactivity: Create and support platforms that allow for two-way communication between farmers and extension agents, experts, and peers. This can include live chat features, discussion forums, and video consultations.

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E-resources available to support farmers

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ABSTRACT

India's growing population puts immense pressure on its agricultural sector. This sector, despite employing nearly 148 million people and contributing 15% of the country's GVA, faces challenges in meeting the rising food demands. Technology offers a solution through e-resources, which are digital tools and information sources that can revolutionize farming practices. This article explores the various types of e-resources available to Indian farmers. These include information services like web portals, mobile applications, and social media platforms. Additionally, consultancy services like Kisan Call Center and mKisan Portal offer expert advice and personalized support. E-resources also encompass service delivery platforms such as Kisan Rath and e-NAM, which facilitate market access and efficient logistics. E-governance services like UMANG and Meri Fasal Mera Byora provide farmers with easy access to government schemes and real-time updates. Finally, e-learning tools like SWYAM MOOCs and KrishiKosh offer educational resources and skill development opportunities. The article acknowledges the challenges associated with utilizing e-resources, including limited ICT infrastructure, lack of skilled personnel, and digital literacy gaps. It proposes solutions like improved infrastructure, training programs, and localized content creation to address these hurdles. Looking toward the future, the article explores potential advancements in e-resources for agriculture. These include AI-powered disease identification systems for livestock and crops, wearable sensor devices for animal health monitoring, and blockchain technology for enhanced food supply chain transparency. By strategically harnessing e-resources, India can empower its farmers, improve agricultural efficiency, and ensure food security for its growing population.

Keywords: *Web portals, mobile application, chatbots, consultation services, e-learning tools,*

Introduction

India's agriculture sector, which contributes 15% of the country's GVA with a 3.3% CAGR in 2022–2023 would be under tremendous strain to fulfill the country's expanding 1.29 percent population's rising food demands. This industry, which employs close to 148 million people, is essential to guaranteeing food security and better nutrition for 1.4 billion people. The industry's ability to support a sizable workforce and provide employment prospects highlights how important it is (BAHS, 2023; PLFS, 2022-23). Technology has revolutionized modern farming by enhancing crop productivity and reducing resource use. Precision agriculture minimizes water, fertilizer, and pesticide consumption, lessening the environmental impact on natural ecosystems. AI-driven climate and weather predictions allow for better planning, while biotechnology creates resilient crops that withstand pests and changing climates. These advancements lead to greater efficiencies, resulting in lower production costs and prices. Moreover, improved facilities and automation provide better working conditions for farm laborers, making farming more sustainable and efficient in meeting global food demands. E-resources, defined as information stored in the form of electrical signals, often on a computer, are transforming the agricultural sector. These digital tools offer numerous benefits, including the ability for multiple users to access the same information simultaneously, enhancing collaboration and decision-making. By providing easy access to vital information and markets, e-resources contribute to increased productivity on farms. The vast storage capacity of these resources allows for the retention of extensive agricultural data, which can be used to optimize farming practices over time. Additionally, e-resources promote the efficient and economical delivery of information to all users, ensuring that farmers, regardless of their location, have the knowledge they need to improve their operations. This accessibility helps bridge the gap between rural farmers and large progressive farmers, leading to more informed decisions and, ultimately, more successful and sustainable farming. The rapid growth in digital infrastructure and usage in India presents significant opportunities for leveraging e-resources. With a teledensity of 85.6%, encompassing 61% in urban and 25% in rural areas, and 1.197 billion telecom subscribers, including a rising number of smartphone and PC users, there is a solid foundation for expanding digital services. The internet usage has surged to 916.77 million, even reaching remote regions with a steady growth of 0.63%. Despite a digital literacy rate of 38% higher in urban areas (61%) compared to rural areas (25%) the substantial government funding of ₹4216.51 crore for the Digital India Programme underlines the commitment to bridging these gaps. As India continues to advance, these

e-resources can be strategically harnessed to drive inclusive growth and enhance digital access across diverse communities.

Types of E-Resources

E-resources include information services, consulting, service delivery, e-governance, and e-learning solutions that improve accessibility, effectiveness, and involvement across several industries.

Information services

Information services utilize web portals, mobile apps, and social media to provide accessible, timely, and interactive resources, enhancing user engagement and information dissemination.

1. Web portals:

A web portal for farmers provides centralized access to agricultural information, market data, weather updates, government schemes, and expert advice, enhancing decision-making and resource management for improved farm productivity and sustainability.

Farmers' Portal: Launched on June 9, 2014, the Farmers' Portal, owned by the Ministry of Agriculture and Farmers' Welfare, GOI, is a comprehensive online platform designed to bridge information gaps in agriculture. It offers real-time weather updates, market prices, details of government schemes, and expert advice to help farmers make informed decisions. As part of the "Digital India" initiative, the portal aims to empower the agricultural sector by leveraging digital resources to enhance productivity and income.

E-Choupal: Launched in June 2000 by ITC Limited, E-Choupal addresses information asymmetry in agriculture through a network of internet-connected kiosks in villages, operated by trained local "Sanchalaks." With 6,450 kiosks across eight states, it serves over 35,000 villages and benefits more than 40 lakh farmers. The platform provides real-time market prices, enabling informed decision-making and direct procurement of farm produce by ITC. E-Choupal enhances agricultural efficiency and empowers farmers by offering information and services in local languages.

Crop Insurance Portal: Launched in May 2015 by the Ministry of Agriculture and Farmers' Welfare, GOI, the Crop Insurance Portal streamlines crop insurance management by integrating farmers, insurance companies, and government agencies on a single platform. It allows farmers to register crop details, select policies, and handle insurance applications, premium payments, and claims. By providing real-time updates and enhancing transparency, the portal aims to increase awareness and efficiency in crop insurance processes, benefiting both farmers and stakeholders.

Participatory Guarantee System of India (PGS) Portal: Launched in 2011 by the Ministry of Agriculture and Farmers' Welfare, GOI, the PGS Portal promotes organic farming through a participatory approach. It offers a cost-effective certification system, fostering farmer collaboration and enhancing consumer confidence in organic products.

VISTAAR: also known as Virtually Integrated System To Access Agricultural Resources, is a decentralized network designed to enhance agricultural efficiency. It connects farmers, extension workers, and service providers through interconnected databases, enabling seamless access to critical agricultural resources. By integrating AI tools, web portals, and applications, VISTAAR facilitates informed decision-making and resource utilization. The system supports the entire agricultural value chain, from land preparation and crop production to market access, while promoting collaboration among government agencies, NGOs, and research institutions. VISTAAR aims to empower farmers by improving service delivery, fostering knowledge sharing, and reducing operational costs in agriculture.

e-Pashu Haat: launched on 26th November 2016 by the Ministry of Agriculture and Farmers' Welfare under the National Mission on Bovine Productivity scheme, is an E-Trading Market portal designed for livestock germplasm and related services. Its primary objective is to connect farmers directly with breeders, minimizing malpractices in animal trading. Additionally, it serves as a centralized information repository for both Central and State Governments, facilitating transparent and efficient livestock trading.

AGMARKNET: launched in March 2000 by the Directorate of Marketing & Inspection (DMI) under the Ministry of Agriculture and Farmers' Welfare, is a crucial platform offering both static (infrastructure, Market, Promotion-related) and dynamic (Price-related) information related to agriculture markets. It provides access to price trends and arrivals for over 2000 varieties and 300 commodities across 2700 markets. The platform is widely used by farmers, traders, research institutes, and government bodies. AGMARKNET also offers personalized SMS alerts and a mobile app for easy access.

The IMD Portal: managed by the Ministry of Earth Sciences, Government of India, has been a pivotal resource for nearly 150 years. It specializes in meteorological observations, offering timely weather forecasts and warnings against severe weather events. The portal also provides climatological data crucial for agricultural and livestock planning, offers location-specific weather information, and promotes research in meteorology, supporting informed decision-making across various sectors.

Krishi-Decision Support System (Krishi-DSS): launched in 2024 during the National Conference on Space-Driven Solutions for Agriculture Transformation in India, is managed by ICAR under the Ministry of Agriculture & Farmers' Welfare, Government of India. It provides vital agricultural information and real time data driven insights through satellite images for weather updates, soil health, reservoir storage and groundwater levels, crop mapping, drought monitoring, and the One Nation-One Soil Information System. This system is designed to empower farmers, support policy-making, and foster collaboration and innovation in the agricultural sector (PIB, 16th August 2024). In addition to Krishi-DSS, there are various types of Decision Support Systems (DSS), each serving different purposes: (a) Data-driven DSS: Utilized for querying databases or data warehouses. (b) Document-driven DSS: Helps in searching and retrieving documents from specific sources. (c) Knowledge-driven DSS: Used for advising or decision-making within organizations. (d) Model-driven DSS: Assists in analyzing complex systems or evaluating different options. These DSS types enhance decision-making capabilities across various fields, including agriculture, business, and management.

2. Mobile application

Mobile apps can aid farmers by providing essential information, enhancing farm management, connecting with peers, and empowering them with tools and resources. These features streamline operations, improve decision-making, and foster collaboration for more efficient and productive farming.

E-Gopala: launched on September 10, 2020, by the National Dairy Development Board (NDDB) under the Ministry of Fisheries, Animal Husbandry & Dairying, Government of India, is a comprehensive digital platform designed to support dairy farmers. It assists in formulating balanced rations using locally available feed, managing 29 common dairy animal ailments, and offers a marketplace for buying and selling dairy animals. E-Gopala also provides real-time information on breeding, nutrition, and animal health through INAPH, along with timely alerts for vaccinations, pregnancy diagnoses, and calving. The app is available in 12 languages, with a call center for farmer queries.

Pashu Poshan: Launched on July 4, 2015, owned by NDDB and the Ministry of Fisheries, Animal Husbandry & Dairying, GOI, offers personalized feed and nutrition plans for livestock. It provides tailored recommendations on feed types and quantities, sends alerts for feeding schedules and supplements, and helps reduce feeding costs, optimizing animal health and productivity.

KISAAN 2.0: launched by ICAR-IASRI, New Delhi, on September 21, 2021, provides a single point of access to more than 300 agricultural apps created by ICAR Institutes. Eleven Indian languages are supported by the site, guaranteeing wide accessibility. It offers thorough details on a range of agricultural topics, such as crops, horticulture, livestock, fisheries, and government programs and services. KISAAN 2.0 is an invaluable tool for farmers, providing them with quick access to essential agricultural tools and information in their language of choice.

BAIF Godhan Seva: launched on December 22, 2017, by BAIF, Pune, is a comprehensive platform for farmers. It facilitates farmer and cattle registration, identification, AI services, and PD follow-up. Additionally, it manages calving, semen management, and offers an appointment to dairy farmers for expert consultations on PD and calving due dates.

Krish-e: on June 15, 2021, Mahindra & Mahindra introduced Krish-e, an agricultural app that provides farmers with professional advice. It offers useful details on the best ways to prepare land, plant crops in different ways, apply fertilizer, and plan crops for higher yields. The software also includes weed management strategies, irrigation procedures specific to different types of soil, detection and treatment of crop diseases, and seed sowing and treatment. It also provides weather forecasts and is accessible in eight languages, so a wide range of users can use it.

Krishify: Farmstock Technologies Private Limited introduced Krishify, a dynamic platform for farmers, on January 1, 2018. It provides a huge library of interesting films about crops and animal husbandry made by professionals in the field of agriculture. By watching and sharing these helpful resources with other farmers, users can increase their knowledge of agriculture. Furthermore, Krishify offers a different way to

make money by allowing users to contribute their own videos and promotes a helpful and friendly farming community.

Kisan Suvidha: The Ministry of Agriculture and Farmers' Welfare, GOI, launched Kisan Suvidha on March 19, 2016, at the Krishi Unnati Mela in New Delhi. In six categories—weather, dealers, market pricing, plant protection, agro advising, and Kisan Call Center (KCC) —this app provides essential farming information. Available in Hindi, English, Punjabi, Tamil, and Gujarati, it enables farmers to upload crop photographs for professional advise and has about 300,000 active users.

3. Chatbots

Chatbots offer numerous advantages, revolutionizing user interaction in agriculture and allied sectors. Available 24/7, they provide continuous support and information, regardless of time. Capable of interacting with multiple users simultaneously, chatbots ensure efficient service delivery, handling numerous queries at once. They leverage natural language processing, allowing users to communicate in a conversational manner, making interactions more intuitive. This enhances resource efficiency by reducing the need for human intervention and streamlining responses. Chatbots are easy to implement and load, saving valuable time for both users and service providers. They also offer a human-like approach, learning and adapting from user interactions to improve over time. Applications such as IVRI Dairy SHRIA, IVRI Sheep & Goat SHRIA, IVRI Swine SHRIA, AgronomoBot, Milchbot, Farmchat, and E-Agro utilize these benefits to enhance user engagement and provide specialized support in agriculture and animal husbandry.

4. Social media

Social media platforms play a crucial role in connecting farmers with valuable agricultural information and resources. Government institutions like MANAGE, IVRI, ICAR, etc. leverage various channels to reach out to the farming community. On YouTube, they provide educational videos and updates on best practices, innovations, and research. Facebook pages allow farmers to follow and engage with these institutions, receiving timely updates and interacting through comments and messages. Twitter (X) offers quick updates and announcements, while LinkedIn serves as a professional network for sharing detailed articles and research findings. Instagram provides a visual platform for showcasing success stories, infographics, and short educational clips. Together, these social media channels enhance the accessibility of information, foster community engagement, and support farmers in improving their practices and staying informed about the latest developments in agriculture.

5. TV show and Radio talks

TV shows and radio programs play a significant role in disseminating agricultural knowledge. "DD Kisan" and "Krishi Darshan" are notable for their comprehensive coverage, with "Krishi Darshan" being the longest-running agricultural TV show, providing valuable insights and updates. On the radio front, "Green Radio" and "Kisan Vani" offer targeted discussions and advice for farmers. These platforms help educate and inform farmers about best practices, new technologies, and market trends. ***DD Kisan:*** introduced on May 26, 2015, and is run by Doordarshan as part of Prasar Bharati. The channel promotes a comprehensive approach to agriculture that includes plantations, animal husbandry, and balanced farming, and it showcases the accomplishments of forward-thinking farmers. Two AI anchors, AI Krish, and AI Bhoomi, will be introduced by DD Kisan. They will offer nonstop news coverage around-the-clock. The channel informs farmers on changes in the weather, local and international markets, and other important information.

Consultancy services

Kisan Call Center (KCC): Introduced on January 21, 2004, by the Ministry of Agriculture and Farmers' Welfare, GOI, the Kisan Call Center operates across 21 locations in India. Available in 22 languages from 6:00 am to 10:00 pm daily, it provides expert advice, information on government schemes, technical support, and market data. With 454 Farm Tele Advisors, farmers can reach out via the toll-free number 1800-180-1551 or 1551 for comprehensive assistance. ***mKisan Portal:*** inaugurated by the Hon'ble President of India on July 16, 2013, the mKisan Portal, managed by the Ministry of Agriculture and Farmers' Welfare, GOI, provides location-specific and crop-specific advisories to farmers. It delivers information via SMS, voice messages, and mobile apps in local languages. Farmers receive personalized updates on weather, pest management, market prices, and government schemes. Since its inception, nearly 24.623 billion SMSs have been sent. Farmers can also seek advice by sending SMS to 51969 or 07738299899. ***Kisan SARATHI:*** launched on July 16, 2021, is a joint initiative by ICAR-IASRI, New Delhi, and Digital India Corporation. The platform provides personalized advisory services to farmers based on their farm and profile. Key features include live interactions with experts in local languages,

access to past advisories, and a comprehensive dashboard for monitoring and evaluation. It also offers mobile call facilities, knowledge databases, push alert messages, and registration through toll-free numbers and the web.

Service Delivery

e-Resources for farmers include Agri Stack, Kisan Rath, e-Gopala, e-NAM, e-RaKAM, and Agromet Advisory Service, offering tools for efficient service delivery, market access, livestock management, and weather updates.

Kisan Rath: a project of the Ministry of Agriculture and Farmers' Welfare, Government of India, was created by the National Informatics Center and debuted on April 14, 2020. With the goal of lowering waste and raising the price of perishable goods, the platform helps farmers and traders choose the best means of transportation for farm produce. Farmer Producer Organizations (FPOs), traders, farmers, and service providers are connected through Kisan Rath, which improves agricultural logistics efficiency. It covers a wide spectrum of stakeholders and is available in eight Indian languages, which helps improve agricultural product value realization and market access. ***e-NAM:*** the Ministry of Agriculture and Farmers' Welfare, Government of India, launched e-NAM (National Agriculture Market) on April 14, 2016, with the goal of creating an electronic trading platform that would serve the entire country. Listing 219 commodities, it promotes "One Nation One Market" for agricultural commodities by attempting to consolidate current mandis under a single online platform. e-NAM, which is run by the Small Farmers Agribusiness Consortium (SFAC), offers a centralized location for all services and information related to the Agricultural Produce Market Committee (APMC). Benefits include real-time price discovery and transparent online trading. In contrast to the conventional mandi system, e-NAM is an online network that connects actual mandis rather than a parallel structure. With 470 mandis currently listed, it involves a variety of stakeholders, including farmers, mandis, traders, buyers, processors, and exporters***. e-RaKAM:*** Under the auspices of the Ministry of Consumer Affairs, Food, and Public Distribution, Central Warehousing Corporation (CWC) and MSTC Limited are in charge of managing e-RaKAM (e-Rashtriya Kisan Agri Mandi), which was introduced on August 1, 2017. This portal makes it easier to auction agricultural produce online, with an emphasis on non-perishable goods like grains and pulses. In addition to giving farmers a place to auction their produce and access storage facilities, it offers warehousing help connected to CWC. CWC, buyers, and farmers are important stakeholders.

e-Governance/ Citizen support services

e-Governance and citizen support services include UMANG for unified access to government services, ICAR-Query Management System for agricultural queries, Matir Katha for soil health, krishi.info for farming information, and Meri Fasal Mera Byora for crop-related data. ***UMANG:*** MeitY and NeGD, GOI are in charge of UMANG, which was established on November 23, 2017. It offers 2,039 services (881 Central and 1,158 State) by integrating services from 207 departments/entities (80 Central and 127 State). With 462.92 crore transactions and 6.75 crore registrations, UMANG offers a single platform for e-Gov service access via a website, mobile app, SMS short code, and toll-free IVR. With support for twelve major Indian languages, UMANG makes it easier to easily access services provided by both local and central government. ***ICAR's Query Management System:*** owned by the Ministry of Agriculture and Farmers' Welfare, GOI, is an online platform that connects farmers, researchers, and experts. It allows stakeholders to submit queries on agriculture, animal husbandry, horticulture, and fisheries, facilitating the exchange of scientific knowledge and practical advice. ***Meri Fasal Mera Byora***: introduced in July 2019 by the Department of Agriculture and Farmers Welfare, Haryana, in association with NIC. The program provides real-time updates, crop registration, and Direct Benefit Transfer (DBT). With 11,19,381 farmers enrolled throughout 6,920 villages and 9,67,761 total owners, the site simplifies agricultural procedures and offers advantages to farmers.

E-Learning tool

E-learning tools for farmers and students include SWYAM MOOCs, E-Krishi Shiksha, Digital Green, Coursera, edX, and KrishiKosh, offering diverse agricultural education and resources online. ***SWYAM:*** The Ministry of Education, GOI, is in charge of overseeing SWYAM (Study Webs Of Active Learning For Young Aspiring Minds), which was introduced on July 9, 2017. It offers curriculum-based courses from high school to postgraduate levels, including professional and skill-based training, and offers high-quality teaching and learning resources via a mobile and web-based platform. With the use of self-assessment quizzes, discussion boards, video lectures, and electronic materials, courses are affordable and

easily accessible to students of all educational levels. ***KrishiKosh:*** a digital repository with a wealth of agricultural knowledge and resources, was introduced in May 2009 by ICAR under the auspices of the Ministry of Agriculture and Farmers' Welfare, Government of India. It provides support to students, educators, scientists, policy makers, researchers, and 103 SAUs and ICAR institutes. KrishiKosh facilitates search, retrieval, and support for academic and research purposes by offering free access to a multitude of content from agricultural and veterinary universities. ***Digital Green:*** founded in 2007 and incubated by Microsoft Research India, Digital Green focuses on enhancing agricultural practices through technology. Its approach includes assessing and diagnosing systems, integrating technology, and building community engagement through the CoCo model (Connect Online Connect Offline). Partnering with seven NGOs across six states (Jharkhand, MP, Orissa, Bihar, AP, and Karnataka), Digital Green, supported by the Bill and Melinda Gates Foundation, produces localized videos featuring early adopter farmers showcasing new technologies or practices. These eight-minute videos are presented using handheld pico projectors or CD players. In Digital Green villages, 85% of farmers adopted new practices, compared to just 11% in control villages.

Challenges and Solutions for utilizing e-Resources

Challenges: Accessing e-resources faces several hurdles, including the need for robust ICT infrastructure, skilled personnel for managing and creating resources, and addressing copyright issues. Security concerns and the high initial cost of infrastructure pose significant barriers, alongside the requirement for high-speed internet. Additionally, there is a lack of standardized practices and the need for ongoing renewal of e-resources (*Shanmugam, A.P, 2017*).

Solutions: To overcome these challenges, improved infrastructure at the village level is essential, ensuring better access to e-resources. Providing timely, relevant information and ongoing skills development through training can help address the need for skilled manpower. Raising awareness about digital tools and creating content in local dialects will enhance usability. Additionally, implementing proper preservation policies will help manage and maintain e-resources effectively (*Jena, P et al., 2023*).

Potential future developments and trends of e-resources in agriculture and allied sector

Future developments in agriculture e-resources include MooMonitor+, HerdDog, Zoeitis CLARIFIDE, AI-DISA, AI-DISC, blockchain technology, IDEXX Herd Health, and advancements in drones and robots.

MooMonitor+: China's Dairymaster introduced MooMonitor+, a wearable sensor device specifically for dairy cows, on February 16, 2017. It offers calving notifications, heat detection, and real-time health monitoring. Veterinarians and dairy farmers are important stakeholders in improving farm management and cow welfare. ***HerdDogg***: owned by HerdDogg Inc., USA, is an IoT-based livestock monitoring system utilizing Bluetooth-enabled smart tags and cloud analytics. The system continuously tracks animal movement and temperature, generating real-time health alerts. It acts as an early-warning system for isolating and treating cattle proactively. Additionally, it provides insights on optimal breeding times and detects missed cycles for early pregnancy diagnosis. Automated daily pull lists and unique flashing lights help manage daily tasks efficiently. ***AI-DISA (Artificial Intelligence-Based Disease Identification System for Animals):*** developed by ICAR-IASRI and IVRI, in collaboration with eight state universities. This system utilizes artificial intelligence to automatically identify diseases in animals through image analysis. It provides expert-prescribed protection advisories and features an Expert Forum for discussing livestock issues. AI-DISA also allows for reporting and accessing expert-reviewed real-time news on livestock diseases across the country. By employing machine learning and AI, AI-DISA offers comprehensive livestock protection advisory services, enhancing disease management and prevention through advanced technology and expert insights. ***AI-DISC (AI-based Disease Identification System for Crops):*** Launched on November 2, 2021, developed by ICAR-IASRI, New Delhi. This mobile application features an automatic image-based module using deep learning to identify crop diseases and pests. Key functions include advisory services from domain experts through an Expert Forum, the ability to upload images with accurate metadata, and annotation of disease lesions and pests. The application validates uploaded images and provides efficient user management. AI-DISC supports automated disease and pest identification in fields, maintains a national repository of infected crop images, and offers expert advisories for crop protection. ***Blockchain***: a distributed ledger technology that enhances transparency in the food supply chain. It helps detect food fraud and counterfeiting by connecting each link in the chain. Blockchain securely stores and shares product data, including expiration dates, nutritional information, allergens, and

production details such as chemical usage, labor practices, and environmental impact. This technology ensures the integrity and traceability of food products from production to consumption.

Conclusion

E-resources present innovative solutions for smart agriculture and livestock production, offering the potential to create more sustainable, efficient, and resilient agricultural systems. These digital tools can significantly improve the management of agriculture and livestock by enabling farmers to crop protection, water management, weather forecast, monitor and optimize animal health, nutrition, and breeding practices in response to increasing challenges. However, the full potential of these e-resources can only be realized by addressing key challenges such as access, affordability, and capacity building among farmers, especially in rural areas. One of the most critical aspects of leveraging e-resources in agriculture and livestock production is ensuring that they are accessible to all farmers, regardless of their location or economic status. This requires investment in digital infrastructure, particularly in remote and underserved areas, to bridge the digital divide. Affordability is another concern, as many small-scale farmers may find it difficult to invest in the necessary technology. Providing subsidies, low-cost solutions, and financial incentives could help make these tools more widely available. Capacity building is equally important. Farmers need the knowledge and skills to use these e-resources effectively. Training programs, workshops, and user-friendly interfaces can empower farmers to integrate digital tools into their daily practices, making them more relevant and acceptable. By combining ICT with traditional farming practices, e-resources can enhance the relevance and acceptability of new technologies among farmers, making it easier for them to adopt these innovations. User-friendly e-resource tools, combined with supportive policies, can significantly enhance the adoption of these technologies. Policies that promote data sharing, protect farmer privacy, and encourage innovation are essential for building trust and ensuring the widespread use of e-resources. Public-private partnerships play a vital role in driving innovation and improving access to e-resources. By collaborating, the public and private sectors can develop tailored solutions that meet the unique needs of farmers, ensuring that the benefits of climate-smart livestock production are realized across the agricultural sector.

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Digital Extension Initiatives of ICAR-Indian Veterinary Research Institute

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ABSTRACT

Digital-extension integrates modern ICT tools with traditional services, enhancing their reach and effectiveness, particularly in agriculture and community development. The Indian Veterinary Research Institute (IVRI), established in 1889, has been a pioneer in animal health and productivity, contributing to the development of vaccines, diagnostic and various immunobiologicals. IVRI's digital extension initiatives encompass a broad range of tools designed to support livestock management. IVRI has developed more than 20 mobile apps that cater to various needs in livestock management, including consultation, information, and decision support. Notable apps for providing consultation include the Online Veterinary Clinic for remote animal care, while for providing customization support for ration balancing like IVRI Pig Ration App or for providing decision-support like the Biosecurity & Biosafety App & Parasite Management Guide or for providing information include the IVRI-Pashu Prajanan app for reproductive health in cattle and buffaloes, IVRI-Pig Farming for pig husbandry, IVRI Vaccination Guide, IVRI Disease control etc. These apps provide essential information on disease control, vaccination, waste management, and balanced pig diets. Various interactive learning apps for veterinary education also have been developed. In addition to mobile apps, IVRI has introduced AI-powered chatbots like Dairy SHRIA, Sheep & Goat SHRIA, and Swine SHRIA to offer real-time, language-supportive information on dairy, sheep, goat, and pig farming. The institute is advancing with VR modules for immersive training, AI-based image/ Voice recognition for disease identification, weight estimation, assessing behaviour pattern etc. Social media and traditional ICT tools, such as radio, TV, and teleconsultancy, are also utilized to disseminate information and provide support. IVRI's innovations aim to create a more informed and connected farming community, contributing significantly to livestock production and food security. Looking forward, IVRI plans to integrate emerging technologies like AR/VR, predictive analytics, and global digital platforms to enhance agricultural and veterinary practices further, fostering a more efficient and personalized approach to livestock management.

Keyboards: *Digital extension services, mobile apps, chatbots, social media,*

Introduction

Digital extension, or electronic extension, refers to the integration of digital technologies/ ICT tools into traditional educational and support services to expand their reach and effectiveness. In today's world, modern technologies and ICT tools are increasingly vital, driving interest and enhancing communication for more effective technology transfer. These tools are revolutionizing development across various sectors, including education, research, and management. By leveraging these technologies, digital extension enhances accessibility, flexibility, and interactivity, allowing users to engage with content and receive guidance from virtually any location and at any time. The adoption of digital extension is particularly impactful in sectors like education, agriculture, and community development, where it helps overcome barriers to access and caters to diverse learning needs.

Digital extension utilizes a variety of tools and techniques to effectively deliver agricultural extension services and support to farmers. Key tools include mobile applications, which offer real-time access to agricultural information, weather forecasts, and market prices; websites and online portals, which provide comprehensive resources such as research articles, best practices, and training materials; and SMS and voice messaging services, which disseminate timely alerts and advice to farmers in areas with limited internet access. Additionally, social media platforms and discussion boards, such as Facebook groups or Whatsapp, telegram, You Tube, Instagram, twitter etc and online forums facilitate peer-to-peer communication, ask questions, and participate in community-driven learning and knowledge sharing. Interactive webinars and virtual workshops offer live, participatory learning experiences on various agricultural topics. Geographic Information Systems (GIS) and remote sensing technologies are also employed for precise data collection and analysis, enhancing decision-making related to crop management and pest control. Collectively, these tools and techniques enable digital extension to reach a wide audience efficiently, provide tailored support, and foster an informed and connected farming community

About Indian Veterinary Research Institute

The Indian Veterinary Research Institute (IVRI), under the Indian Council of Agricultural Research (ICAR), Ministry of Agriculture and Farmers Welfare, Government of India, is one of the country's oldest research institutions. Established in 1889 as the Imperial Bacteriological Laboratory in Pune, Maharashtra, IVRI's headquarters are now located in Izatnagar, Bareilly, Uttar Pradesh. In addition to its main campus, IVRI operates two other campuses (Mukteswar and Bangalore) and three regional stations (Palampur, Kolkata, and Pune). As of December 9, 2023, the Institute celebrated 134 years of service, having achieved numerous milestones and made significant contributions to national food security. IVRI's primary mission is to advance animal health and productivity through fundamental and strategic research, as well as to provide high-quality education and technology transfer. The Institute is ISO 9001:2008 certified and leads in the field of veterinary sciences.

Since it began offering education and training in 1900, IVRI has expanded its academic programs. Postgraduate programs were introduced in 1958 in affiliation with Agra and Rohilkhand Universities. On November 16, 1983, IVRI was granted Deemed University status by the University Grants Commission. As a Deemed University, IVRI offers Master's degrees in 20 disciplines (including MVSc in 17, MSc in two, and MBA in Agricultural Business Management) and Doctoral degrees in 17 fields of Veterinary Science. It also launched an undergraduate program (BVSc & AH) in 2015, with an intake of 55 students, and introduced a BTech in Biotechnology in 2023. Additionally, the Institute offers one-year PG Diplomas in 27 courses and has established MoUs with several Central and State Agriculture Universities to extend its expertise in veterinary and animal sciences. IVRI has made considerable contributions to human resource development, with its alumni serving in prominent positions both domestically and internationally. Over its 134-year history, the Institute has achieved numerous scientific and academic successes, including receiving the Sardar Patel Outstanding ICAR Institution Award twice. To commemorate its 125 years of contributions, the Government of India issued a "Special Postage Stamp" and "Special Postal Cover" on December 9, 2014.

The Institute has played a crucial role in enhancing livestock production by controlling and eradicating economically important diseases, such as Rinderpest, CBPP, African horse sickness, and Dourine. IVRI's research has led to the development of high-quality vaccines for various diseases, including sheeppox, goatpox, buffalopox, blue tongue disease, goat plague, swine fever, brucellosis, foot and mouth disease, and gumboro disease in poultry. To support effective disease control programs, IVRI has developed novel diagnostic methods for early detection of diseases like foot and mouth disease, blue tongue disease, rotavirus infection, Japanese encephalitis, parvovirus in dogs, and swine fever. The Institute has also created a range of therapeutics using both traditional and modern approaches, such as herbal formulations based on Ayurveda for mastitis and tick infestation and advanced biotechnology-based treatments like IgG therapy and stem cell therapies.

In addition to animal health, IVRI focuses on animal production and nutrition, developing techniques to improve animal health and productivity. Notable achievements include compressed complete feed blocks, molasses-based multi-nutrient liquid supplements, region-specific mineral mixtures, and various nutraceutical supplements. The Institute has also developed two new livestock breeds—Vrindavani Cow and Landly Pig—and characterized and registered the Rohilkhandi goat and Ghurrah pig. Value addition to animal-origin food products is another area of research, leading to the development of nutritious products such as functional chicken nuggets, emulsion-based chicken products, meat pickles, vegetable-incorporated meat products, chicken meat chips, premium chicken soup, and milk chips.

IVRI supports national programs through various divisions. The Division of Biological Standardization serves as the Central Control Laboratory for India, overseeing the quality testing of veterinary vaccines and diagnostics. The CADRAD provides referral diagnostic services for disease outbreaks, and the Centre for Wildlife Conservation Management & Disease Surveillance supports wildlife conservation with husbandry guidelines and critical healthcare services. Notably, this center was recognized as The National Referral Centre on Wildlife Healthcare by the Central Zoo Authority in 2006. The Institute also operates the Referral Veterinary Polyclinic and Teaching Veterinary Clinical Complex (TVCC) for livestock and pet care, and has established the National Animal Science & Veterinary Educational Museum and a Mini Zoo for educational and recreational purposes. IVRI boasts a substantial technology portfolio, with 99 patents filed, 32 granted, 23 designs and 43 copyrights registered, and 40 technologies commercialized to 157 industries and entrepreneurs.

Digital Extension initiatives of ICAR-IVRI

In the field of animal science, ICT has transformed education, particularly in Western countries, by

making learning more efficient, engaging, and interactive through computer-aided methods. The global adoption of ICT in animal science education highlights its positive impact, as modern computers offer speed and interactivity, reducing the burden on teachers and enabling self-paced, self-motivated learning. ICT tools and techniques have evolved to deliver health and production knowledge to animal owners in a more targeted and effective manner. The ongoing IT revolution has reshaped teaching and learning, drastically improving the speed and quality of information dissemination. Today, ICT tools assist animal owners in various ways, including SMS-based agro-advisory services, web-based advisory and discussion forums, e-commerce platforms, information kiosks, mobile apps, and the latest innovation—chatbots. These tools allow learners to progress at their own pace and reduce the need for a large number of extension workers. Digitized information systems are becoming increasingly important, fostering user engagement and facilitating efficient communication and technology transfer.

The ICAR- IVRI has a long history of experimenting and developing ICT tools for the various stakeholders. With a humble beginning in 2008 with development of information systems the institute is now working on very advanced ICT modules using the artificial intelligence tools for supporting the livestock health and production**.** The initiatives of the institute over the last 15 years in development of the ICT tools has been very progressive. The initiatives can be mainly categorized into Information /Expert Systems, Mobile Apps and Chatbots. Although the initiatives can be further classified based on their functions into various other kinds such as Informative, Service providing, Consultation, Decision support, Interactive learning. A brief overview of the various ICT tools developed by the institute are given below.

1. Information/ Expert Systems:

Information/Expert Systems are advanced software packages designed to streamline access to agricultural knowledge by integrating a comprehensive database with a search engine. These systems feature a robust database containing extensive information on livestock management, health, and livestock care, with the latest research and expert insights. The search engine component allows users to efficiently retrieve relevant information by entering specific queries or keywords. With a user-friendly interface, these systems simplify information access, enabling farmers to quickly find tailored advice and solutions. By enhancing information retrieval and accessibility, these systems support better decision-making and improve farm management practices, particularly in areas with limited access to on-ground experts. The Information/ expert systems developed at the institute are given below:

i. **LPDIS/PAKRSP**: The Livestock and Poultry Disease Information System (LPDIS) and Pashudhan avum Kukkat Rog Suchna Pranali (PAKRSP) were developed and released by the Indian Veterinary Research Institute (IVRI), Izatnagar, in 2011. The LPDIS is in English, while the PAKRSP is in Hindi. These systems focus on 78 major diseases affecting livestock (including cattle, buffalo, sheep, goats, pigs, and horses) and poultry, as well as nine essential practices for sustainable production. They offer comprehensive information on infectious, non-infectious, metabolic, parasitic, and fungal diseases across these species. A standout feature of these systems is their engaging presentation, which includes high-quality visuals, audio support, and animations to enhance understanding. Each disease is detailed under four key areas: epidemiology, symptoms, treatment, and prevention and control. Designed for livestock owners, veterinary professionals, and students in animal health disciplines, the systems are interactive and user-friendly. The LPDIS includes original, high-resolution photographs and a range of multimedia elements to improve clarity and appeal. Users have rated these systems highly for their effectiveness in conveying disease-related knowledge. Both systems are commercially available from the institute and have been acquired by pharmaceutical companies, state animal husbandry departments, agricultural universities, veterinary colleges, national boards, Krishi Vigyan Kendras, and various ICAR institutes, highlighting their commercial value and widespread adoption**.**

ii. **Animal health Information system (AHIS)**: Two more interactive softwares one for the Para Veterinarians and stockman entitled “Animal Health Information System” (AHIS) in English and another for the farmers of Maharashtra entitled “Health information system for dairy animals” in Marathi has been developed at IVRI, Izatnagar for animal health management (Phand *et al*, 2013, Tiwari *et al*, 2013). The Marathi software was commercialized to Nimitya Enterprises, Pune, which is making the software available at nominal price to the dairy owners of Maharashtra.

iii. **Pashuchikitsa and Pashupalan Prashnottri**: A compact disc entitled “Pashuchikitsa and PashupalanPrashnottri” at the IVRI, Izatnagar was yet another effort to provide solutions to farmers on their frequently asked queries through e- module, which was easy to search and operate.

iv. **Bhains Prajanan soochna Pranali**: This is also an information system for buffalo reproduction which provides detailed information on various reproductive disorders of buffaloes in the North West Gangetic Plains of UP and the ways to prevent and cure them. The system is in hindi language and provides information with the help of text, visuals (Animation, photos, line drawings etc) and audio backup. The primary goal of developing the information was to develop a user-friendly and standalone interactive information system that will guide the buffalo owners to address the reproductive problems in buffaloes. (Sethi, 2012).

v. **Goat Health Management Information system (GHMIS)**: This software was developed by the institute for educating the goat owners on various health issues. This is multilingual software in three languages: English, Hindi and Bangla and can be procured from the institute. The goat owners can learn about various diseases of goats, the symptoms of healthy and sick animals, vaccination schedule of goats and their deworming schedule. The system is backed up with the language specific audio, text and good quality visuals to impart the goat health related information in an attention-grabbing manner (Roy, 2014).

vi. **Dog health Management Trainer (DHMT)**: Review of many studies revealed that dog owners possess inadequate knowledge about various scientific dog rearing practices. Therefore, a study was taken up to assess the information needs of 1000 dog owners from various parts of the country and based on the results, this system was developed. The system for the pet owners entitled "Dog health management Trainer" provides the information on various dog breeds popularly reared in India, dog registration, behavior, feeding management, housing, breeding and reproduction, important diseases, general management, vaccination and deworming schedule for dogs. The system was tested on 100 dog owners and found effective in enhancing knowledge.

vii. **Information system for organic livestock farming**: The system was developed by Indian Veterinary Research Institutes and provides details about the organic livestock farming practices, Standards, Certification procedure, overview of organic farming in India and helps farmers in setting up an organic livestock farm.

viii. **Expert System on Dog health**: Expert system for dog diseases was developed based on the results obtained from the secondary data analysis of the diseases reported by 10 various clinics of the country. Based on the prevalence of the diseases 48 diseases have been incorporated in the system. The system provides a tentative diagnosis of the disease/ problems of the dogs based on the clinical symptoms and also help in providing the detailed information about the disease and its prevention and treatment. This system can support the busy canine practitioners in their regular practice and act as a ready reckoner for these diseases/ problems

ix. **Pig Feed Formulator**: The Pig Feed Formulator was aimed at optimizing pig nutrition by helping farmers create feed formulations that meet the specific dietary needs of pigs at various stages of growth. This helps in improving overall health, growth rates, and feed efficiency. The PFF provides information support and customization in English & Hindi languages and supports for balancing ration for various categories of pigs with an additional tutorial video with audio backup and pictures in hindi and English.

2. Mobile Apps:

Mobile apps, short for mobile applications, are software programs designed to run on smartphones, tablets, and other mobile devices. They can help with things like providing information, education, services, entertainment and e-commerce. Apps are designed to make the phone more useful and can be easily accessed from app stores like the Apple App Store or Google Play Store. Each app serves a specific purpose and can offer features like notifications, offline use, and integration with other services. ICAR-IVRI has developed a total of 20 mobile apps with various features viz., providing consultation, information/ education, service, decision support & interactive learning. The brief of the various apps developed by the institute are presented below:

i. **Apps for Online Consultation**: These are those apps that facilitate virtual consultations between users and professionals, such as doctors, therapists, or advisors, enabling remote, real-time interaction and guidance. ICAR IVRI has developed one such app viz., **Online Veterinary Clinic**. The OVC is an extension of Referral Veterinary Clinic services offered at IVRI premises. The major objective of the app is to provide the animal owner with easy and hassle-free access to IVRI veterinary clinic services at any given point in time from the comfort of his home, thus saving him the logistics, finance, and time incurred in bringing the animal to IVRI clinic

ii. **Apps for Information/ Education:** These apps are designed to provide users with valuable information, including some latest updates, educational content, or reference materials, helping them stay informed and updated. They are ideal for users seeking to expand their understanding or stay informed about specific areas of interest. By offering easily accessible and organized content, these apps help users quickly find and absorb knowledge without needing to sift through multiple sources. The institute has developed various such apps for farmers/ field veterinarian and the brief of these is given below

a. **IVRI-Pashu Prajanan App:** The App is targeted to impart knowledge and act as a ready reckoner about reproductive disease/ disorders in cattle and buffaloes and measures to treat and control them. The major reproductive diseases/disorders covered in the app are Anestrus, Repeat Breeding, Silent Heat/Silent Estrus, Uterine Torsion, Dystocia, Abortion, Uterine Prolapse, Retention of Foetal Membranes/ Placenta, Metritis, Brucellosis, Campylobacteriosis and IBR-IPV. The app additionally provides basic information on Artificial Insemination in cattle and buffaloes.

b. **IVRI- Vaccination Guide:** The IVRI- Vaccination Guide is targeted to impart knowledge and skills about vaccination in domestic animals, poultry and pets. The App provides basic information about vaccination in livestock, poultry & pets and covers specific information about vaccination related to all the major bacterial and viral diseases. For each of the disease in various species, the information on the causative agents, types of vaccines available, serotype / strain used for the vaccines, vaccination schedule and commercially available vaccines are provided in the app. The App also provides detailed information about the government and private institutions involved in vaccine production in the country

c. **IVRI- Pig Farming App:** Pig Farming has gained significant importance now a days and emerged as a profitable enterprise option for livestock entrepreneurs. The Pig Farming (*Shookar Palan*) App is targeted to impart scientific knowledge and skills for promoting pig farming. This is an educational app providing information on breeds, housing, feeding, breeding, healthcare and general management of pigs. The app additionally supports for economic analysis and evaluation of various pig farming projects.

d. **IVRI-Dairy Manager App:** The App is targeted to impart knowledge and skills for promoting dairy farming. This is an educational app providing information on breeds and housing, feeding, calf and general management, clean milk production and identification & vices of dairy animals. Educational videos on clean milk production and neonatal calf management have been included in the App for enhancing the knowledge and skills of the personnel's involved in dairy farming.

e. **IVRI- Landlly pig:** The App is targeted to impart knowledge about faster growing pig variety namely Landlly developed by ICAR-IVRI, Izatnagar. The Landlly variety was developed by crossing exotic potential lines of Landrace with indigenous Bareilly Local pigs with inheritance level of 75% Landrace X 25% Bareilly local pig. The inter-se mating with intensive selection was followed for 6 generations to stabilize heterocyst effect. This variety expected not only to benefit socioeconomically weaker communities in terms of their sustainable livelihood security but also to address the issues of pig production system under changing climatic scenario by improved production and productivity. The information contained in the App is presently in 2 languages viz., Hindi and English looking to the potential user of this pig mostly in North India.

f. **IVRI-Disease Control App:** The app is targeted to impart knowledge about important diseases of Livestock, Poultry & dogs, their symptoms, diagnosis, treatment, Prevention & Control. The livestock diseases covered include Bacterial Diseases viz., HS, BQ, Anthrax, Enterotoxaemia, Mastitis, Brucellosis, Glanders; Viral Diseases viz., FMD, Sheepox & Goatpox, BlueTongue, CCPP, Swine Fever, PPR; Parasitic / Protozoan Diseases viz., Fascioliasis, Amphistomiasis, Babesiosis, Trypanosomiasis, Mange and Anaplasmosis. The Poultry Diseases covered include Salmonellosis/ salmonella paratyphoid, Ranikhet, FowlPox, Fowl Cholera, Mareks Disease, IBD, Duck Plague, Infectious Coryza, CRD while diseases of Dogs covered are CD and Rabies. The app also provides information about the Exotic & Emerging diseases apart from information on various Disease Diagnostic Laboratories in India, various Diagnostic facilities offered by ICAR-IVRI, Important organisations involved in disease control & Government schemes and guidelines for disease control in India.

g. **IVRI-Technology & Services:** IVRI- Technologies & Services App is an inventory of important technologies developed by the ICAR-Indian Veterinary Research Institute which have been commercialized or are ready for commercialization along with the services provided by the

Institute. The major objective of the app is to promote and showcase the information about important technologies such as the features, utility, IPR status and inventors for its easy commercialization. The app mainly contains the technologies in the areas of Animal Health, Animal Feed, Animal Reproduction and Breeding, Animal Management, Surgical/Farm based equipments, Value Added Livestock Products and Miscellaneous technologies. A list of all the companies who have procured the technologies is also provided in the app. Further, the various types of services viz., Vaccine testing, Clinical, Diagnostic, Supply of Biologicals and other products by the Institute is also available in the app

h. **IVRI Waste Management Guide App:** IVRI-Waste Management Guide App is designed to impart information and knowledge about management of waste originating from agriculture, livestock and household activities. The app covers information related to composting & its various methods, vermicomposting, its various methods & detailed information on biogas production. The app also provides information on newer alternatives of waste management viz., organic farming, waste decomposer, liquid manures & technologies for crop residue management. The app is useful for all the households as it contains detailed information on utilization of household waste.

i. **IVRI- Antimicrobial resistance (AMR) App:** Antimicrobial resistance is the ability of microbes such as bacteria, viruses, parasites or fungi to grow in presence of chemicals that would normally kill it or limit its growth. While a spontaneous or induced genetic mutation in bacteria may confer resistance to antimicrobial drugs, genes that confer resistance can be transferred between bacteria in a horizontal fashion. Thus a gene for antibiotic resistance, which has evolved via natural selection, may be shared amongst the pathogen in nature, thus propagating it in the environment. The development and spread of resistance has caused treatment failures and consequently more severe and longer-lasting diseases, increased hospitalization rates, higher number of deaths and costs to the society. This app attempts to shed light on the burning problem of AMR and highlight the various mechanisms through which AMR is acquired. Further, the app intends to educate various stakeholders and general public regarding the AMR problem with the ultimate aim of creating awareness. It is an offline app & developed for Android platforms.

j. **IVRI-Veterinary Clinical Care:** The IVRI-Veterinary Clinical Care App is targeted to impart knowledge and skills to Graduating Veterinarians & Field Veterinary Officers about most frequent clinical conditions encountered in field conditions related to medicine (Mastitis, Bloat, TRP, Ketosis, Milk fever, Ruminal impaction & Calf diarrhoea), gynaecology (Pyometra, Anestrus, Repeat Breeding, Dystocia, RFM, Uterine torsion, Uterine prolapse, Cervico- vaginal prolapse & COD) & surgery (Urolithiasis, Caesarean Section, Hernia, Castration, Fracture & Wound). The App covers information about each of these conditions under the various subheads viz., About, Symptoms, Diagnosis, Treatment and Prevention & Control. In the surgery related cases information on preoperative and postoperative procedures are detailed. Educational videos on important surgical procedures like Tube Cystostomy, External Skeletal Fixation etc have been included in the App for enhancing surgical skills in some advance surgeries. The App also contains links to various important organizations dealing with animal health

k. **Zoonoses:** Zoonoses refer to those infections and diseases that are naturally transmissible between vertebrate animals and man. The close proximity of man and animals in their day to day lives puts human life at risk from the impending dangers of zoonotic infections. This App will be useful to students of veterinary and medical degree programmes, practicing veterinarians, health care workers and general public. This App aims at providing basic information about important zoonotic infections including their modes of transmission, symptoms, prevention and control measures. The list of national disease control programmes with respect to zoonotic diseases has also been included along with the list of notifiable diseases in animals

l. **CARI Backyard Poultry Farming App:** CARI-Backyard Poultry Farming App is specifically targeted to impart knowledge and skills to the entrepreneurs / farmers, rural youth and farm women about the backyard poultry farming as a livelihood option. The app contains information about the Importance of backyard poultry (especially the features and nutritional benefits), its breeds & varieties, housing management (including housing needs, space requirements etc.), bird's management (chicks, grower & adult management), feeding management, innovative feeding resources, water management, health care (diseases, vaccination & medications), organic poultry farming & marketing of the products.

iii. **Service Providing**: Apps that offer specific services directly to users, such as preparing a lesson plan, developing maps, customised plans for events, booking taxis, ordering food, or managing home services, streamlining access to essential or convenience services. IVRI has created such apps that apart from providing educational content also help for service function like creating customized rations & Record keeping. These apps offer specific services tailored to users' needs. These apps provide functionality beyond just delivering content; they actively assist users in managing and customizing their goals. These apps are

   a. **IVRI Pig Ration App:** The IVRI- Pig Ration App, is targeted to impart and promote scientific knowledge and skills about balanced pig ration formulation. Imbalanced feeding to pigs is a major problem in field condition. Majority of the piggery owners feed their pigs based on their traditional knowledge and information passed through generation to generation with locally available feed ingredients. Animals on such imbalanced ration show poor health, growth and reproductive performance thereby causing high cost of meat production. The IVRI-Pig Ration App can help the end users to formulate balanced ration for the various categories of pigs based on the locally available feed ingredients. The app additionally provides for ready diets for different categories of pigs. Use of this mobile app for balanced pig ration can help to enhance the profitability of the piggery enterprise. It is developed for Android platforms.

   b. **IVRI Artificial Insemination app:** The App is targeted to impart knowledge and skills to Graduating Veterinarians, Field Veterinary Officers and Paravets about Artificial Insemination (AI) in cattle and buffaloes. The App covers information on various aspects related to AI viz., symptoms of heat, stages of estrus cycle, heat detection, AI kit, proper time of AI, common sanitary measures, thawing, loading of AI gun, semen deposition and post AI advise& follow-up. Additionally, the App provides guidelines for semen handling and pregnancy diagnosis in cattle and buffaloes. The App also provides facility for record keeping of the AI and provides post AI notification for follow up. The App also provides detailed information about the frozen semen stations in India along with the availability of semen of various breeds of cattle &buffaloes and crossbreds. Educational videos on various methods of Heat detection viz., visual observation, use of Crystoscope and teaser bulls for heat detection besides Artificial Insemination techniques have been included in the App for enhancing the skills of the personnel involved in AI.

iv. **Decision Support**: Apps that assist users in making informed decisions by analysing data, providing recommendations, or offering predictive insights based on user inputs or external factors. IVRI has developed such apps for calculating farm biosecurity and calculating parasitic infestation and resistance for various stakeholders. These are as follows:

   a. **IVRI Biosecurity & Bio Safety App:** The IVRI-Biosecurity & Biosafety App covers the information about biosecurity and biosafety of dairy, pig and poultry farms. The various aspects covered under this app includes the basic concept of biosecurity and its advantages, detailed information about the measures pertaining to biosecurity and biosafety in farms viz., location and design of farms, restricted movement, isolation and quarantine, cleaning and disinfection, management of feed and water, disposal of carcass, disposal of clinical and other wastes, disposal of farm effluents/manure, personal hygiene, health management, reproductive management, documentation and record keeping, actions during disease outbreak and examples of disinfectants used.

   b. **IVRI Parasite management Guide App:** The IVRI- Parasite Management Guide app designed and developed by ICAR-IVRI, Izatnagar, UP &IASRI, New Delhi is targeted to impart knowledge and skills to Graduating Veterinarians, Field Veterinary Officers and Paravets about Parasite Management Guide in cattle and buffaloes. The App covers information on Animal Parasitic diseases are of great economic constraints in India which causes huge losses in terms of loss of production and mortality. The application provides concrete knowledge of parasitic diseases in various species of domesticated and wild animals, life cycle of the parasite, the organ system involved, pathogenesis, diagnosis and management of these parasites. The application also provides insight to the deworming schedule and drugs which can be used along with their dose and dosage. This app has basic and also details of the Veterinary Parasitology subject and is prepared keeping in mind the professional students, vet practitioners and farmers. Some FAQs are also provided regarding the management of some diseases for the pet owners and farmers.

   c. **Interactive Learning**: Apps that engage users through interactive educational experiences, including quizzes, games, simulations, or multimedia content, to facilitate learning and skill

development. The institute ahs developed four such apps which are in the form of tutorial quiz apps and help in self paced learning for the students in some of the social science and veterinary disciplines. These are **IVRI Extension Methods Tutorial App, IVRI Research Methods Tutorial App, IVRI-Animal Genetics and Breeding Tutorial App and IVRI-Veterinary Surgery and Radiolgy Tutorial App**. These apps are Multiple Choice Questions (MCQ) based Drill and Practice educational learning tool targeted to impart knowledge and skills to students and contain three the feature to assess the performance of students at three difficulty levels. Because of their interesting feature of self-paced learning, the students can learn the subject at their own time and speed.

3. Chatbots

A chatbot is a software application designed to simulate conversation with human users, especially over the internet. Chatbots use various forms of artificial intelligence and natural language processing to understand and respond to text or voice inputs. They can range from simple rule-based systems that follow predefined scripts to advanced AI-driven models like ChatGPT, which generate responses based on a vast amount of data and complex algorithms. Chatbots are commonly used in customer service to handle inquiries, assist with troubleshooting, and provide information. They can also be found in other areas like virtual assistants, online shopping, and even social media. The goal of a chatbot is to make interactions more efficient and to provide support or information in a conversational manner. ICAR-IVRI has initiated the development of AI powered Chatbots for support of livestock owners. These are IVRI- Dairy SHRIA, IVRI Sheep & Goat SHRIA & IVRI Swine SHRIA. **These are** the Smart Heuristic response-based Intelligent Assistant, which are exclusively developed for prompt redressal of queries by individuals engaged in dairy farming and small ruminant farming. These chatbots utilize Natural Language Processing (NLP) and machine learning algorithms, delivering real-time and pertinent information to users. These support 10 Indian languages, and have speech input and output features too, ensuring a seamless and accessible learning experience. The **Dairy SHRIA** covers an extensive array of dairy farming topics, including breeding strategies, optimal feeding practices, preventative healthcare measures, general management techniques, calf-rearing procedures, organic dairy methodologies, training resources, insurance options, and economic considerations, thus serving as a comprehensive solution for all dairy farming needs**. While the Sheep & Goat SHRIA** covers a comprehensive range of sheep and goat farming topics, viz., breeding strategies, optimal feeding practices, preventative healthcare measures, general management techniques, kid and lamb rearing procedures, marketing methodologies, training resources, insurance options, and economic considerations. The **Swine SHRIA** covers the pig farming and pork processing comprehensively providing solution related to care and management practices, breed selection, feeding strategies, and general farm management, healthcare with a special focus on emerging diseases, biosecurity measures, housing, marketing, processing, training, insurance, credit facilitation, licensing, animal welfare, and organic pig farming.

4. Other Initiatives

- **VR Modules**: The domain of **Augmented and Virtual Reality** for Agriculture and Allied sectors is predicted to be extensively explored in the foreseeable future. Under NAHEP, IVRI is instrumental in developing a Virtual reality module regarding correction of Uterine torsion as a digital learning and training tool for Veterinarians. Large number of such ARVR modules have been developed under NAHEP by various institutions for enhancing the learning experience of students & farmers.
- **Image recognition:**
- **AIDISA**: The institute in collaboration with ICAR-IASRI & various other institutes and universities under NAHEP component 2 has developed Artificial Intelligence based Disease Identification System for Animals (AI-DISA) which is an AI-powered mobile application for automatic image-based disease identification of animals.
- **Pig Weight Estimation**: The institute has developed another mobile application designed to estimate pig live weight using advanced convolutional neural networks. This app leverages a comprehensive database of images showing pigs from a dorsal view to train its algorithm. By analyzing the pigs' morphology, the application can predict their weight with over 80% accuracy for both Landrace and Landlly breeds. Further, the institute is also working on development of a mobile app for the image-based weight estimation of pigs.
- **Biometric identification** using machine vision is another important use of the machine vision technology. The institute has also worked towards development of Muzzle-based cattle

identification, milk yield and body weight determination. The system uses CNN to extract muzzle features in cattle which provides unique identification with an accuracy of ~98%. The Body weight determination using muzzle dimensions is also being done with 81% accuracy. The work is in progress for milk yield determination also

- **ANN Based economic point of cattle milk production:** The ANN is used to predict investment on cattle till age at first calving (AFC) and milk production based model developed showed more than 98% prediction accuracy
- **Acoustics and AI-based animal identification:** Another experiment is going on for assessing the behaviour pattern of pigs using the Voice recognition. Sound frequencies collected from pigs are being analyzed using CNN for the identification of pigs. Different sound feature based spectrograms are being used for identification of the reproductive behaviour of pigs. Work is in progress
- **Sensor-based cooling system for pigs to combat heat stress:** PID controlled evaporative cooling system has been installed in the swine production farm of IVRI. Approx. 7% THI reduction to ensure comfort to the pigs resulting in 15.6% increase in average daily body weight gain of pigs

Social Media: Social media refers to digital platforms and applications that enable users to create, share, and engage with content, connect with others, and participate in online communities. Popular examples include Facebook, Twitter, Instagram, and LinkedIn. Social media is vital in agriculture and livestock management as it enhances knowledge sharing, enabling farmers to access best practices, educational resources, and real-time updates on weather and disease. It offers direct marketing opportunities and brand-building potential, connecting producers with consumers and expanding market reach. Additionally, it fosters community building and networking, allowing for peer support and collaboration among stakeholders. By facilitating quick dissemination of information and trends, social media helps farmers and livestock owners stay informed about innovations and market demands, ultimately driving productivity and sustainability in the sector. ICAR- IVRI is also harnessing the Social Media platforms and has launched three You tube channels i.e., IVRI You Tube channel, IVRI Deemed University Educational Channel and KVK IVRI You Tube Channel. All three channels are providing educational videos on best practices. Further, the institute has its own Facebook page, twitter and Instagram account and following the scheme of One Technology One Day regular technology updates are being posted apart from all other important news and events.

Conventional ICT tools

Apart from the advanced and innovative ICT tools, the institute is also using the well known and most popular ICT medium like the Radio, TV as a means of digital extension. Programmes like Farm School on Air, Phone In programmes, Kisan Vaani etc are regularly organised in collaboration with the AIR Bareilly & AIR Rampur. Expert talks are being regularly delivered by the institute experts in the local TV station as well as for the DD Kisan channel. Further, the institute provides tele consultancy services through the Kisan Call Centre. The institute has a level II node of the KCC catering to two states UP & UKD. Apart from KCC the institute also has its helpline number (05812311111). The institute KVK provide support to the farmers through the Kisan SARATHI platform also. Further, the institute is regularly organizing various training programmes in Virtual mode or Hybrid mode for benefit of the beneficiaries who are unable to visit the institute. Other extension programmes such as workshops and Interface meetings with various stakeholders viz., Veterinary officers, Directors and Senior officers of SDAH, Private industry, officials of milk cooperatives, SMS of KVK and officials of ATARI are being regularly organised in Hybrid mode to have a wider reach in shorter time. These programmes in Hybrid mode were found to be more successful than the one organised in physical mode.

Way Forward

With the advancement in the ICT tools and technologies the digital extension will experience paradigm shift. The institute keeping in pace with the advancements in the field envisions to develop ICT platforms that can help in providing highly personalized veterinary advice tailored to specific farm and animal health data. The use of AR VR modules would be used for providing immersive training and remote consultations. Precision livestock farming equipped with latest tools would help in real-time monitoring of livestock, ensuring better health management. Enhanced global connectivity will guarantee that these services reach even the most remote regions of India. Predictive analytics will offer insights into disease management and environmental impacts, further supporting animal welfare.

Collaborative digital platforms will foster global interaction among veterinarians, researchers, and farmers, enhancing India's agricultural and veterinary landscape in line with the goals of a developed and innovative nation. As ICT progresses, older technologies like legacy systems and outdated hardware will be phased out. Emerging innovations such as quantum computing, 5G, AI, and blockchain will take their place, offering improved efficiency, capabilities, and integrated solutions

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Pusa Samachar: Multimedia based Extension Model for Information dissemination through social media

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ABSTRACT

The "Pusa Samachar" initiative, launched by the Indian Agricultural Research Institute (IARI) on August 15, 2020, employs a multimedia-based extension model to enhance agricultural information delivery through social media. This innovative approach addresses the evolving needs of farmers in high-tech agriculture by providing timely and relevant information on crop management, weather forecasts, pest control, and market prices in a format that is easy to understand. The model utilizes various multimedia elements—text, graphics, audio, and video—to facilitate complex information dissemination. By leveraging platforms like YouTube and WhatsApp, Pusa Samachar has successfully reached over 2.1 million views across 214 episodes, significantly engaging with farmers in regional languages. The methodology includes structured content creation, expert participation, and a two-way communication channel via WhatsApp for problem resolution. Feedback indicates high viewer engagement, with 86% of farmers regularly watching episodes and 90% sharing content with peers.

Data analysis reveals strong demographic engagement, with notable viewership from males aged 35-44 years. Although the content's credibility and relevance have been positively received, farmers have suggested improvements in audio-visual quality and episode duration. The initiative stands out for its in-house production, ensuring high-quality, research-based agricultural advisories while maintaining a sustainable and continuous delivery model. Overall, Pusa Samachar effectively bridges the information gap, enhancing agricultural productivity and income for farmers through improved knowledge dissemination.

Keywords: Pusa Samachar, Pusa Whatsapp Salah, Innovative extension model, IARI, ICT based extension

Introduction

Increasing production and productivity is a major challenge in front of agriculture scientists and farming community. Agricultural extension services provide critical access to the knowledge, information and technology that farmers require to improve the productivity and thus improve the quality of their lives and livelihoods. It is hence crucial to provide farmers with the knowledge and information in a quality and timely way. Access, efficiency and affordability of agricultural information continues to be a major impediment for raising agricultural productivity among smallholders in the developing countries. Due to immense population of farmers and different topographies of our country, dissemination of right information in convenient time was the huge obstacle. The present extension functionary to farmers ratio is 1156:1 (DFI committee, 2017). With the vision of doubling farmers' income, paradigm shift has been observed in extension approaches for transforming subsistence farming to agripreneurship. Now, farmers need problem centered, location specific and timely information in crop production as well as in marketing.

Information and Communication Technology (ICT) is an umbrella term incorporating all modes of transmission like electronic devices, networks, mobiles, services and applications which help to disseminate information with the help of technology. In the recent years, ICT has proved to be extremely beneficial for farmers and helped them in getting easy access to customized information regarding improved varieties, cropping pattern, use of high-yielding seeds, fertilizer application, pest management, marketing, entrepreneurship etc. Information and Communication Technology (ICT) can have a leading role in the dissemination of right information to needful farmers at right time. ICT services provide critical access to the knowledge, information and technology that farmers require to improve the productivity and thus improve the quality of their lives and livelihoods.

There have been some initiatives in India, using ICT for agricultural development. In most of these projects, agriculture is only a small component. India has gathered successful and enriching experiences with IT projects like Gyandoot project (Madhya Pradesh), Warana Wired Village project (Maharashtra), Information Village project of the M S Swaminathan Research Foundation (MSSRF) (Pondicherry), ITC e-Choupal, iKisan project of the Nagarjuna group of companies (Andhra Pradesh), Automated Milk Collection Centres of Amul dairy cooperatives (Gujarat), Land Record Computerization (Bhoomi) (Karnataka), Knowledge Network for Grass Root Innovations –Society for Research and Initiatives (SRISTI) (Gujarat), application of Satellite Communication for Training Field Extension Workers in Rural Areas (Indian Space Research Organisation). In adddition to these, a few non-governmental organisations (NGOs) have initiated ICT projects such as Tarahaat.com by Development Alternatives (Uttar Pradesh and

Punjab), Mahitiz-samuha (Karnataka), VOICES – Madhyam Communications (Karnataka); Centre for Alternative Agriculture Media (CAAM) etc.

There has been paradigm shift in ICT usage with advent of smart mobile phones. In India, total active telephone (mobile and fixed) subscribers are 1169 million, out of which 524.39 million are from rural areas. Since last six years, the share of rural telephone subscribers increased from 40.14% to 44.87% and rural internet subscribers from 92.18 million to 302.35 million, which is a huge increase of 228% (TRAI, 2021). Mobile telephone is the most influential and omnipresent tool of agriculture extension to disseminate information and to give advisories to farmers. The areas where mobile telephones are widely used in agriculture is information services on availability of inputs, quality of inputs, contacting middlemen for marketing of produce, pest and disease management of crop and market price of inputs (Syiem *et al.*, 2015). Push & Pull SMS, Interactive voice response system, and Kisan Call Center are the mobile telephony initiatives to cater the diverse need of farmers and information dissemination. In India, mobile technology has reached over 30 times as many people as the Internet (Velu & Prakash, 2010). Mobile phones were most accessed and most regularly used by the majority of respondents since they are inexpensive and can be utilized by even illiterate farmers (Syiem & Raj, 2015). To harness the potential of mobile telephony under National e-Governance Plan-Agriculture (NeGP-A), Ministry of Agriculture and Farmers Welfare has launched various modes of delivery of e-enabled services including mobile telephony.

India has at least two-decade long experience of using ICT in agriculture. ICTs have gone through different stages and many of these will continue to evolve in response to changing technology and business environment in agriculture as well as in response to emerging challenges in agriculture ICT can play critical role in strengthening the capacities of not only farmers but also for the field level functionaries and intermediaries. Developing the right or relevant content at the appropriate level has always been a challenge and more efforts are needed in this direction

***Pusa Samachar*: Multimedia based Extension Model for Enhanced Information Delivery and Usage**

As traditional agriculture evolves into high-tech agriculture, relevant information is required for agriculture productivity and efficiency, finally resulting in a profitable yield and income for farmers. Incorrect or misconstrued information might result in poor agriculture practices and a significant financial loss. Social and economic progress are inextricably linked to improved communication and information accessibility. Modern information and communication technologies can help to promote communication, participation, information dissemination, and knowledge and skill sharing, so that judgments can be made in a timely manner. Farmers require several forms of information at various stages of the production process, including weather forecasts, pest attacks, inputs, cultivation practices, pest and disease management, and price information. The information can be disseminated in an appropriate manner and in a style that is simple to comprehend. This method can be regarded as a novel and effective method for transforming information using multimedia-based interactive media. Text, graphics, art, sound, animation, and video elements are all woven together in multimedia. Multimedia technologies are useful for demonstrating complex and dynamic processes that are difficult to describe using traditional media and approaches.

Several organizations in India are making substantial use of current information technology to improve communication between researchers, extension workers, and their farmer clients in order to more efficiently transfer technologies and knowledge in a cost-effective manner. Even in agriculture, social media, which was traditionally mostly used for entertainment, has enormous potential for information exchange and collaboration. According to GFRAS (2015) survey on 60 countries, Ninety-five percent of respondents agreed that social media can help bridge the gap between stakeholders in agricultural innovation systems. Mobile based Technology especially social media can provide content in vernacular language, which can be achieved by strengthening of existing technologies by local language-based content development ultimately the services can be applicable to farmers (ICFA, 2017). It is vital to ensure that adequate material is created for farmers in a language that they can comprehend and in an appropriate format in order for ICT applications to boost their production (World Bank, 2017).

Multimedia based advisory services deliver information through different technologies, but the access and usage of these technologies differ, so the basic purpose of research area should focus on information effect disentangling from technology effect. Purpose of information delivery to the information poor should focus not only on knowledge gain and sharing but also in terms of productivity and increase in income level and focusing on timelines and relevance of the information. With these above considerations, Indian Agricultural Research Institute came up with the innovation of multimedia-based information delivery through social media platform giving crop based seasonal management information

and weather information as well as problem specific solution through multimedia-based extension model named 'Pusa Samachar' for two-way information sharing through social media. To cover broad range of stakeholder, it has started regional language-based information delivery.

'Pusa Samachar' was launched on 15 August 2020 and first episode of Pusa Samachar was uploaded on 22 August 2020. Every Saturday at 7 pm new episode is being uploaded at IARI official YouTube channel. A total of 214 Hindi episodes (till September 21, 2024) has been designed and broadcasted from official channel of IARI. In the year 2023-24, 53 hindi episodes of Pusa Samachar has been broadcasted from official channel of IARI. The subscribers are increasing day by day and it has crossed 50,000. More than 15000 Pusa WhatsApp salah were given for queries redressal of farmers. Overall, the e-content has 2.1 million views with over 1 lakh watch hours by viewers. Along with Pusa Samachar episodes, special videos on important agricultural crops were also uploaded. In every episode time specific crop management practices, successful farmer stories, Pusa WhatsApp salah and weather broadcast is being given.

In addition to Hindi, more than 150 regional language-based episodes (*Telugu, Kannada, Oriya, Tamil, Bengali*)

Methodology of the Pusa Samachar Model

Pusa Samachar episodes are being fully prepared and uploaded by a dedicated committee specially constituted for this purpose. The detailed methodology is as follows

(i) **Content Decision:** Based on the season and crop time, the relevant content of an episode is decided by the committee and approved by Director, ICAR-IARI New Delhi. In every episode, following content is given

- **Time specific crop management practices:** In every episode, time specific crop management practices with respect to two crops is included.
- **Pusa Whatsapp Salah:** One dedicated Pusa WhatsApp number (9560297502) has been launched, in which farmers sends their farm problems with pictures. Suitable solution of questions is obtained from IARI scientists and shared to the farmers to resolve their queries. Four pertaining questions and solutions are also included in the episode.
- **Weather broadcast:** Weather information and weather-based farm advisory for upcoming week (based on IMD) are included in every episode with suitable graphics.
- **Successful Farmers Case/Videos:** Time to time coverage of successful farmers is done. Their inspiring story, innovating farming practices, entrepreneurial spirit are covered. More than 15 successful stores have been covered.

Till now, 521 topics were covered in 17 different disciplines/areas covering Vegetable Sciences (23.70%), Agronomy (20.20%), Genetics (18.50), Plant Pathology (11.60%), Horticulture (8.80), Entomology (5.10) and other important disciplines.

(ii) **Expert Selection:** Once the content is approved, the experts for the episode are identified and informed. The date and time slots for expert's video bytes is finalized.

(iii) **Scripting:** Once the content is approved, the script of the episode is prepared for the anchors. The experts also prepare their own script for narration.

(iv) **Video Shoot:** After scripting, anchor shoot and expert shoot are done in Central Photo Lab as well as in scientist labs and experimental fields. The Central Photo Lab has all facilities for audio and video shooting along with editing facilities. Parallelly, expert shoot, crops shoot for graphics/visuals are also taken as per prefixed time slots.

(v) **Editing:** The anchor video and experts' videos are then edited at Central Photo Lab, by dedicated editing experts under the supervision of concerned expert and *Pusa Samachar* scientists.

(vi) **Uploading:** Once the episode is ready after editing, it is double checked for errors and then uploaded in official channel of ICAR-IARI and which is accessible to the public at 7 pm every Saturday.

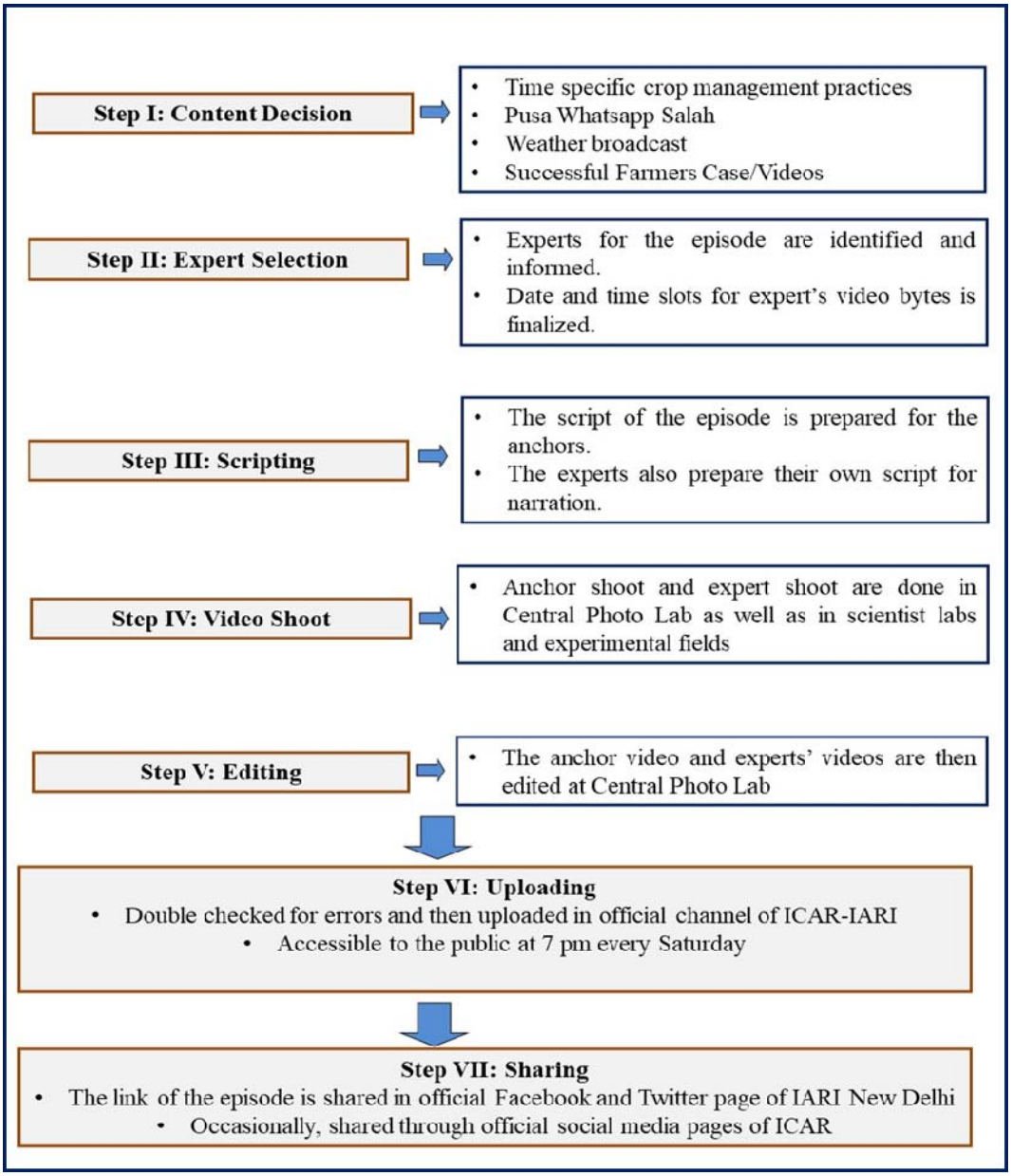


Figure: Detailed methodology of Pusa Samachar (Every week)

(vii) Sharing: The link of the episode is shared in official Facebook and Twitter page of IARI New Delhi. Occasionally, it has been also shared through official social media pages of ICAR.

Special Episodes: In addition to regular episodes, *Pusa Samachar* special episodes dedicated to a particular crop are also being made. *Pusa Samachar* Rice episode, wheat episode, mustard episode and Millet episode has become quite famous among farmers.

Crop Specific Short Videos: Time to time, short crop management videos are also being prepared and uploaded to solve the current farm problem quickly. Till now more than 40 short videos has been uploaded. Management of Dwarfism (Fiji virus) in rice, newly launched Pusa basmati varieties, DSR in rice, Herbicide tolerant Rice varieties are among these short videos which have become quite popular among farmers.

In every episode *time specific crop management practices, successful farmer stories, Pusa WhatsApp salah and weather broadcast* is being given. One dedicated Pusa WhatsApp number has been launched, in which

farmers are sending their farm problems with pictures and scientists of IARI are replying promptly within 24 hours.

Content Analysis of Pusa Samachar

A total of 521 topics were covered in 17 different disciplines/areas including farmers success stories. Analysis has shown that among disciplines the topic coverage was maximum in Vegetable Sciences followed by Agronomy, Genetics, Plant Pathology, Horticulture, Entomology, Protected Cultivation, Agricultural Engeenering Microbiology, Soil Science, Economics and Floriculture

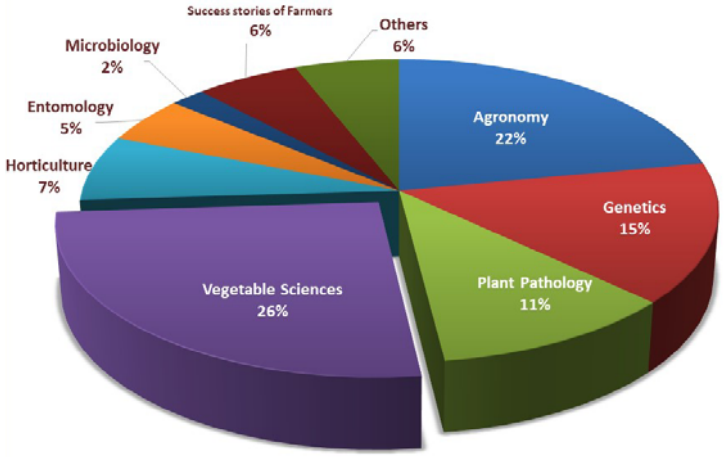


Figure 1: Coverage of topics (discipline wise) in Pusa Samachar (Hindi)

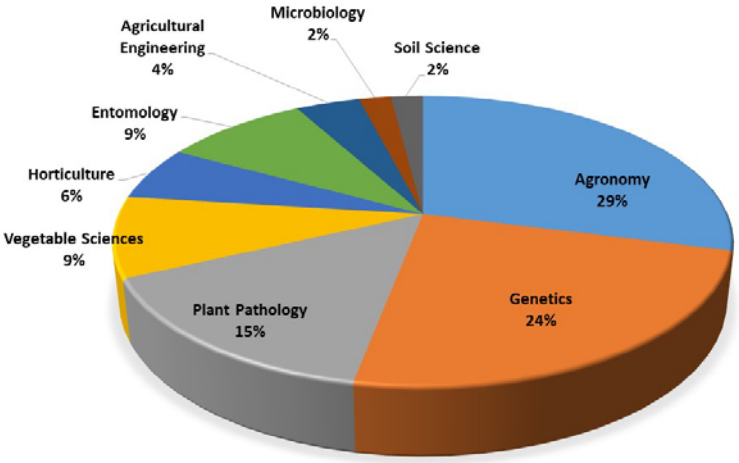


Figure 2: Coverage of topics (discipline wise) in Pusa Samachar (Regional)

Crop wise the coverage is as: 153 topics of cereals (rice, wheat, maize, millets), 103 topics of vegetables (leafy vegetables, pea, onion, garlic, carrot, tomato, potato, bathua, okra, bittergourd, bottlegourd, cucumber, chilli, general management), 43 topics on pulses (chikpea, lentil, mungbean), 41 topics on fruits (papaya, guava, mango, apple, citrus), 19 topics of oilseeds (mustard), 4 topics of floriculture (rose and protected cultivation) and 75 topics on general topics (integrated farming system, soil less cutivation, leaf colour chart, pusa decomposer, farm bills, career in agriculture, pusa STFR meter, biofertilizers application, spirulina, mushroom production etc.). Along with these, 51 special videos on different crops were also covered.

YouTube analytics of the Model

Demographics: It was also found that 17.12 percent of total watch hours was contributed by females and 82.88 percent of total watch hours was contributed by males. On analysis of data age wise it was found that maximum numbers of viewers are of 35–44 years (44% views), followed by 45–54 years (20% views), 55–64 years (18% views), 18–24 years (10% views), 25-34 years (6% views), and 65 plus years (2%).

Trend of Number of Views over Time: A total of 2.1 million views were there in 214 episodes and specific crop videos. On the basis of analysis the episodes were categorised into low, medium and high category on the basis of mean and standard deviation w.r.t.views over Time. Analysis of data has shown that 51 episodes were under high category, 30 episodes were under low category. Rest of the episodes were under medium category.

Trend of watch time (hours): A total of 1 lakh hours watch time was there in 214 episodes.

Number of subscriber added by each episode: A total of 47000 subscribers has subscribed the channel. The episodes were categorised into low, medium and high category on the basis of mean and standard deviation w.r.t. subscribers added by each episode. It was evident from data analysis that 42 episodes were under high category with more than 200 subscribers added in each episode, 12 episodes was under low category with less than 50 subscribers added in each episode. Rest of the episodes were under medium category.

Sharing service and Traffic source analysis: WhatsApp (90,015 shares) followed by Facebook (4000 shares), gmail (312 shares), twitter (157 shares), facebook messenger (91 shares). It was also found that viewers has watched the episodes maximum through browse features (870000 views), followed by external sources (450000 views), suggested videos (200000 views), youtube search (120000 views), channel pages (90000 Views), notifications (51000 views) and Other YouTube features (42000 views).

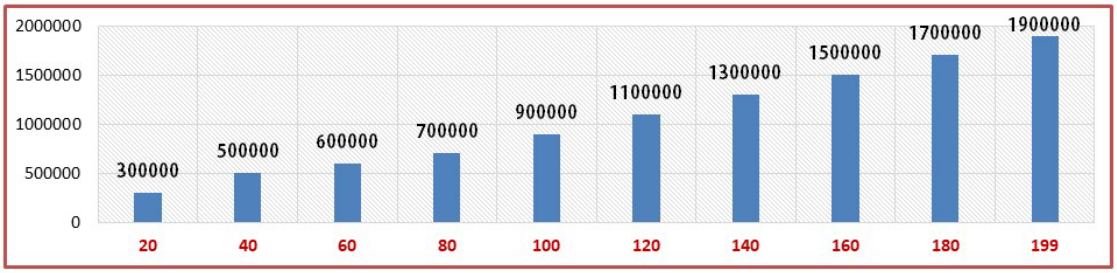


Figure 3: Trend of number of views over time in Pusa Samachar (Hindi)

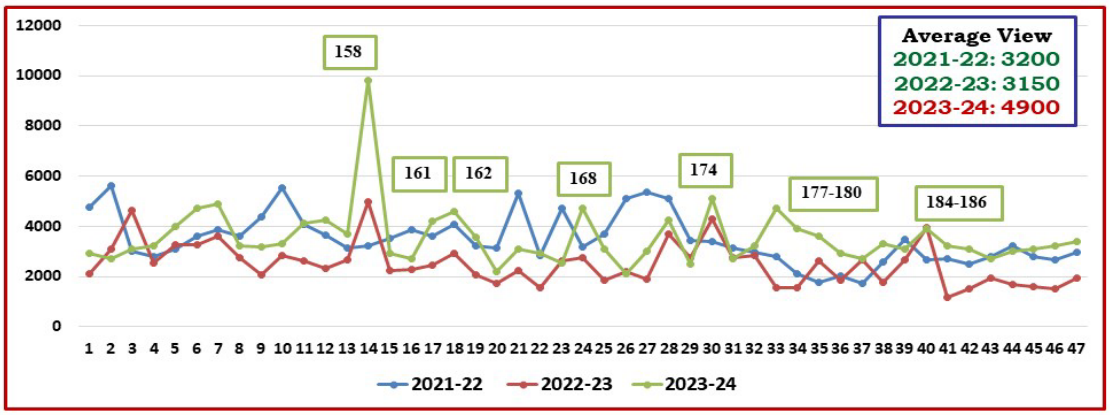


Figure 4: Three years views comparison of episodes under Pusa Samachar (Hindi)

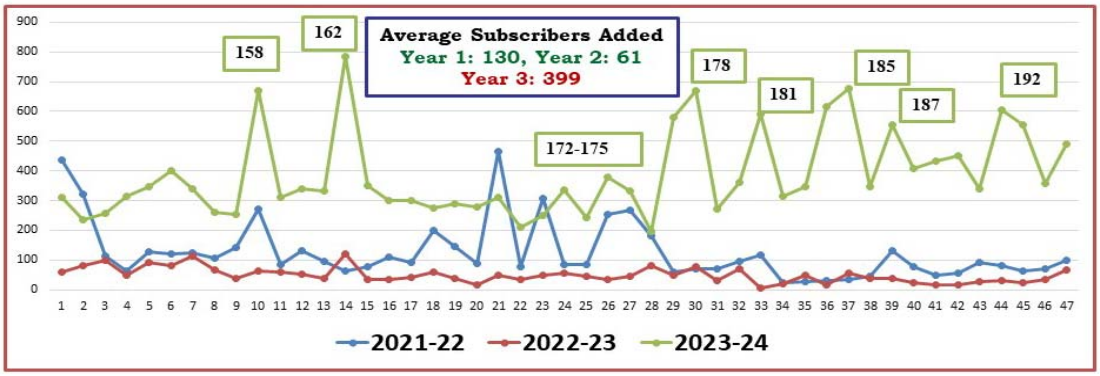
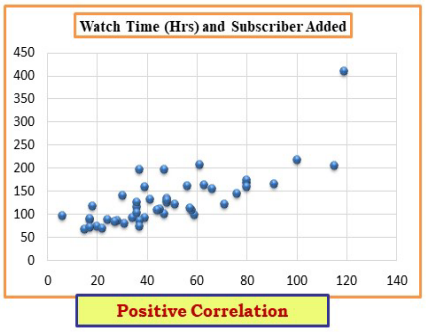


Figure 4: Number of subscribers added by each episode of Pusa Samachar (Hindi)

Impressions and click through rate: The overall impressions of the channel are 20176553, which means that IARI YouTube channel contents are visible to 20176553 people in their respective YouTube home page or from any other browse features. However, the click through rate is 8.40% which indicates that 8.40 % of total impressions/audience are actually clicking on uploaded videos and started watching them. This indicates that a huge audience potential (95.59%) is still left untapped, where IARI YouTube channel can work upon, so that this potential can be harnessed as regular subscribers.



Year	Impressions	Impressions click-through rate (%)	Views
2021-22	4354838	6.20	270000
2022-23	5112781	7.1	363007
2023-24	10708934	12.0	1285072
Total	20176553	8.4	19,18079

Impressions Overyears

Figure 5: Correlation between Watch time and Subscribers along with Impression and click rate under Pusa Samachar (Hindi)

Devices and Operating systems: Table 1 shows that maximum views (93.16 %) and watch hours (84.59%) has come from mobile phone which indicates that maximum part of audience are using mobile phone for viewing contents in IARI YouTube channel, followed by Computer. Analysis of operating system usage clearly indicates that maximum views (93.16 %) and watch hours (82.27 %) has come from android operating system. Thus, it can be concluded that maximum number of audiences is using android mobiles for watching contents of the channel, followed by computers with windows as operating system.

Device and Operating System used by audience

Device used by Audience			
Device type	**Views**	**Watch time (hours)**	**Average view duration**
Mobile phone	282550	15939.3083	0:03:23
Computer	16869	2486.3659	0:08:50
TV	2089	314.1263	0:09:01
Tablet	1746	103.5502	0:03:33
Game console	9	0.338	0:02:15
Operating system used by Audience			
Operating system	**Views**	**Watch time (hours)**	**Average view duration**
Android	273340	15477.0749	0:03:23
Windows	15914	2369.3474	0:08:55
iOS	8919	503.4191	0:03:23
KaiOS	3027	224.1578	0:04:26
Macintosh	880	114.2276	0:07:47
Smart TV	494	86.5371	0:10:30
Amazon Fire OS	369	39.2943	0:06:23

Pusa Whatsapp Salah: To cater customized crop information needs of farmers a WhatsApp number was made available to all farmers. Farmers across India are sending photographs and description of their field problems. The solution of farmers problem is being given by scientists of IARI, New Delhi promptly with specific and customized recommendations. Selected problems along with farmers name and solution are being shown in *Pusa Samachar* episodes under *Pusa WhatsApp salah* segment. This has connected IARI scientists directly to farmers and subscribers. In addition to problems, farmers are sending their feedback and suggestion regularly.

Uniqueness of the Model in comparison to existing ones

This multimedia-based extension model of ICAR-Indian Agricultural Research Institute, New Delhi is the first in-house and one of its own kind initiatives of an ICAR institute, which has following uniqueness as compared to other initiatives

1. **Content Credibility:** Many YouTube channels (mostly private owned channels) are providing farm advisories/information, but their credibility is always in question. Pusa Samachar contents come from scientists of IARI, New Delhi based on research findings, therefore the credibility and validity of the content are very high and thus, acceptability of the information by farmers is also high.
2. **Sustainability of the Model:** After launch of Pusa Samachar since 2020, the continuity of the episodes has been maintained and not a single episode has been missed even during Covid times. IARI's rich diversity of multidisciplinary specializations and dedicated Pusa Samachar team has made this model sustainable.
3. **Timely, location specific and need based information of major crops:** Pusa Samachar disseminates need based and timely information of crops based on crop season. The experts give holistic solutions with updated and current information for better crop management.
4. **Pusa Whatsapp Salah:** This is unique and one of its own kind initiates. One dedicated Pusa WhatsApp number (9560297502) has been launched, in which farmers sends their farm problems with pictures. Suitable solution of questions is obtained from IARI scientists and shared to the farmers to resolve their queries. Four pertaining questions and solutions are also included in the episode.
5. **Weather broadcast:** Weather information and weather-based farm advisory for upcoming week (based on IMD) is included in every episode with suitable graphics.
6. **Total inhouse production**: This model is in-house production of IARI with no help taken from outside professionals. All video shoot and editing are managed by in-house team of IARI with no external cost.

Validation of the Pusa Samachar model based on Primary data from stakeholders

Perception of the stakeholders about the quality of Pusa Samachar was captured on the basis of primary data exclusively collected from prime stakeholders (farmers). To capture the detailed perception of the stakeholders with respect to Pusa Samachar. Primary data was collected from Uttar Pradesh, Punjab and Haryana (since majority of viewers are from these states). From each state 5 districts were selected randomly and from each district 60 respondents were selected. Thus, sampling consisted of 900 farmers.

It was found that most of the farmers (86%) regularly watch *Pusa samachar* and 90% among them share this content with their colleagues. Analysing the source of information about *Pusa samachar* model, YouTube was the major source of information (71 %) followed by WhatsApp (18 %), verbal communication with fellow colleagues (6 %) and Facebook (5%). Perception of Stakeholders was captured under three heads: content and design, ease of understanding and fulfilment of information need. It was found that overall, most of the farmers (84%) believed that delivery of information is matching with the crop duration, information is rightly delivered during pest and disease infestation, highly updated content is given, content has been presented systematically, content is clearly comprehensible, content is well structured, style of presentation of experts is easily comprehensible.

Significant number of farmers (51%) believed that Audio quality, Graphics and Video quality needs further improvement. Most of the farmers (75%) believed that time duration of each crop section within an episode is optimum, however full-time duration of each episode should be reduced. It was also found that most of the farmers (72%) believed that catchy and attractive Thumbnail should be used to attract audience in YouTube. A knowledge test was executed to know how much farmers knowledge gain has occurred after watching Pusa Samachar episodes. Based on analysis, farmers were categorised into low, medium and high category on the basis of mean and standard deviation w.r.t. knowledge score. It was found that 41% of farmers were under high category and 22 % are under low category. Rest 37% farmers belonged to medium category of knowledge gain.

Conclusion

Agriculture faces several challenges, especially in developing countries due to deficiencies in infrastructure in rural areas. ICTs can play a very crucial role by disseminating location specific and timely information to farmers to help them make better and well-informed decisions. Through ICTs farmers can obtain the latest up-to-date information, learn and practice income remunerative farming. It is in this regard that Pusa Samachar has evolved as a unique model to reach farmers with customized information.

The present model has shown that research institutions can effectively act as a knowledge hub for scientific content development and dissemination by harnessing the power of social media. Due consideration should be given to audio, video and graphics management in multimedia for large-scale acceptance. Findings from this study show that different ICAR institutions can deliver multimedia advisory

services as ICAR has regional and crop-specific institutions in different areas, and thus tailor-made advisory services can help farmers of every region. State Departments of Agriculture can focus on developing specific multimedia-based crop-based information about variety, disease and pest management with special reference to contingency crop management during crop failure that can perform better compared to the only audio-based advisory of extension professionals.

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Video Based Extension Strategies

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ABSTRACT

In recent years, video-based strategies have transformed livestock extension services, revolutionizing information dissemination and farmer engagement. With the rise of digital technology, particularly smartphones and internet access, video-based strategies have introduced a new paradigm in extension services, allowing for broader reach and enhanced understanding among farmers. Videos provide a dynamic medium for conveying complex information, making them invaluable in livestock management, where visual demonstrations significantly improve learning outcomes. These strategies are cost-effective and adaptable to varying skill levels, benefiting both learners and educators. Initiatives like Digital Green have demonstrated the power of video in increasing the adoption of agricultural practices, offering a model for incorporating multimedia into extension programs. Video-based content, ranging from educational tutorials to expert interviews and virtual tours, enhances knowledge transfer, community building, and crisis management. By utilizing high-quality, engaging, and accessible videos, livestock extension programs can better support farmers, ensuring that essential information reaches those who need it most in an effective and impactful manner.

Keywords*: Video based extension, Digital Green, Educational tutorial, livestock extension program, information dissemination*

Introduction

Video-based strategies have emerged as a transformative tool in the realm of livestock extension, revolutionizing how information is disseminated and how farmers interact with educational content. Traditionally, livestock extension services relied heavily on face-to-face interactions, printed materials, and radio broadcasts to deliver crucial information to farmers. While these methods were effective to some extent, they often struggled with limitations such as geographical constraints, inconsistent access to resources, and challenges in demonstrating practical skills. With the advent of digital technology and the proliferation of smartphones and internet access, video-based strategies have introduced a new paradigm in extension services. Video-mediated extension reaches a broader audience than the government's traditional extension methods and results in greater farmer understanding and adoption of the technologies presented (Abate *et al.*, 2023). Videos offer a dynamic and engaging way to convey complex information, making them particularly valuable in the context of livestock management, where visual demonstrations and real-time guidance can significantly enhance learning outcomes. Video offers the advantage of being a low-cost medium while still allowing content to be tailored to the skill levels of both students (Muralidharan *et al.*, 2019) and teachers (Jackson and Makarin, 2018). Given the success of video-based learning in various fields, it's unsurprising that there has been a push for video-based training in agriculture sector as well (Fabregas *et al.*, 2019). Hörner *et al.* (2021) demonstrated that incorporating videos into a "farmer-to-farmer" extension program helps promote the adoption of practices related to Integrated Soil Fertility Management (ISFM), especially among farmers who are not part of farmer groups.

Digital Green Initiative

Digital Green is an independent non-governmental organization dedicated to training farmers to create and share short videos. These videos allow farmers to document their challenges, share solutions, and highlight success stories. It operates in seven states across India, as well as in parts of Ethiopia, Ghana, and Afghanistan. The organization engages with over 150,000 farmers, more than 70% of whom are women, in over 2,000 villages (Bornstein, 2013). In 2013, Digital Green received a Global Impact Award from Google, worth Rs 3 crore, and in 2012, it was honored with the Manthan Award. In a four-month trial across 16 villages (comprising 1,070 households), Digital Green was found to increase the adoption of certain agricultural practices by six to seven times compared to traditional person-only agricultural extension methods (Gandhi *et al.*, 2007). Video-based strategies are increasingly popular in livestock extension due to their ability to convey complex information clearly and engagingly. Some effective video-based strategies to be considered are given below:

1. Educational Tutorials

How-To Guides: Create step-by-step videos on essential practices, such as animal health care, feeding techniques, and breeding practices. These videos can help producers learn new skills or refine existing ones.

Best Practices: Showcase best practices in animal husbandry, such as proper housing, waste management, and biosecurity measures.

2. Demonstration Videos

Equipment Use: Demonstrate the operation of new or complex machinery and equipment used in livestock farming.

Practical Applications: Show real-life applications of new technologies or techniques in action, such as automated feeding systems or disease management protocols.

3. Case Studies

Success Stories: Feature successful livestock operations and the strategies they used to overcome challenges. This can inspire and provide practical examples for other farmers.

Problem-Solving: Document and analyze common problems faced by livestock producers and provide solutions based on real-world cases.

4. Expert Interviews

Veterinary Advice: Interview veterinarians and animal health experts on topics like disease prevention, treatment options, and nutritional needs.

Industry Insights: Talk to industry professionals about trends, innovations, and market dynamics affecting livestock farming.

5. Interactive Content

Q&A Sessions: Host live or recorded Q&A sessions where experts answer questions from viewers on various livestock-related topics.

Polls and Surveys: Incorporate polls or surveys within videos to engage viewers and gather feedback on specific issues or topics.

6. Virtual Tours

Farm Tours: Provide virtual tours of successful farms or facilities to show how different operations are managed and maintained.

Facility Walkthroughs: Offer insights into specialized facilities like feed mills, veterinary clinics, or processing plants.

7. Training and Certification

Online Courses: Develop video-based courses for training and certification in specific skills or knowledge areas relevant to livestock management.

Workshops: Record workshops or seminars and make them available online for broader access.

8. Crisis Management

Emergency Protocols: Create videos on handling emergency situations, such as disease outbreaks, natural disasters, or accidents, and outline emergency response protocols.

Recovery Strategies: Provide guidance on recovery and rebuilding strategies after a crisis.

9. Community Building

Farmer Networks: Facilitate networking and community building through video series that connect producers and foster peer-to-peer learning.

Discussion Forums: Use video to moderate discussions on common challenges and innovations in the livestock sector.

10. Marketing and Promotion

Product Showcase: Highlight new products, technologies, or services available to livestock producers.

Branding: Use videos to build brand awareness for agricultural businesses or cooperatives.

Tips for Effective Video-Based Strategies:

- High Quality: Ensure videos are high-quality in both content and production. Clear visuals and good audio are crucial.
- Accessibility: Make sure videos are accessible to all, including subtitles for those with hearing impairments and translations for non-native speakers.
- Engagement: Keep videos engaging by using visuals, animations, and interactive elements where possible.
- Regular Updates: Update content regularly to keep it relevant and useful for your audience.

Incorporating these video-based strategies can enhance the effectiveness of livestock extension programs, providing valuable information and support to producers in an engaging and accessible format.

Various steps involved in Development of Educational Videos

Video development involves a series of steps that ensure the final product is well-planned, effectively produced, and polished for its intended audience. Here's a comprehensive overview of the steps typically involved in video development:

1. Pre-Production

Pre-production is the planning phase, where all aspects of the video are mapped out before shooting begins.

Concept Development: Define the purpose, audience, and core message of the video. This involves brainstorming ideas and deciding on the type of video (e.g., promotional, tutorial, documentary).

Scriptwriting: Write a detailed script that outlines the dialogue, voiceover, and action. It serves as a blueprint for what will happen in the video.

Storyboarding: Create a visual representation of each scene through sketches or digital illustrations. This helps visualize the shot composition, camera angles, and transitions.

Budgeting: Establish a budget that covers all expenses, including equipment, location fees, manpower, post-production, and any other costs.

Scheduling: Develop a timeline for the project, including deadlines for each phase of production and the shoot schedule.

Location Scouting: Identify and secure best locations for the shoot. Consider factors like lighting, accessibility, and permits.

Equipment and Resources: Arrange for the necessary equipment (cameras, lighting, microphones, etc.).

2. Production

Production is the phase where all the planning is executed, and the actual footage is captured.

Setting Up: Prepare the location by setting up equipment, lighting, and sound. Ensure that everything is working properly before shooting.

Directing: Guide the actors and crew to achieve the desired performances and shots. The director communicates the vision and ensures the script and storyboard are followed.

Shooting: Record all scenes as planned, capturing multiple takes if necessary. Monitor audio and video quality throughout the shoot to ensure consistency.

Managing Continuity: Keep track of details like props, costumes, and positioning to ensure consistency across shots and scenes.

3. Post-Production

Post-production involves editing and finalizing the video for release.

Editing: Assemble the recorded footage into a coherent sequence. This includes selecting the best takes, arranging clips, and creating a rough cut of the video.

Visual Effects and Graphics: Add any visual effects, animations, or motion graphics needed to enhance the video or convey additional information.

Sound Design: Edit the audio, including dialogue, sound effects, and background music. Ensure that the sound is balanced and clear.

Exporting and Formatting: Export the final video in the appropriate format and resolution for its intended platform (e.g., YouTube, social media, broadcast).

4. Distribution and Marketing

After production of final video its distribution and sharing is done through various strategies as follows.

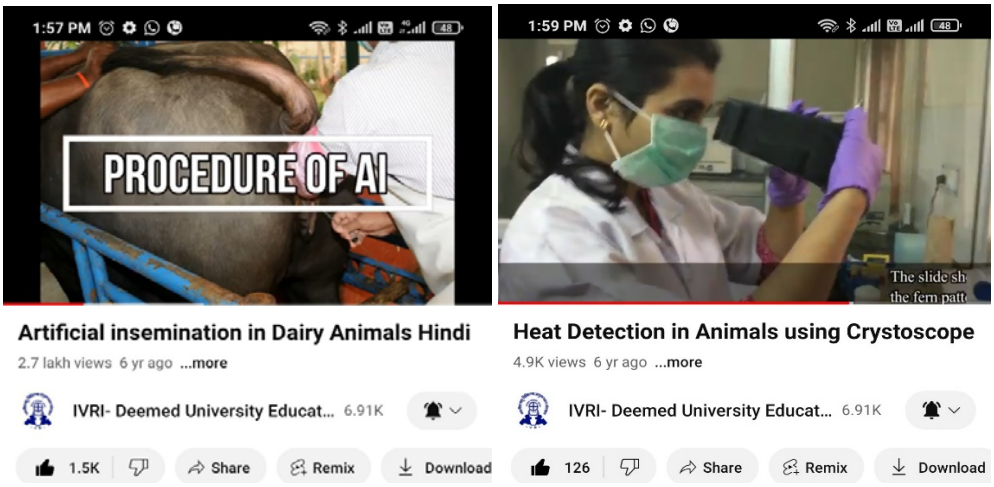
Platform Selection: Choose the platforms where the video will be distributed (e.g., YouTube, Vimeo, social media, website).

SEO and Optimization: Optimize the video for search engines and platforms by using relevant keywords, tags, descriptions, and thumbnails.

Promotion: Develop a marketing strategy to promote the video through various channels like social media, email campaigns, and collaborations.

Monitoring and Analytics: Track the video's performance using analytics tools to measure engagement, views, and other key metrics.

By following these steps, video developers can create high-quality content that effectively communicates their message and engages their audience.



The Impact of Video-Based Strategies on Livestock Extension

1. Enhanced Learning and Retention

Videos cater to various learning styles by combining visual, auditory, and textual elements. This multimodal approach enhances comprehension and retention of information. For example, instructional videos on animal husbandry techniques can demonstrate proper feeding, handling, and health care practices, allowing farmers to see these practices in action rather than relying solely on written instructions.

2. Broader Reach and Accessibility

Video-based extension breaks down geographical barriers, making high-quality educational content accessible to farmers in remote or underserved areas. Farmers with limited access to traditional extension services can benefit from video tutorials, expert interviews, and virtual farm tours, thus democratizing access to vital knowledge.

3. Real-Time Updates and Flexibility

Videos can be updated regularly to reflect the latest research, technologies, and practices in livestock management. This flexibility ensures that farmers have access to the most current information without waiting for printed materials or scheduled extension visits. Furthermore, videos can be viewed at the farmer's convenience, allowing for asynchronous learning that fits into their schedules.

4. Practical Demonstrations

Livestock management often involves hands-on practices that are best understood through demonstration. Videos can effectively showcase techniques such as vaccination procedures, feed formulation, and equipment operation, providing farmers with practical, visual guidance that written instructions alone may not convey.

5. Cost-Effectiveness

Producing and distributing video content can be more cost-effective compared to traditional extension methods. Once created, videos can be shared widely without incurring additional costs for printing or travel, making them an economical option for reaching large audiences.

Challenges and Considerations

While video-based extension offers numerous advantages, it is not without its challenges. Addressing these challenges is crucial for maximizing the effectiveness of this approach:

1. Technical Limitations

Access to reliable internet and modern devices can be a barrier for some farmers, particularly in remote areas with limited infrastructure. Ensuring that videos are optimized for various devices and can be accessed offline or in low-bandwidth conditions can help mitigate this issue.

2. Content Quality and Relevance

The effectiveness of video-based extension relies on the quality and relevance of the content. Poorly produced videos or content that does not address the specific needs of the target audience can diminish the impact of the extension service. Ensuring high production values and tailoring content to the local context and needs is essential for success.

3. Engagement and Interaction

While videos can deliver information effectively, they may lack the interactive elements of face-to-face extension services. Integrating interactive features such as quizzes, discussion forums, and live Q&A sessions can enhance engagement and provide opportunities for farmers to seek clarification and feedback.

4. Training and Support

Farmers may require training on how to access and use video-based content effectively. Providing guidance and support to help farmers navigate digital platforms and utilize video resources can improve adoption and utilization.

Conclusion

Video-based strategies represent a significant advancement in livestock extension services, offering enhanced learning experiences, broader reach, and practical demonstrations that traditional methods may lack. By addressing the challenges associated with technical limitations, content quality, and engagement, video-based extension can be a powerful tool for improving livestock management practices and supporting agriculture and livestock development. As technology continues to evolve, the integration of video-based approaches in extension services is likely to become increasingly prevalent, further transforming the landscape of agricultural education and support.

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User Centric Approach in e-Extension

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ABSTRACT

In India, agriculture and allied sectors are crucial to the nation's economy, and improving productivity in these sectors is essential to meet the demands of a growing population. Agricultural extension services have historically utilized traditional methods like television, radio, and newspapers to disseminate information. However, the advent of mobile phones, the internet, and other digital platforms has introduced e-Extension, which leverages Information and Communication Technology (ICT) to enhance agricultural knowledge and services. Despite these technological advances, many farmers still face challenges in effectively utilizing these resources. A user-centric approach to designing ICT tools can address these challenges by focusing on the specific needs, behaviors, and constraints of the users—farmers in this context. This approach involves several key principles and steps: focusing on users and their needs, iterative design, evidence-based design, and multidisciplinary collaboration. The process begins with context exploration to understand user requirements and constraints, followed by defining design criteria, making informed design decisions, and developing and testing prototypes. Evaluation methods ensure that the final design meets user needs and functions effectively. User-centric design methods include focus groups, usability testing, card sorting, participatory design, questionnaires, and interviews. Each method offers different benefits, such as enhanced usability and increased engagement, but also comes with challenges, including digital literacy and internet connectivity issues. By adopting a user-centric design approach, ICT tools for agricultural extension can be better tailored to farmers' needs, leading to improved productivity and technology adoption in the agricultural sector.

Keywords*: User-centric approach, e-Extension, Information and Communication Technology (ICT), card sorting, participatory design, questionnaires, and interviews*

Introduction

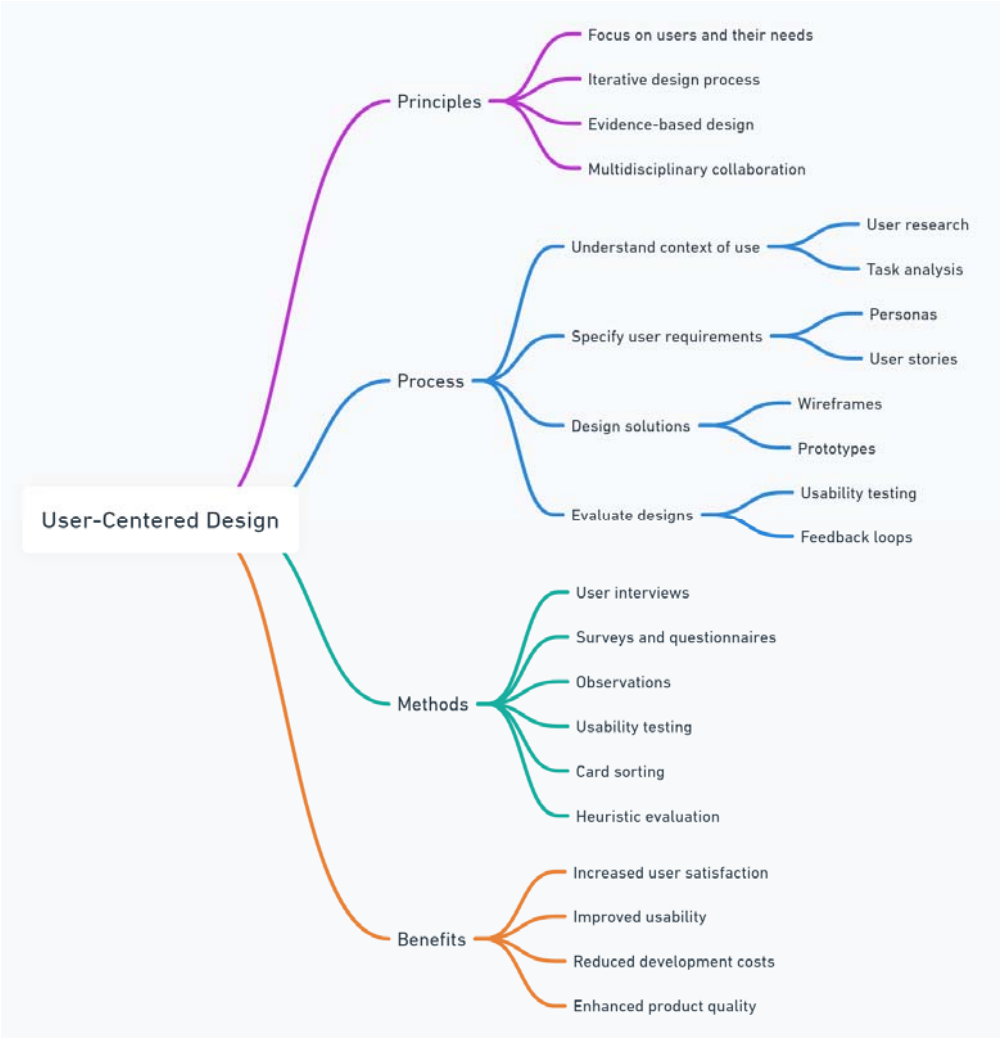
In India, agriculture and allied sectors are most significant contributors to the nation's economy. To meet the demands of the increasing population there is a pressing need to improve the productivity of the agricultural and livestock products. To achieve this the farmers should know about the advances in the respective fields. The extension services play a vital role in improving the productivity as they decrease the knowledge gap among farmers and increase the productivity. In early years, the services are provided through traditional methods like television, radio and newspapers. However, the rapid raise in utilization of mobile phones, internet and other digital platforms (Information and Communication Technology) transforming the way in which the services are provided. The use of ICT tools to extend agricultural knowledge and services to farmers and other stakeholders in the agriculture sector is termed as e-Extension. This facilitate sharing of information regarding real time weather forecast, best practices to follow to improve the productivity, current market prices, running government schemes and subsidies. Despite these advancements, many farmers are not utilizing them effectively. To overcome this challenge, **user centric approach** can be adopted by keeping the needs of the stakeholders at the center of the developing process. This approach ensures that ICT tools are designed and deployed in a way that aligns with the specific needs, behaviors, and challenges faced by the farmers, thereby increasing their effectiveness and adoption.

User centric approach\design:

User-centric design (USD) is an iterative design process in which designers focus on the users and their needs in each phase of the design process. The term USD is given by Donald Norman and he wrote about it in his book titled "The Design of Everyday Things". This design became popular after the book was published and mostly used by the product manufacturing organizations. This design helps in prioritizing the needs and preferences of the customers in every aspect of its operations, from product development and marketing to customer support and beyond.

Principles of User-centric design:

- Focus on users and their needs.
- Iterative design process
- Evidence –based design
- Multidisciplinary collaboration



Essential elements for USD:

- **Visibility:** Users should immediately understand the product's purpose, what it offers, and how to interact with it.
- **Accessibility:** Information should be easily and quickly accessible to users. Multiple methods like call-to-action buttons, a search bar, and a menu should be available to help them find what they need.
- **Legibility:** Text should be straightforward and easy to read.
- **Language:** Use short, simple sentences and clear language for better comprehension.

Steps in user centric approach

1. Context exploration

- First we should identify the beneficiaries of the product and what are their requirements
- Identify who the primary users of the product are, why they will use the product, what are their requirements and under what environment they will use it.
- We should understand the existing constraints faced by the farmers in acquiring information related to livestock through interviews.
- The goal of these interviews was to understand the different types of information flows available to farmers, and their limitations as perceived by the agricultural extension agents.

2. Design criteria

Using insights from the interviews, we should identify the requirements that needed to be addressed by the design in the specific area.

- Context specificity

- Diverse perspectives
- Adaptability
- Resource efficiency
- Constant availability
- Accountability

3. Design decisions

In brainstorming sessions, we used the generated insights about available and preferred information channels and communication technologies to take several preliminary, interrelated design decisions. For each design criterion defined in step 2, we took a design decision, based on how a mobile phone-based solution could address it.

4. Prototyping sessions

Based on the design decisions, we developed various prototypes and tested among the potential users. Then observe the user behaviour and reaction. Interactions between the farmer and the extension agents were also recorded. Then jointly discussed users' perceptions of the various prototypes and took decisions on the eventual design. Based on the decisions taken with farmers and extension agents, we eventually determined the characteristics of the service.

5. Evaluation

Assess the outcomes of the evaluation against the user's context and requirements to check how well the design is functioning.

Methods used in user-centric design

Focus group: A group of beneficiaries are invited to share their thoughts, feelings and any ideas regarding the product. It helps in understanding the requirements of the users.

Usability testing: It is done by collecting the data from people when they use it. The user is asked to use the product and inform any difficulties in performing task while using it.

Card sorting: The participant is asked to sort the index cards into groups and name them. This helps in analyzing the data statistically.

Participatory design: In this method the users not only asked to suggest but also actively involves them in design and decision making processes.

Questionnaire: It is used to collect statistical data by asking the users for their responses to a pre-determined set of questions.

Interviews: It is face-to–face interaction with the interviewee or participant to know about their point of view in detail about the product.

Method	Cost	Output	Sample size	When to use
Focus groups	low	Non statistical	Low	Requirements gathering
Usability testing	high	Statistical and Non Statistical		Design & Evaluation
Card sorting	high	Statistical	High	design
Participatory design	Low	Non-statistical	Low	Design
Questionnaires	Low	Statistical	High	Requirements gathering & evaluation
Interviews	High	Non-statistical	Low	Requirements gathering & evaluation

Popular user-centered design methods (Source: Web Credible)

Benefits of user centric e-extension approach

- **Enhanced Usability:** User-centric ICT tools are designed with the end-user in mind, making them more intuitive and easier to use. This improved usability helps users perform tasks more effectively and reduces the learning curve.
- **Improved Accessibility:** By focusing on the needs of diverse users, these tools are designed to be accessible to people with varying levels of digital literacy and physical abilities. This inclusivity ensures that more users can benefit from the technology.
- **Increased Engagement:** When ICT tools are tailored to users' needs and preferences, they tend to be more engaging. This can lead to higher user interaction and sustained use, as the tools address specific needs and interests.
- **Better Decision-Making:** User-centric design often incorporates relevant and actionable information that helps users make informed decisions. This improved access to pertinent data supports better decision-making processes.

- **Empowerment:** When users feel that a tool is designed to meet their specific needs, they are more likely to feel empowered and confident in using it. This empowerment can lead to greater independence and autonomy.
- **Efficiency:** User-centric ICT tools streamline processes and reduce unnecessary steps, which enhances overall efficiency. Users can complete tasks more quickly and with fewer errors, saving time and resources.
- **Increased Adoption of New Technologies:** Tools that are designed with users in mind are more likely to be embraced and adopted. When technology meets the real needs of its users, there is less resistance to change and a higher rate of adoption.
- **Economic Benefits:** Efficient, user-friendly technology can lead to cost savings for both users and organizations. Improved productivity and reduced training costs contribute to economic advantages, making technology investments more viable.

Challenges of user centric e-extension approach

- **Lack of Digital Literacy:** Many users, especially in rural areas, may have limited experience with digital tools and technologies. This lack of digital literacy can hinder their ability to effectively use e-extension services and access valuable information.
- **Internet Connectivity:** Reliable internet access is essential for e-extension services to function effectively. In many regions, especially rural areas, poor or intermittent internet connectivity can limit the accessibility and usability of digital tools.
- **Language Barriers:** E-extension services must accommodate multiple languages and dialects to be inclusive. Language barriers can prevent users from fully understanding or engaging with the content, especially if the service is not available in their native language.
- **Cultural Differences:** Cultural differences can impact how users perceive and interact with e-extension services. Designs and content that do not consider local customs, practices, and values may not resonate with users or may be misinterpreted.
- **Sustainability:** Ensuring the long-term sustainability of e-extension services can be challenging. This includes maintaining technological infrastructure, updating content regularly, and securing ongoing funding or support to keep the services operational.
- **Tailoring Content:** Adapting content to meet the diverse needs of users can be complex. Content must be relevant, practical, and tailored to different user contexts, which requires ongoing research and customization to address varying needs and preferences effectively.

Way forward for effective utilization of user centric e-extension approach

1. **Enhance Digital Literacy**:
   - **Training and Education**: Implement training programs and workshops to improve digital skills among farmers and other stakeholders. Use local institutions and community leaders to facilitate learning.
   - **Simple Interfaces**: Design intuitive and user-friendly interfaces that require minimal technical skills, making it easier for users to navigate and use e-extension tools.
2. **Improve Internet Connectivity**:
   - **Infrastructure Development**: Collaborate with government and private sector partners to enhance internet infrastructure in rural and underserved areas.
   - **Offline Access**: Develop offline capabilities or content that can be accessed without continuous internet connectivity, such as downloadable resources or SMS-based services.
3. **Overcome Language Barriers**:
   - **Multilingual Support**: Provide e-extension services in multiple languages and dialects relevant to the user base. Use local language experts to ensure accurate and culturally appropriate translations.
   - **Visual Content**: Utilize images, videos, and infographics to convey information, reducing reliance on text and making content more universally accessible.
4. **Address Cultural Differences**:
   - **Localized Content**: Customize content to reflect local customs, practices, and needs. Involve local communities in the design and development process to ensure cultural relevance.
   - **Cultural Sensitivity Training**: Provide training for developers and content creators on cultural sensitivity and inclusivity.

5. **Ensure Sustainability**:
   - **Ongoing Support**: Establish mechanisms for continuous support and updates to keep e-extension services relevant and effective. Create partnerships with local organizations for maintenance and support.
   - **Funding and Resources**: Secure diverse funding sources and resources to sustain e-extension initiatives. Explore public-private partnerships and grant opportunities.

6. **Tailor Content Effectively**:
   - **User Feedback**: Regularly gather feedback from users to understand their needs and preferences. Use this feedback to iteratively improve content and services.
   - **Customizable Options**: Provide options for users to personalize or customize the content they receive, allowing them to access information most relevant to their specific situation.

7. **Leverage Technology Innovations**:
   - **AI and Data Analytics**: Use artificial intelligence and data analytics to offer personalized recommendations and insights based on user behavior and needs.
   - **Mobile-Friendly Design**: Optimize e-extension services for mobile devices, given their widespread use in rural areas.

8. **Foster Collaboration and Partnerships**:
   - **Stakeholder Engagement**: Engage with a range of stakeholders, including government agencies, NGOs, technology providers, and local communities, to collaborate on e-extension initiatives.
   - **Knowledge Sharing**: Promote knowledge sharing and best practices among organizations working on similar projects to enhance overall effectiveness and impact.

Conclusion

The effective utilization of user-centric e-extension approaches is crucial for enhancing agricultural productivity in India. By focusing on the unique needs and challenges faced by farmers, these digital tools can transform agricultural practices, making them more efficient and accessible. The iterative design process ensures that the end-users' voices are prioritized, leading to solutions that are not only functional but also engaging.

However, significant challenges remain, such as limited digital literacy, inconsistent internet connectivity, and cultural barriers. Addressing these issues through targeted training, improved infrastructure, and localized content is essential for maximizing the reach and impact of e-extension services.

As we move forward, fostering collaboration among stakeholders, leveraging technological advancements, and ensuring sustainability will be vital. By embracing a user-centric approach, we can empower farmers, enhance their decision-making capabilities, and ultimately contribute to a more productive and resilient agricultural sector. This holistic strategy not only benefits individual farmers but also supports the broader goal of food security and economic growth in India.

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Vlogs-A New Way of E-Extension

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ABSTRACT

Vlogs, or video blogs, have emerged as a dynamic tool in the agricultural e-extension landscape, leveraging audiovisual elements to enhance communication and engagement. Unlike traditional written blogs, vlogs offer a visually appealing and interactive format that resonates with diverse audiences, particularly in rural areas. This paper explores the significance of vlogs in agricultural extension, highlighting their advantages such as visual demonstrations, accessibility, real-time updates, and the ability to cater to varying literacy levels. Vlogs also facilitate peer learning, showcase innovative practices, and encourage youth participation in agriculture. Despite challenges like the digital divide and varying content quality, the benefits of vlogs in providing timely, relatable, and cost-effective agricultural knowledge are substantial. The process of creating effective vlogs involves careful planning, recording, editing, and promoting, with best practices emphasizing clarity, engagement, and local relevance. As technology advances, vlogs are poised to further transform agricultural extension, offering immersive learning experiences through innovative tools. This paper underscores the crucial role vlogs play in modernizing agricultural education and enhancing farmer engagement.

Keywords: *Vlogs, blogs, e-extension, design, researchable issues*

Introduction

E-Extension refers to the use of Information and Communication Technologies (ICTs) to extend agricultural knowledge and services to the farmers and rural communities. Traditional extension services involved face-to-face communication, field demonstrations, and physical visits by extension agents. However, with the emergence of ICT based digital tools, the mode of knowledge dissemination is changing rapidly. Among these digital tools, **vlogs (video blogs)** has emerged as an innovative and powerful tool for e-extension.

In the contemporary agricultural landscape, e-extension has emerged as an innovative & powerful tool, significantly transforming the way information is produced, processed, stored and shared to farmers and other stakeholders. E-extension has now become an essential tool in the modern agricultural landscape because it enhances the accessibility, affordability, and timeliness of extension services. By integrating ICT tools into agricultural extension, farmers can make better-informed decisions, improve their productivity, and adapt to changing environmental and market conditions, thereby contributing to overall agricultural development.

Vlogs: Meaning & Concept

A Vlog (video blog) is a type of blog where the content is presented in a video format. Unlike written blogs, vlogs combine the visual and audio elements to make the communication of information more engaging and relatable. They can be hosted on platforms like YouTube, Facebook, Instagram, and other social media sites. Vlogs allow content creators to interact with their audience more directly and personally.

Vlogs (video blogs) are gaining prominence as an effective tool in the field of agricultural e-extension landscape due to their engaging format, widespread reach, and ability to convey complex information in a visually appealing and easy-to-understand manner.

Vlogs are particularly effective in agricultural extension due to several key advantages:

- **Visual Demonstration:** Agriculture is a practical field where visual demonstrations are highly effective. Through vlogs, farmers can see practical demonstrations of techniques such as crop planting, soil testing, pest management, and more.
- **Accessibility:** With the widespread availability of smartphones and affordable internet access, farmers in even remote areas can watch vlogs. This makes them a valuable tool for reaching a wider audience.
- **Interactive and Engaging:** Vlogs offer a personal touch, as the creator (often an expert or peer farmer) can directly speak to viewers, making the information more relatable and trustworthy.
- **Mobile and On-Demand:** Farmers can watch vlogs on their mobile phones, at any time that suits them, making learning flexible and convenient.

Why Vlogs in E-Extension?

Vlogs (video blogs) have emerged as an effective tool in the field of agricultural e-extension due to their engaging format, widespread reach, and ability to convey complex information in a visually appealing and easy-to-understand manner. Here are some key reasons why vlogs are important in e-extension:

- **Visual Appeal and Engagement:** Vlogs leverage the power of visual communication to make complex agricultural practices more understandable. Farmers can observe actual demonstrations of techniques such as planting methods, pest control, or equipment usage, making the learning process more engaging and impactful than text-based content alone.
- **Demonstrating Practical Knowledge:** Agricultural practices often require practical, hands-on demonstrations. Vlogs allow extension officers, experts, and progressive farmers to show step-by-step procedures directly to farmers, enhancing their understanding of modern techniques, equipment, or solutions to common agricultural challenges. For example, a vlog demonstrating how to install a drip irrigation system is more effective than written instructions.
- **Increased Reach and Accessibility:** Vlogs can be shared easily via platforms like YouTube, Facebook, WhatsApp, or Instagram, allowing farmers to access them on their smartphones from anywhere, at any time. This wider accessibility helps extension services reach farmers who are unable to attend in-person training sessions or live in remote areas with limited access to physical extension services.
- **Language and Literacy Considerations:** Vlogs are particularly useful in regions with low literacy levels. Since they rely primarily on visual and spoken communication, they can easily convey messages to farmers who may not be comfortable reading written materials. Vlogs can be created in local languages, making them more relatable and easier for farmers to grasp key concepts.
- **Real-Time Updates and Timely Information:** Vlogs allow for quick dissemination of timely information. For instance, if there is an outbreak of a particular pest or a sudden change in weather conditions, a quick vlog can be created and circulated, giving farmers real-time advice on how to respond. This can be especially important for perishable crops or urgent situations requiring immediate action.
- **Cost-Effective Knowledge Sharing:** Vlogs offer a cost-effective way of disseminating knowledge. Unlike organizing physical demonstrations or workshops, vlogs require minimal resources once the video is created. They can be reused, shared across multiple platforms, and accessed by a large audience without additional costs for repeated training sessions.
- **Peer Learning and Farmer-to-Farmer Communication:** Farmers are more likely to trust and learn from other farmers who have successfully implemented a technique or solved a problem. Vlogs featuring farmer testimonials, success stories, or innovative practices serve as a medium for peer learning. This enhances the credibility of the information and motivates other farmers to adopt similar practices.
- **Addressing Specific Queries:** Vlogs can be created to address frequently asked questions or specific queries from farmers. For example, if many farmers in a region are struggling with a certain pest, an extension agent can create a vlog specifically addressing that issue. This personalized approach helps cater to the immediate needs of the farming community.
- **Encouraging Youth Participation:** Younger generations, who are often more familiar with technology and digital platforms, are more likely to engage with vlogs than traditional agricultural extension methods. By using popular platforms and content formats that appeal to youth, vlogs can help bridge the generational gap in agriculture, encouraging the involvement of tech-savvy youth in farming.
- **Encouraging Innovation and Adoption of Modern Techniques:** Vlogs can showcase innovations in agriculture, such as precision farming tools, new crop varieties, or sustainable practices, and demonstrate how they can be applied. This helps reduce resistance to adopting modern techniques by showing their practical benefits and the ease of implementation.
- **Feedback and Interaction:** Many vlog platforms enable viewers to leave comments or questions, providing a valuable opportunity for interaction between farmers and experts. Extension officers can monitor these comments and respond to questions or concerns, creating a two-way communication channel that enhances learning.

Thus, Vlogs serve as an effective, engaging, and widely accessible tool in agricultural e-extension. They provide visual demonstrations of techniques, reach a large audience, accommodate low literacy levels, and offer timely and cost-effective solutions to farmers' needs. Vlogs play a crucial role in

modernizing agricultural extension, making information more accessible, engaging, and easier to implement in the field.

Difference between Blogs and Vlogs: A blog is essentially a text-based content whereas Vlog is a video-based content designed to achieve a pre-specified purpose. However, there are some difference between the two as shown in the table below.

Aspect	Vlog	Blog
Primary Medium	Video (visual + auditory content)	Text (written content)
Engagement Style	Visual and audio appeal, engaging through personal presence, visuals, and spoken words.	Written words, images, and sometimes infographics, requiring reading.
Platforms	YouTube, Vimeo, Instagram, TikTok, etc.	Websites, WordPress, Blogger, Medium, etc.
Content Delivery	Requires recording, editing, and producing video content.	Requires writing, editing, and structuring text-based content.
User Interaction	Viewers engage through likes, comments, and shares on video platforms.	Readers engage through comments, likes, and shares on blog platforms.
Production Complexity	Requires video recording equipment, editing software, and sometimes complex production.	Requires word processing tools, minimal design elements, and less technical equipment.
Consumption	Easier to consume on the go, can listen or watch.	Requires active reading, more time-consuming.

Benefits of Vlogs for E-Extension

1. **Enhanced Learning Experience**: Vlogs make learning more interactive by combining visual, audio, and sometimes even textual elements. This improves knowledge retention and application.
2. **Timely Updates**: Farmers can be provided with real-time updates on important issues like weather conditions, pest outbreaks, and market prices through vlogs.
3. **Language and Cultural Adaptability**: Vlogs can be created in local languages and tailored to the cultural context of different regions. This makes the content more understandable and acceptable to local farmers.
4. **Peer Learning**: Farmers who have succeeded in implementing certain agricultural techniques can share their experiences through vlogs, promoting peer learning and building trust among viewers.

Key Features of a Vlog: A Vlog will have the following features as described below.

- **Video-Based Content**: A vlog is centered around video as the primary content format, with vloggers speaking directly to the camera to engage viewers. Visual storytelling and audiovisual presentations are the main elements.
- **Personal Connection**: Vlogs often feel more personal because vloggers appear on screen, allowing viewers to connect with them through facial expressions, tone of voice, and body language.
- **Direct Engagement**: Vloggers often encourage viewers to engage by asking them to like, comment, and subscribe, creating an interactive community around their content.
- **Regular Updates**: Vloggers typically upload new content regularly, whether it's daily, weekly, or monthly, maintaining audience interest and loyalty.
- **Creative Editing**: Vlogs often feature cuts, transitions, music, and visual effects to keep the content visually dynamic and engaging.
- **Platform-Specific Optimization**: Vlogs are optimized for video-sharing platforms like YouTube, TikTok, or Instagram, with attention to SEO (search engine optimization), metadata, and thumbnails.
- **Call-to-Action (CTA)**: Vlogs frequently include CTAs at the end, asking viewers to take specific actions such as subscribing to the channel, watching other videos, or visiting a website.

Types of Vlogs: Different types of Vlogs are as follows.

1. **Personal/Diary Vlogs**: Vloggers share their day-to-day lives, thoughts, or experiences in a casual, conversational format. This type is often informal and relatable, making viewers feel like they are following along with the vlogger's life. Example: **Daily vlogs** or **week-in-my-life vlogs**.
2. **Travel Vlogs**: These vlogs focus on documenting trips to various locations, showcasing the culture, food, landmarks, and experiences of different destinations. They are visually rich and informative for those interested in travel. Example: **Travel guides, hotel reviews, or adventure vlogs**.

3. **Tutorial/How-To Vlogs**: Vloggers provide step-by-step instructions on how to complete specific tasks or learn new skills. These vlogs are educational and typically focus on areas like makeup tutorials, cooking, fitness, or DIY projects. Example: **Beauty tutorials, fitness routines, or cooking lessons**.
4. **Review Vlogs**: These focus on reviewing products, services, or experiences. Vloggers provide their opinions, often demonstrating or unboxing the product to help potential buyers make informed decisions. Example: **Tech reviews, unboxing videos, or beauty product reviews**.
5. **Event Vlogs**: Vloggers capture footage from events such as festivals, concerts, conventions, or social gatherings to share the experience with viewers who may not have attended. Example: **Concert vlogs, fashion show vlogs, or conference vlogs**.
6. **Educational/Informational Vlogs**: These vlogs provide insights on specific topics like science, history, or current events. They focus on explaining concepts or sharing knowledge in a video format. Example: **Science explainer videos, history lessons, or informative talks**.
7. **Challenge or Trend-Based Vlogs**: Vloggers participate in popular online challenges or trends, often with humorous or entertaining results. Example: **30-day challenges, reaction videos, or viral internet challenges**.
8. **Opinion/Discussion Vlogs**: In these vlogs, the vlogger shares their views or opinions on specific topics, whether political, social, or cultural issues. The format is more conversational, often inviting audience debate. Example: **Rant vlogs or commentary on trending topics**.

Vlogs in Agricultural Extension: Some Examples

There have been many instances of using Vlogs by a number of individuals and agencies. Some of them are explained below.

- **YouTube Channels**: Several agricultural experts, organizations, and progressive farmers have set up YouTube channels to share farming knowledge. Examples include *Krishi Jagran* and *The Indian Farmer*, where vloggers share innovative agricultural practices, crop management techniques, and interviews with successful farmers.
- **Social Media Vlogs**: Platforms like Instagram and Facebook are also popular for short agricultural vlogs. These platforms allow users to share quick tips, tutorials, and updates through short video clips.
- **Farmers' Own Vlogs**: Increasingly, farmers themselves are becoming content creators, sharing their day-to-day farming activities, challenges, and solutions in their local context.

Challenges of Using Vlogs in E-Extension: Although Vlogs have proved to be quite successful and effective in communicating the messages to the targeted clients, the also encounter various constraints/ challenges as described below.

- **Digital Divide**: Not all farmers, especially those in remote areas, have access to high-speed internet or smartphones. This limits the reach of vlogs in certain regions.
- **Content Quality**: The quality of information in vlogs needs to be credible and well-researched. There's a risk of misinformation if the vlog creators are not adequately trained or if the content is not vetted.
- **Technological Literacy**: Some farmers may lack the technical skills to access or navigate video-sharing platforms, necessitating additional training and support.

PROCESS OF CREATING A VLOG

Creating a vlog involves several steps, from planning and recording to editing and publishing. Below is the typical process:

(i) Planning and Idea Generation

- **Choose a Niche/Topic**: Select the topic or theme you want to vlog about. This can range from personal experiences (lifestyle, travel) to educational content (tutorials, reviews, how-tos).
- **Target Audience**: Identify your audience and think about what kind of content they will find engaging and useful.
- **Create a Script or Outline**: Although vlogs are more conversational, it's helpful to write an outline or script to keep the flow organized and ensure you cover all necessary points. For unscripted vlogs (like daily diaries), you can still list key talking points to avoid losing focus.

(ii) Recording the Vlog

- **Equipment**: Use a camera, smartphone, or webcam to record your vlog. Good quality visuals and clear audio are essential. Consider lighting, background, and positioning.

- **On-Camera Presence**: Be confident and natural in front of the camera. Maintain eye contact, and ensure your voice is clear and engaging.
- **Environment**: Choose a quiet, well-lit place to record your video. Avoid background noise and cluttered visuals that might distract viewers.

(iii) Editing the Vlog

- **Editing Software**: Use video editing software like Adobe Premiere Pro, Final Cut Pro, or iMovie to cut unwanted footage, add transitions, music, text overlays, or special effects.
- **Structure**: Edit the video to maintain a logical flow, trimming unnecessary parts and ensuring a smooth storyline. Add opening/closing credits, captions, and any necessary call-to-action (CTA).
- **Engagement**: Consider adding subtitles or captions for accessibility. Use background music and sound effects to make the content more engaging.

(iv) Uploading and Publishing

- **Platform Selection**: Choose the right platform for your vlog (e.g., YouTube, Instagram, Facebook). Create an account or use your existing account.
- **SEO Optimization**: To make your vlog more discoverable, optimize it for search engines by adding a descriptive title, relevant tags, and a detailed description. Use appropriate keywords related to your topic.
- **Thumbnail Design**: Create an eye-catching thumbnail for your vlog, as it is one of the first things viewers will see.

(v) Promoting the Vlog

- **Social Media**: Share the vlog across different social media platforms to increase visibility.
- **Collaborations**: Engage with other vloggers or influencers in your niche to cross-promote content.
- **Engage with Viewers**: Reply to comments, questions, and suggestions from viewers to build a loyal audience.

(vi) Analyzing Performance

- **Analytics**: Most platforms, like YouTube, offer analytics that provide insights into video views, watch time, audience demographics, and engagement rates. Use these metrics to improve future vlogs.
- **Feedback**: Consider viewer comments and feedback to enhance your content and align better with audience preferences.

Best Practices for Creating Effective Agricultural Vlogs: Some of the best practices which Vloggers follow are as follows:

- **Keep Content Simple and Focused**: Avoid using complex jargon. Vlogs should provide clear, step-by-step instructions for practical farming techniques.
- **Engage Viewers with Interactive Content**: Encourage viewers to ask questions in the comments section and respond to them in follow-up videos.
- **Use Local Language and Examples**: Using local dialects and examples from the region can increase the effectiveness of the vlog.
- **Consistency in Posting**: Regular updates keep viewers engaged and help build a community of followers who rely on the channel for agricultural knowledge.

Future of Vlogs in E-Extension

Vlogs are transforming the agricultural extension landscape by making knowledge more accessible, engaging, and interactive. As technology evolves, there will be further integration of advanced tools such as **virtual reality (VR)** and **augmented reality (AR)** in vlogging, creating even more immersive learning experiences for farmers. Partnerships between governments, agricultural universities, and rural development organizations can further promote the use of vlogs for agricultural extension purposes.

Specific Examples of Agricultural Vlogs from India: A number of Vloggers are there who keep producing the specialized content for different types of clients. Some of them are elaborated below.

1. Krishi Jagran

- **Platform**: YouTube
- **Description**: Krishi Jagran is a popular YouTube channel and digital platform that provides farmers with a variety of agricultural updates, market news, and technology-driven farming techniques. The channel frequently shares vlogs on farming practices, government schemes,

and new advancements in agriculture, making it a comprehensive source of agricultural knowledge.
   - **Topics Covered**: Crop management, organic farming, agritech innovations, livestock care, weather updates, and government schemes.
   - **Link**: Krishi Jagran on YouTube
2. **The Indian Farmer**
   - **Platform**: YouTube
   - **Description**: This YouTube channel, run by a progressive farmer, shares insights on practical farming techniques, smart farming methods, and new technologies. The vlogger presents information in an engaging manner, often providing on-field demonstrations, making it easy for other farmers to learn from and implement these methods.
   - **Topics Covered**: Drip irrigation, organic fertilizers, polyhouse farming, pest management, and innovative technologies.
   - **Link**: The Indian Farmer on YouTube
3. **Farmers' Academy**
   - **Platform**: YouTube
   - **Description**: This is an educational vlog designed specifically for farmers, offering training on sustainable and profitable farming techniques. The vlogs focus on low-cost agricultural solutions, organic farming, and eco-friendly pest control methods.
   - **Topics Covered**: Vermicomposting, natural pesticides, dairy farming, and organic vegetable cultivation.
   - **Link**: Farmers' Academy on YouTube
4. **Modern Farming Techniques**
   - **Platform**: YouTube
   - **Description**: This channel focuses on providing information about modern and mechanized farming techniques suitable for Indian conditions. The vlogs are often field-based and show real-time applications of various farming machines and equipment, which help farmers adopt new technology.
   - **Topics Covered**: Use of machinery in agriculture, soil health management, precision farming, and advanced irrigation systems.
   - **Link**: Modern Farming Techniques on YouTube
5. **Smart Farmer India**
   - **Platform**: YouTube
   - **Description**: Smart Farmer India offers agricultural vlogs that focus on smart farming practices using modern technology. The vlogs provide information on precision farming, IoT in agriculture, and how small farmers can adopt affordable tech solutions.
   - **Topics Covered**: IoT in agriculture, greenhouse farming, sensor-based irrigation, and agribusiness strategies.
   - **Link**: Smart Farmer India on YouTube
6. **Innovative Farmer**
   - **Platform**: YouTube
   - **Description**: This vlog focuses on innovative agricultural techniques that have been tested and proven by farmers across India. It showcases on-the-ground solutions for crop diversification, integrated farming systems, and natural resource management.
   - **Topics Covered**: Agroforestry, crop rotation, aquaponics, integrated farming, and climate-resilient practices.
   - **Link**: Innovative Farmer on YouTube
7. **Nashik Farmer**
   - **Platform**: YouTube
   - **Description**: Run by a farmer from Nashik, Maharashtra, this channel documents the daily life of a farmer, including crop planning, pest control methods, and insights into growing specific crops such as grapes and pomegranates. The channel often shares real-time challenges and solutions, making it relatable for other farmers.
   - **Topics Covered**: Grapes and pomegranate cultivation, irrigation techniques, pesticide management, and crop disease management.
   - **Link**: Nashik Farmer on YouTube

These examples demonstrate how Indian farmers and agricultural experts are increasingly using vlogs to share their knowledge and experiences, helping other farmers improve their agricultural practices through a modern, accessible medium.

Further, some specific examples of agricultural **vlogs from Uttar Pradesh (U.P.) and Uttarakhand**:

1. **Kisan of Uttarakhand**
   - **Platform:** YouTube
   - **Location:** Uttarakhand
   - **Description:** This channel provides insights into farming practices suitable for the hilly terrain of Uttarakhand. It focuses on organic farming, horticulture, and traditional agricultural techniques. The vlogger shares practical tips and solutions specific to the challenges faced by farmers in Uttarakhand, including soil erosion and water management.
   - **Topics Covered:** Organic farming, terrace farming, water conservation techniques, and high-altitude crops such as apples and medicinal plants.
   - **Link:** Kisan of Uttarakhand on YouTube

2. **Kheti Kisani (Farming)- Uttar Pradesh**
   - **Platform**: YouTube
   - **Location**: Uttar Pradesh
   - **Description**: This YouTube channel, run by a farmer from Uttar Pradesh, focuses on farming techniques that can be applied to the plains and riverbank areas. The channel offers guidance on crop diversification, mechanized farming, and the use of fertilizers and pesticides. The vlogs also cover local government schemes that support farmers in Uttar Pradesh.
   - **Topics Covered**: Wheat and sugarcane farming, government agricultural schemes, soil testing, and mechanized sowing.
   - **Link**: Kheti Kisani on YouTube

3. **Uttarakhand Krishi**
   - **Platform**: YouTube
   - **Location**: Uttarakhand
   - **Description**: Focused on promoting sustainable farming methods in Uttarakhand, this channel emphasizes eco-friendly agricultural practices and agroforestry. It also provides information about local markets, the cultivation of medicinal plants, and organic crop production, tailored to the state's hilly and forested areas.
   - **Topics Covered**: Agroforestry, organic vegetable cultivation, medicinal plant farming, and sustainable farming techniques.
   - **Link**: Uttarakhand Krishi on YouTube

4. **UP Kisan**
   - **Platform**: YouTube
   - **Location**: Uttar Pradesh
   - **Description**: This vlog, run by farmers in Uttar Pradesh, covers traditional and modern farming practices that are relevant to the local climate and soil conditions. The channel offers valuable information on the best practices for growing staple crops like rice, wheat, and pulses, while also introducing mechanization and technology that are beneficial to local farmers.
   - **Topics Covered**: Rice and wheat cultivation, pest control, government subsidies, and farm mechanization.
   - **Link**: UP Kisan on YouTube

5. **Uttarakhand Farmer's Life**
   - **Platform**: YouTube
   - **Location**: Uttarakhand
   - **Description**: This vlog focuses on the everyday life of a farmer in Uttarakhand, documenting seasonal farming activities, weather challenges, and innovative techniques. The vlogger provides insights into fruit cultivation, organic manure preparation, and rainwater harvesting, which are essential for sustainable farming in hilly areas.
   - **Topics Covered**: Apple and peach farming, organic manure, rainwater harvesting, and crop rotation in hill farming.
   - **Link**: Uttarakhand Farmer's Life on YouTube

These vlogs provide region-specific agricultural advice and insights, making them valuable resources for farmers in U.P. and Uttarakhand. They cover various crops, techniques, and local challenges, helping farmers in these states improve productivity and sustainability.

Related Research on Vlogs as a New Wave of e-Extension

Several studies have explored the use of vlogs and digital platforms for agricultural extension:

i. **Shirsath *et al.* (2017)**: This study highlighted the potential of digital platforms, including YouTube and other social media channels, for disseminating agricultural information. Vlogs were found to be highly effective in communicating practices like soil testing, pest control, and organic farming.

ii. **Gupta & Verma (2020)**: This research focused on the effectiveness of vlogging in **farmer-to-farmer extension**. It found that videos created by successful farmers garnered higher trust and engagement, leading to better adoption of agricultural practices by viewers.

iii. **Das *et al.* (2022)**: This study evaluated the use of vlogs in rural agricultural education and noted that video-based content significantly improved **knowledge retention** and **practical application** of agricultural techniques among smallholder farmers in India.

iv. **Chatterjee & Kar (2021)**: They studied the role of social media and vlogs in the **adoption of precision farming techniques**. They found that visual content and video tutorials helped simplify complex technologies, making them more understandable and accessible to farmers, especially those with lower literacy levels.

These research studies emphasize that vlogs not only extend the reach of traditional agricultural extension services but also improve engagement, enhance learning, and promote knowledge sharing in a visual and interactive manner

Researchable Issues on Vlogs in Agricultural Extension

While there is a growing body of research on the use of digital media in agricultural extension, studies specifically focusing on vlogs are still emerging. Many studies explore broader themes like video-based extension or digital agriculture. Here are some potential research questions and areas for exploration:

1. **Effectiveness of Vlogs:**
   - **Knowledge, Attitudes, and Practices (KAP):** Do vlogs effectively increase farmers' knowledge, change their attitudes, and influence their agricultural practices?
   - **Adoption of Innovations:** How can vlogs be used to promote the adoption of new agricultural technologies and practices?
2. **Reach and Accessibility:**
   - **Geographic Reach:** Can vlogs reach farmers in remote areas with limited access to traditional extension services?
   - **Language Barriers:** How can vlogs be adapted to overcome language barriers and reach diverse audiences?
3. **Engagement and Interaction:**
   - **Viewer Engagement:** What factors contribute to viewer engagement with agricultural vlogs?
   - **Community Building:** Can vlogs foster online communities among farmers and agricultural professionals?
4. **Production and Distribution:**
   - **Cost-Effectiveness:** How can vlogs be produced and distributed in a cost-effective manner, especially in resource-limited settings?
   - **Quality Standards:** What are the best practices for producing high-quality agricultural vlogs?
5. **Comparison with Traditional Extension Methods:**
   - **Effectiveness:** How do vlogs compare to traditional extension methods in terms of knowledge transfer and impact?
   - **Complementarity:** Can vlogs complement traditional extension methods to enhance their effectiveness?

Conclusion

Vlogs represent a new frontier in agricultural extension services, offering a modern, visual-based method of sharing knowledge that aligns with the needs of today's tech-savvy farmers. When utilized effectively, vlogs have the potential to empower farmers with the knowledge they need to improve their practices, increase productivity, and adapt to modern agricultural challenges.

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Writing Blogs: Skill set required

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Prologue

Most of us are used to reading research papers, popular articles, and success stories, written often in great lengths. But, you would agree with me, often we don't have time & patience to read lengthy articles. This is going to be even further harder with fast pacing of life. So what's the option? Blogs could be the answer. Let's explore the world of blog & blogging, the way I understand it.

Blogging is hard because of the grind required to stay interesting and relevant- Sufia Tippu

What's a blog?

Blog is a regularly updated website or web page, typically one run by an individual or small group, which is written in an informal or conversational style. You can find plenty of blogs online on a range of topics. The bloggers jot down their personal experiences and opinions, at times detailed information too on specific subjects like technology, leisure, travel, food, fashion, and more. Blogs are short, crisp, engaging & solution oriented.

Blog is a kind of online journal where an individual, group, or corporation presents a record of activities, thoughts, or beliefs often a bit informal way-conversational

Why to write blog?

Have you created something unique or you think you can make a difference in society or profession through your work or thoughts, which are so novel? You would like to share it with wider audiences with enhanced reach and with desired impact in shortest possible time. You would be looking for the platform to share that innovative stuff with right audiences. Also, blogging is a marketing tactic that is used to get your business more online visibility. A business blog is a marketing channel (just like social media, direct mail, email marketing, etc.) that helps support business growth. You know the audience or your customers, whom you want to share your ideas with. It's important to understand whom you're writing for and why they would be interested in? This will help tailor your content to meet their needs and preferences. You must be clear, why you're writing the blog and what you want to achieve through your blog. As Agricultural Extension professionals your audience largely would be extensionists or professionals engaged in farming sector. So, you would be interested in sharing information, which can be of interest to the stakeholders in agricultural sector.

I blog because I have something to say – Eddie Huang

Many international organizations including CGIAR institutions, UN agencies, the World Bank, non-profits and private companies are now sharing their ideas and good practices through blogs. The individuals like me too though only occasionally indulge in blogging to share my thoughts, ideas with wider audiences. I understand it well that blogging is like a business that requires effort, time, and attention. I believe writing blogs is one good way to hone my writing skills, explore new ideas and build an online presence that revolves around my passions and expertise. Through my blogs I can inspire, educate, and entertain my readers. Many professional bloggers are making money and even have made it their full-time job. I have yet to reach to that level of excellence & demand as blogger.

The first thing you learn when you're blogging is that people are one click away from leaving you. So you've got to get to the point, you can't waste people's time, you've got to give them some value for their limited attention span – Alex Tabarrok

How to write blog?

If you are getting tempted to write a blog and willing to take deep dive into the world of blogging, find first what is blogging? Blogging is the act of writing and publishing content on a blog. It involves creating posts, managing the blog's content, engaging with readers, and often promoting the blog through various channels. Writing a good blog requires effort, planning, and a strong understanding of your target

audience. Select a topic that is interesting and relevant to your target audience. Do some research and brainstorm ideas to help you come up with an engaging topic.

Source: https://www.wix.com/blog/how-to-start-a-blog

Blogging can be a highly effective tool for disseminating farming innovations due to its accessibility, wide reach, and potential for engaging various stakeholders. Here's how blogging can serve this purpose:

1. **Accessibility and Reach**: Blogging platforms are accessible to a global audience, making it easier to share new practices, technologies, and research in agricultural sector with a broader audience. This includes farmers, researchers, educators, and policymakers who can access the information anytime and anywhere.
2. **Community Engagement**: Blogs can foster a sense of community among readers, where they can share their experiences, ask questions, and discuss the applicability of certain innovations. This engagement can lead to the exchange of ideas and further refinement of practices.
3. **Education and Awareness**: Blogs can be used to educate farmers and the general public about innovative techniques, such as sustainable farming practices, new breeds, or crop or veterinary care advancements. By regularly updating the blog with new content, it can serve as an ongoing educational resource.
4. **Visual and Practical Content**: Through blogs, detailed guides, tutorials, and case studies can be shared, often accompanied by images, videos, and infographics. This visual content can make complex information more digestible and practical for farmers to implement.
5. **Searchability and Permanence**: Unlike other forms of communication, blog content remains searchable and can be archived, allowing for easy reference to past innovations or methods. This is particularly useful for building a repository of knowledge over time.
6. **Linking to Other Resources**: Blogs can link to other relevant resources, such as research papers, videos, and expert opinions, providing a comprehensive resource hub for those interested in animal husbandry innovations.

Overall, blogging not only helps in disseminating innovations but also in creating a platform for continuous learning and exchange of knowledge in the field of animal husbandry.

Look at your blog like a product or a brand. What's going to make your blog different from what's already out there? – Brian Dean

Title of the blog: An attention-grabbing headline

Remember, you are writing the blog for an audience about whom you already know about- their interests in particular. Try to capture their attention from the very beginning. So, select topics that are relevant to your audience and interesting enough to capture their attention. The title of the blog should be so compelling and appealing that it makes them to love it at first sight. Ensure that the topic is well-

covered and provides value to readers. Your title should grab the reader's attention and make them want to read more. Ensure the title accurately reflects the content of the post. Always keep in mind; a good blog post is about one topic, one story, one idea. Don't try to say so many different things in one blog post.

Blogging gives me a platform to open up my thoughts to the external world
Ashmeet Khurana

The First para: A captivating lead paragraph

You know how much first impressions matter, right? If title of your blog has compelled the readers to read, the first para should excite them further to read it till the end. If at any point, the readers feel you are not interesting enough, they may give up reading it. It's your job to hook the readers. So, start with a question, a quote, or a surprising fact to draw readers in. Also, give readers an idea of what to expect from the post. It should generate curiosity among the readers to continue reading it.

If you want readers to actually read your post, you will have to seduce them and make it worth their while- Peter Casier, "The Art of Seduction"

Interesting supporting points, this is the body of the article

Break your content into sections with clear headings to improve readability. Keep paragraphs short and concise. Use lists and bullet points to highlight key points. Use simple and clear language; write as if you're having a conversation with the reader. Ensure your post is informative and provides real value to the reader. Use examples to illustrate your points and make the content relatable. Put the most information first, use sub-headings & bullets. It's better if links are provided for further & more detailed information by citing papers, articles and other information sources. Write in a conversational tone that is easy to read and understand. Use anecdotes, examples, and humor to make your writing engaging. People have short attention spans, so keep your blog post concise and to the point. Break up long paragraphs into shorter ones and use bullet points or subheadings to make the content easier to scan. Use images, videos, and infographics to break up the text and make your blog post more visually appealing. An ideal blog should not exceed 1000 words, better if wrapped-up in 600 to 800 words. It's a matter of training, practicing, continuous engagement & experience (Box 1).

Box 1: My Blogging Journey

I published my first blog on 7 July 2013 at AESA platform. Incidentally, it was also the beginning of the Blog section at AESA i.e BLOG-1: Beyond treatment and breed improvement. In this blog, I had argued, the focus of livestock development in India should shift from breed improvement and disease management to strengthening knowledge provision to livestock keepers. Afterwards, I went on writing blogs for several platforms. In 2014, I got awarded for my blog published on the occasion of World Congress on Agro-forestry. I got a big break in 2017, when I got an invitation to attend a Social Media Bootcamp at FAO Headquarters in Rome. This was a big turning point for me, since I learnt some basic skills of blogging from Peter Casier, who happened to be Social Media Coordinator at FAO then. In a week, under his erudite guidance, I could publish 5 blogs in 5 days covering different sessions of 44th session of FAO's Committee on Food Security. I wrote about gender, livestock, organic agriculture, soils and youth issues. It has been a memorable experience for me having lasting impact that enabled me to write several blogs at various platforms later on. Yet another great moment came for me in 2017, when Global Forum on Agricultural Research and Innovation (GFAiR) invited me to share my Social Media success story. Such breaks boost the morale & confidence.

I'm still learning every time I publish a new blog! Still a long way to go to write good blogs!

I believe, what Penelope Trunk said…

"Blogging is good for your career. A well-executed blog sets you apart as an expert in your field."

Blogs on Animal husbandry Extension

While writing blogs my focus is always on the agricultural extension, particularly on the projects I am handling like Agricultural Education, Agricultural extension, youth, gender, organic farming & livestock etc. As you all know, Covid-19 was a difficult & unprecedented experience for all of us, when we were confined to four walls of our homes. I took this as an opportunity to indulge in blog writing. I wrote a number of blogs during or after the Covid. Writing on issues of contemporary interests draws

people to these blogs and appreciation I get inspires me to write even better & impactful. There can be a number of areas; you can consider writing blogs for stakeholders in livestock sector. For instance, if you are an animal health specialist, you can write on One health (Box2).

Box2: Why One Health?

You might be wondering why so much attention to one health lately! You are not the only one, many still lack a clear understanding of One health- what it is all about? One Health is an integrated approach to health that recognizes the interconnection between people, animals, plants, and their shared environment. This concept emphasizes that the health of humans, animals, and ecosystems are closely intertwined and that efforts to improve one area often positively impact the others. In today's globalized world, where humans and animals are in closer contact than ever before, understanding the interconnectedness of our health is crucial. As such, One Health is more than just a concept; it's a necessary strategy for achieving global health security.

Our health matters, equally important is animal health

Over 60% of emerging infectious diseases in humans originate from animals. These are known as Zoonotic diseases. By monitoring animal health, we can identify potential threats to humans and take preventive measures. The Covid 19 pandemic, probably explains best, why one Health since it is largely believed it originated from animal source.

The overuse of antibiotics in both humans and animals can lead to antibiotic-resistant bacteria, which can spread through the environment and affect multiple species. The One Health Approach emphasize a coordinated approach to antibiotic use that can help mitigate this global health threat. Pollution, deforestation, and climate change directly impact the health of humans and animals. For instance, the destruction of natural habitats can lead to increased human-wildlife interactions, raising the risk of disease transmission. Addressing environmental issues is, therefore, a key component of One Health.

How you can contribute to One Health?

- *Only use antibiotics when prescribed by a healthcare provider or veterinarian, and never pressure for unnecessary prescriptions.*
- *Support businesses and policies that prioritize environmental sustainability, which in turn supports the health of all living beings.*
- *Help protecting wildlife and natural habitats that reduces the risk of zoonotic disease transmission and preserves biodiversity.*
- *Be part of the Public education campaigns that can help communities understand the importance of sustainable practices, responsible pet ownership, and the impact of human activities on wildlife and the environment.*

The efforts needed

Governments, healthcare providers, veterinarians, environmentalists, and policymakers must work together to develop and enforce regulations that promote a healthier planet for all. Implementing a One Health approach involves tracking diseases across species and environments. This integrated surveillance can help detect and respond to outbreaks more effectively. By understanding and respecting the connections between human, animal, and environmental health, we can create a safer, healthier world for future generations. Let's be part of One health!

(I am not an animal health or One Health expert, just tried to make a case, you can make it a lot better, practical & effective with tips provided here, use of hyperlinks coupled with your experience).

Summing up

A good blog invariably ends up with a call for action. I believe my blog post should end with a call-to-action that encourages my readers to take a specific action. Also, after reading the blog, readers should feel like leaving a comment. Before publishing my blog post, I generally make sure to edit and proofread it for grammar and spelling errors. Often, I ask someone to read it to catch any mistakes I might have missed. I focus on producing a blog that's great for my readers. Once I have published my blog post, I promote it on social media and other platforms to increase its visibility and reach among a larger audience. Once a blog is published, I often share the link at various Social Media channels, FB, Linkedin, Tweeter including my email subscribers etc. to promote my blog. This helps my blog reaching to a broader audience. My job doesn't end here. I have to nurture the blog by responding to readers' comments to build a community. At

times, I encourage readers to comment, share, or suggest further ideas to improve my own understanding of the issues. Some bloggers even use analytics tools to track the performance of their blog posts so as to understand what works.

What you do after you create your content is what truly counts – Gary Vaynerchuk

I believe, this article and presentation made by me on this topic would help my readers particularly the participants of the training programme. I wish you would be able to create compelling, well-organized, and valuable blog posts that engage readers and keep them looking for more information.

My Tips for blogging…

- Be engaged in activities worth sharing
- Be creative, interactive & engaging to sustain interest
- Be alert & updated on topics of interest
- Have a positive outlook, suggest ways forward
- Personalize actions, use "l", We, You
- Write like you talk
- Be aware of Social Media- DOs & DON'Ts
- Always remember, EVERYONE appreciates a simple, actionable, and enjoyable post

You can master blogging, just take the first step …

Catalyzing Information Gain through Massive Open Online Courses (MOOCs)

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ABSTRACT

Massive Open Online Courses (MOOCs) have revolutionized access to information and education by providing free or low-cost courses to a global audience, catering to the needs of farmers and students alike. The current discussion deals with multifaceted aspects of MOOCs viz. the origin, pedagogical approaches, key steps in development, and impact of MOOCs on information gain and education systems. It examines the key challenges, including retention rates, quality assurance, and the digital divide, while also highlighting the potential of MOOCs to democratize education and promote lifelong learning. Through the case of 'MOOC on Pig Farming' developed by Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana, the chapter provides insights into how institutions and learners are adapting to this innovative educational model, and it discusses the future directions of MOOCs in a rapidly changing educational landscape.

Keywords: *Animal Sciences, Digital, Farmers, Information, MOOCs, Online Course*

Introduction

Extension in its conventional sense means bridging the gap between a scientist's laboratory to farmer's farm. Earlier days it was done by extension experts by visiting the farmers' field but with advent of Information and Communication Technologies (ICTs) and enhancement in digital literacy, the extension efforts have been redoubled with much more efficiency. ICT is basically an umbrella term which encompasses all the technologies meant for information dissemination. Mobile phones, information kiosks, computer systems, satellite communications, social media, mobile apps, etc. All these technologies form the unified ICT axiom. Massive Open Online Courses abbreviated as MOOCs are recent addition into the ICT pool meant for online learning. These digital learning technologies have proved their vitality, during and post-pandemic era. MOOCs are developed by abridging the functionalities of digital learning technologies and learning management systems. MOOCs have proven to be useful for both teachers and learners and are revolutionising the teaching-learning process. These courses, accessible to anyone with an internet connection, offer a flexible, affordable, and scalable approach to education. The University Grants Commission (UGC), a premier organization governing the regulatory framework has notified that universities can offer upto 40 percent of the courses through MOOCs. Even the Indian Council of Agricultural Research (ICAR) has also mandated to offer courses through MOOCs. This chapter explores the multifaceted world of MOOCs, emphasizing their origins, pedagogical approaches, impact on traditional education, economic models, role in lifelong learning, and future trends.

Origin of MOOCs

The idea of online education pre-date MOOCs, but the specific MOOC model first emerged in the late 2000s. The first online courses were started in the year 2008 by David Wiley of the Utah State University and Alex Couros of the University of Regina. The term "MOOC" was coined in 2008 by Dave Cormier of the University of Prince Edward Island and Bryan Alexander of the National Institute for Technology in Liberal Education, in response to a course offered by George Siemens and Stephen Downes at the University of Manitoba. This course, "Connectivism and Connective Knowledge", was offered to 25 tuition-paying students, with an additional 2,300 online participants from around the world who were not charged. This early MOOC embodied principles of connectivity and social learning, leveraging the power of networks to create a new educational experience.

MOOCs began to gain significant traction in 2011 with the launch of several high-profile platforms, including Coursera, edX, and Udacity. These platforms were founded by professors from prestigious universities, such as Stanford, Massachusetts, and Harvard, who aimed to make quality education accessible to a broader audience. The courses were typically free, with an option to pay for a certificate upon completion. This model allowed anyone with internet access to learn from world-renowned experts, breaking down barriers to education.

Pedagogy of MOOCs

MOOCs differ from traditional classroom-based education in several key ways. The primary mode of content delivery in MOOCs is typically through video lectures, which are often supplemented by readings, quizzes, and discussion forums. The structure of a MOOC is usually modular, allowing students to progress through the course at their own pace. This flexibility is one of the key attractions of MOOCs, as it accommodates the diverse schedules and learning paces of participants.

However, the pedagogical approach of MOOCs has been a subject of debate. Critics argue that MOOCs often lack the depth and rigor of traditional courses, as the absence of face-to-face interaction can make it difficult to engage students fully. The completion rates for MOOCs are typically low, with estimates ranging from 5% to 15%. This is often attributed to the lack of personalized feedback and the limited interaction between instructors and students.

Proponents of MOOCs, on the other hand, emphasize their potential for reaching a vast and diverse audience. MOOCs are particularly valuable for lifelong learners and those in developing countries who may not have access to quality education. The use of peer assessments and discussion forums can also foster a sense of community and collaboration, even in the absence of direct interaction with instructors. These online courses respect certain technical specifications and the follow four characteristics: they leverage web formats, are collaborative, contain evaluation modules, and are limited in time.

The experimentation of MOOCs for academic purposes is quite significant, however, there are very few examples of MOOCs catering to the Indian farming community. These courses for farmers can ascertain significant information gain along with scientific learning. The proponent can be accepted for the technology transfer and adoption.

Steps to Develop MOOCs

There are two basic steps in development of MOOCs i.e. development of content, which is generally in the form of videos and development of a learning management system, which is the web skeleton of the MOOC. The content is to be developed by the scientists however, the development of learning management system can be outsourced from a person with knowledge of developing and handling software. The following steps can be considered for development of MOOCs:

1. **Selection of topics pertaining to the subject domain**: For example, if a MOOC on pig farming is to be developed, various topics pertaining to pig housing, feeding, healthcare, management, etc. can be selected.
2. **Inviting content from the experts on selected topics:** The experts of the specific field should be identified and content is to be invited from them. The credibility of the content lies on the selection of the expert.
3. **Validating and editing the content as per the needs of the online course:** As MOOC is limited-time technology, therefore, the validation and editing of content plays a major role. The information should be to-the-point focussing on the topic under consideration.
4. **Video recording of lectures by concerned experts:** The experts can be called for recording of video lectures. There are two type of recording strategies which can be adopted i.e. either one expert fluent in language and phonetics can record all the lectures or individual experts who have contributed content can be invited for video lecture recording.
5. **Editing videos and development of MOOCs platform:** This step is the most important step in development of MOOCs. The focus of the editor should be on the things which are to be removed rather than on the things which needs to be kept. The irrelevant information should be edited. The emphasis should be laid on adding more videographic and photographic content, if MOOCs are being developed for the farmers and if MOOCs are to be developed for students, then complete coverage of content through videos, photos and text should be done. The development of MOOCs platform is basically the learning management system which is to be developed by a software developer.
6. **Uploading videos and reading resources online:** The developed videos and reading material in the form of documents should be uploaded on the developed learning management system. The learning management system is a system in which the lectures are played in a hierarchy leading to the completion of course. The videos must be scientifically aligned, for example reverting to the case of MOOC on pig farming, the videos on breeds and breeding can be provided at first followed by videos on housing, feeding, reproduction, healthcare, etc.

7. **Test run of MOOC:** To avoid any technical glitches and to check the orientation of the MOOC, it is necessary to test run the MOOC. One expert must register and watch the complete MOOC for any glitches or amendments.
8. **Advertising MOOC:** The MOOC can be advertised through various online and offline media. The weblink to access MOOCs can be communicated through major media platforms to arouse the interest of end users.
9. **Feedback:** The users can be contacted for obtaining feedback and necessary amendments can be made after the feedback. Popular social media handles can be created for wide publicity, feedback and query redressal.

There are certain plugins and trackers which needs to incorporated in the learning management system being developed for educational purposes. For example, plugins for tracking the daily progress and attendance of the users (farmers or students or any other stakeholder). Provisions needs to be made in such a way that after completion of every lecture, the farmers can post their feedback/queries to the experts and the same will be addressed through email/phone by the media handler. After the completion of MOOC, the learning outcome of the users can be tested by devising a simple quiz. The users obtaining 50 percent or more in the quiz can be declared 'Pass', which will lead them to download their e-certificate automatically. If a user fails to obtain passing scores, s/he can retake the quiz but the re-tries can be limited to few attempts after which the user shall retake the whole MOOC. The revenue generation step in the form of 'certificate fee' can be kept at this stage, wherein a payment gateway can be added for accepting payments from the users. In addition to this, users' discussion forum will make them to interact with one another and with experts. If in case the users find any difficulty in accessing the MOOCs online, they can talk to media handler or to an expert on a dedicated mobile number or through social media. MOOC method of trainings will be created in totally fool-proof manner which will be of utmost benefit for the users.

Personalization in Learning Management System

During the development of learning management system, the personalization feature needs to be added in it. Personalization allows the users to keep track of their progress along with time management for accessing the course. Personalization is basically the individual's personal profile on learning management system for which a user creates a username and password to login. Further, the data of all the registered users can be stored online in their personal profiles which can be accessed by the developers by default, thereby creating a repository of farmers' data for future use. The successful completion of quiz by obtaining pass scores at the end of the MOOC will enable farmers to download their e-certificate which can also be stored in the personal profiles. All the MOOCs undertaken by the users can be reflected in their respective personal profiles which they can access anytime. For accessing MOOCs in future, the farmers can login to their already created personal profiles.

Experiences of Guru Angad Dev Veterinary & Animal Sciences University

Although the MOOCs were initially developed for academic interests but Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana aimed at using these learning technologies for benefitting the farming community by developing livestock-based MOOCs for farmers. Till time in India, majority of the MOOCs has been developed for students or scholars for academic purposes and none, so far has been developed for the farming community in local language like Hindi, Punjabi, etc. In the year 2022, GADVASU in its new endeavour developed a MOOC on pig farming for the farming community in Hindi language which is first of its kind in India. The MOOC on Pig Farming consists of 30 lectures in toto out of which 2 lectures are introductory lectures and 28 lectures are related with the subject matter of pig farming. The lectures are arranged in set of seven lectures per week, thus making the course of four weeks. The lectures are developed in a highly interactive manner for the farmers including less of text and more of photographs and videos.

The MOOC on Pig Farming can be accessed at www.vetmoocs.in following through the following steps:

1. Search www.vetmoocs.in on web search engine and open the MOOC platform. The MOOC platform is a website on which lies the whole of MOOC on 'Pig Farming'. Before accessing the MOOC, user need to sign-up for the same.
2. On the top right corner of the website, red colored "Sign up" button is provided. Click on the Sign up button to create user profile for accessing the MOOC.
3. After clicking on the Sign up button, a Registration Form will appear on screen in which the user needs to fill his/her First Name, Last Name, Email and Password. The user must enter the already

created email which is used by him/her regularly and create a new password specifically for accessing the MOOC. This email and password will be later used for logging into the MOOC platform for accessing the MOOC.

4. Press the "Sign up" button and a code will be sent on the mail user has entered in the preceding step for verification purposes. A new screen asking the verification code will be opened. The user needs to open his/her email which he/she has entered and fill the verification code at the place provided and click on "Continue".
5. A new login page will be opened with spaces for email and password. Login using the email and password which was entered during sign-up. After entering the credentials, click on "Login".
6. After logging in, the personal profile of the user on MOOC platform will open. Scroll down and click on the icon provided for online course on pig farming.
7. A new page with details of the course will open. At this page, user needs to register for accessing the course. For registration, simply click on "*Namankit Karein*" provided as a red button. If the user wishes to pursue course later on, he/she can wishlist the same by clicking on purple button.
8. After registering for MOOC on Pig Farming, a new page will open which will have the bar for the progress made in course i.e. how much the course has been completed. To start course click on "Start lesson".
9. After clicking on "Start lesson", the video platform will appear. Click on the play button to start the video. There are two introductory videos and 28 subject matter videos. The 28 subject matter videos are divided into four weeks. Each week has seven videos which can be accessed as per choice and time of the farmers.
10. After watching the video, click on the next video to watch it. The user needs to watch all the videos completely as the watch hours are tracked in the complete course.
11. Although the MOOC on Pig Farming has been kept free of cost but if someone wants to download e-certificate, then he/she has to undertake quiz of 20 questions and mark atleast 10 correct answers. After obtaining passing marks in quiz, the user will be redirected to payment gateway, wherein he/she has to pay a sum of Rs. 500 as Certificate Fee and after payment of Certificate Fee, the certificate will be automatically downloaded.
12. At the end of every video, a button for asking the questions has been provided. If a user is having any doubt in the video, he/she can click on "Ask a new question" and drop his/her query below which will be resolved by the experts. However, the same forum can be used by the users to discuss their practices and knowledge among themselves as well.

The MOOC undertaken by the users will be reflected in their respective personal profiles which they can access anytime. For accessing MOOC or any video of MOOC in future, the users will have to login into their already created personal profile. Any changes or development regarding the MOOC will be communicated through registered email. If someone wants to change the password or forgets the password of the MOOC profile, the same can be done using the registered email. Queries or problems regarding MOOC on Pig Farming can be addressed by writing a mail to gadvasuvetmoocs@gmail.com.

After doing the piloting on MOOC on Pig Farming, Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana is developing MOOCs on goat farming, poultry farming, value addition of milk and value addition of meat.

Benefit Accrual

With the development of MOOCs, not only the doors of new learning systems get opened for the farmers but also be a milestone event in redoubling extension efforts towards better livestock production and productivity. The MOOCs can provide farmers and other interested stakeholders with easy access to quality and credible knowledge resources round the clock. Shifting trainings from classroom set up to online platforms like MOOCs can enable farmers to access the courses during their leisure time according to their own pace and time. Though MOOCs will reduce the physical contact of farmers and teachers but the inbuilt feedback mechanism and discussion forum in MOOCs will help farmers to interact with their peers or subject matter specialists. With development of MOOCs, the farmers need not to visit premises of the institutes for asking about training programmes as they can access the MOOCs anytime and as per their wish. Further, after successful completion of MOOC, the farmers will be able to download their e-certificate after taking a simple quiz.

MOOCs can aid in effective learning as the classroom lectures mostly limit the teacher to blackboard teaching but dynamicity can be assured in MOOCs by addition of content related videos,

photos and diagrams in the video lectures. Increasing dependence of farmers on mobile phones and other gadgets along with increasing levels of digital literacy will help in adoption of MOOCs at faster rates. Further, there will be no geographical limitation and unnecessary travel modalities for the farmers to be physically present at the institute for taking trainings. Contrarily, institute can reach to the farmers through digital means for equipping them with first-hand and scientific knowledge and skills through MOOCs. As MOOCs are generally free of cost for the farmers and hence, cut the expenses incurred by the farmers on trainings. The MOOCs created in local language cater the training needs of large number of farmers of the country. Moreover, MOOCs once created can be used again and again in preliminary as well as in refresher trainings. The discussion forum created in the MOOC platform enable farmers to discuss their problems, achievements and learnings with themselves and with the experts.

Impact on Higher Education

Some scholars believe MOOCs as a disruptive force that could undermine traditional universities, while others see them as a complementary tool that can enhance the educational experience. One of the most significant impacts of MOOCs has been on the accessibility of education. By offering courses online for free or at a low cost, MOOCs have made it possible for millions of people around the world to access high-quality education. This has been particularly transformative for individuals in developing countries, where access to higher education is often limited.

MOOCs have also influenced the way traditional universities approach online education. Many institutions have begun offering their own online courses, either independently or in partnership with MOOC platforms. This has led to a proliferation of blended learning models, where online and face-to-face instruction are combined. Blended learning allows universities to reach a wider audience while maintaining the benefits of in-person interaction.

The Economics of MOOCs

The economic model of MOOCs has evolved significantly since their inception. Initially, most MOOCs were offered for free, with revenue generated through optional paid certificates. However, as the popularity of MOOCs grew, so too did the demand for more sustainable revenue models. Many MOOC platforms have introduced a range of monetization strategies, including charging for graded assignments, offering premium courses, and partnering with employers to provide job placement services. Some platforms have also begun offering fully accredited online degrees in partnership with universities. These degrees are typically offered at a fraction of the cost of traditional degrees, making them an attractive option for students seeking a more affordable education.

Considering the costs incurred on development of MOOCs, these can be categorized into two categories i.e. non-recurring and recurring. The non-recurring costs consists of charges incurred on content development in the form of videos and learning management system. The recurring charges are incurred on web-domain renewal and hosting of learning management system. The returns can be realized from user fees and advertisements.

MOOCs and Lifelong Learning

One of the most significant contributions of MOOCs is their role in promoting lifelong learning. In a rapidly changing world, where technological advancements and globalization are reshaping the job market, the need for continuous education has never been greater. MOOCs provide an accessible and flexible way for individuals to acquire new skills and knowledge throughout their lives. The diversity of MOOCs available means that learners can choose from a wide range of subjects, from computer science and data analytics to humanities and social sciences. This allows individuals to pursue their interests and passions, as well as to gain skills that are directly applicable to their careers. MOOCs have also played a role in democratizing education, by making it possible for people from all walks of life to access high-quality learning resources. This has been particularly beneficial for those who may not have had the opportunity to attend traditional universities, such as working professionals, stay-at-home parents, and individuals in remote or underserved areas.

Future of MOOCs

As MOOCs continue to evolve, their impact on the educational landscape is likely to grow. Several trends are shaping the future of MOOCs, including the increasing use of artificial intelligence and data analytics to personalize learning experiences, the expansion of micro-credentials and stackable certificates, and the growing collaboration between MOOC providers and traditional universities. Artificial intelligence

(AI) has the potential to revolutionize MOOCs by providing more personalized learning experiences. AI can be used to analyze student performance data and provide tailored feedback, recommend additional resources, and even predict which students are at risk of dropping out. This could help to address some of the challenges associated with MOOCs, such as low completion rates and limited interaction between students and instructors. Micro-credentials and stackable certificates are also becoming increasingly popular in the MOOC space. These credentials allow learners to gain recognition for completing specific courses or modules, which can then be combined to earn a larger qualification, such as a degree. This approach offers greater flexibility and allows learners to build their qualifications over time, at their own pace. Finally, the growing collaboration between MOOC providers and traditional universities is likely to lead to new and innovative forms of online education. Universities are increasingly integrating MOOCs into their curricula, either as a supplement to traditional courses or as part of fully online degree programs. This has the potential to create more diverse and accessible educational pathways, and to further blur the lines between traditional and online education.

Conclusion

Massive Open Online Courses have come a long way since their inception, transforming the way we think about education and information gain. While MOOCs have faced challenges, including concerns about quality and sustainability, they have also opened up new opportunities for learners around the world. As technology continues to advance, and as the demand for lifelong learning grows, MOOCs are likely to play an increasingly important role in the global educational landscape. The impact of MOOCs extends beyond education, touching on issues of equity, access, and economic opportunity. By making high-quality education available to anyone with a mobile and an internet connection, MOOCs have the potential to democratize learning and to empower individuals to take control of their own educational journeys. As we look to the future, it is clear that MOOCs will continue to be a driving force in the ongoing transformation of extension and education.

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Social Media for Extension Services

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ABSTRACT

Agricultural and veterinary extension services are pivotal for rural development, bridging the gap between research institutions and rural populations to enhance agricultural and livestock practices. However, in countries like India, the extension workforce is inadequate, with one extension worker serving nearly 3,000 farmers and only a fraction of households receiving assistance. Information and Communication Technologies (ICTs), including social media, offer promising solutions to these challenges. With India's growing mobile and internet penetration, platforms such as Facebook, WhatsApp, YouTube, and Twitter are becoming essential tools for extension services. Social media enables real-time communication, broad information dissemination, and interactive engagement, supporting agricultural and veterinary knowledge transfer. Effective use of social media involves engagement, policy establishment, comprehensive information sharing, adaptability, content moderation, and encouraging direct interaction. Despite challenges such as limited ICT access and information overload, social media's potential to improve agricultural practices, livestock management, and rural development is substantial. By leveraging these platforms, extension services can enhance outreach, foster collaboration, and contribute to food security and sustainable development.

Keywords*: Social media, Facebook, WhatsApp, YouTube, and Twitter, livestock management*

Introduction

Agricultural and veterinary extension services are crucial to rural development, providing farmers, livestock owners, and rural communities with essential knowledge, skills, and resources to enhance their agricultural and livestock practices. These services serve as a vital link between research institutions, government agencies, and rural populations, ensuring that scientific advancements and best practices reach those who need them most. Agricultural extension focuses on improving crop production, soil management, pest control, and irrigation techniques, while veterinary extension prioritizes animal health, disease prevention, nutrition, and livestock management. Together, these services drive productivity and sustainability, improving food security and contributing to the overall well-being of rural communities. The importance of extension services lies not only in boosting agricultural and livestock productivity but also in promoting climate resilience, environmental sustainability, and social cohesion. Extension services enable rural communities to access markets, enhance public health by controlling zoonotic diseases, and equip farmers with leadership and decision-making skills. However, the reality is challenging. In India, for instance, there is only one extension worker for every 2,879 farmers (Mukherjee and Maity, 2015), and only 41% of farm households receive any assistance from government or private extension services (Bera, 2014). Similarly, veterinary institutions reach only 8% of households (NSSO, 2014). According to a survey, only 41 per cent of the farm households received any assistance from either government or private extension services, and the government extension machinery covering only 11 per cent of the households who received extension assistance (Bera, 2014). Globalization has accelerated the need for rapid agricultural transformation, yet infrastructure deficits, low productivity, and insufficient extension coverage remain significant obstacles. A major issue is the lack of qualified technical personnel, with many public extension positions unfilled, leaving existing workers overburdened and less effective (Mukherjee and Maity, 2015). Extension workers are often tasked with multiple duties beyond their primary role, diluting their focus and reducing efficiency. Despite these challenges, Information and Communication Technologies (ICTs) offer promising solutions. Though television and radio have been used for disseminating agricultural information for a long time (Purushothaman *et al.*, 2003), the recent developments in the mobile, computing and networking technologies provide new ways of technology transfer. With the rise of mobile technology, web-based services, and social media platforms, digital tools are becoming integral to extension efforts. India's surge in mobile subscriptions, internet penetration, and social media use has created new opportunities for reaching a larger and more diverse rural audience. According to the January 2017 update of ICRA Ltd. (Investment Information and Credit Rating Agency Ltd.), till 30 October 2016, there were 1078 million mobile subscribers in India, and which is growing 7.5 per cent annually (ICRA Research Services, 2017). Unique mobile user penetration in 2016-2017 has been 35 per cent, whereas the mobile's share of web traffic is 79 per cent. India's internet users grew by 40 per cent while globally the growth was of 9 per cent, making the growth 4 times higher in India (ETtech, 2016). Social media penetration is 14 per cent while growth of social media users in 2016-2017 have been

40 per cent (55 million), which is second highest in the world (We are social, 2017). Social Media Platforms like Facebook, YouTube, and Twitter have become powerful tools for information dissemination, offering new avenues to enhance the reach and impact of extension services.

Social Media

Social media are web-based tools of electronic communication that allow users to personally interact with others individually or in groups for the purposes of exchanging information, sharing thoughts and opinions, influencing and facilitating decision-making by creating, storing, retrieving and exchanging information in any form (text, pictures, video, etc.,) by anyone in the virtual world. Merriam-Webster (2015) defines social media as forms of electronic communication through which users can create online communities to share information, ideas, personal messages and other content.

Various terminologies used under social media includes:

- Platform: The specific social media website or application (e.g., Twitter, TikTok)
- User: The individual, group, or entity engaging on the platform (e.g., IVRI, CII-FACE)
- Post: The content being shared on the platform by a user, or the comments, replies, or subsequent collaborative engagement (e.g., a tweet, an Instagram story, a Facebook comment)
- Content: The actual information or media being shared in the post (e.g., text, images, GIFs)

Through social media tools extension scientists and extension agents as well as farming community can share information in multiple ways in form of texts, photos, pictures, audio, audio-visuals and web links. Social media in India has witnessed explosive growth, becoming a transformative force in the way people communicate, share information, and engage with content. The unique features of participation, openness, conversation, community, and connectedness (Mayfield, 2008) have contributed to a rich user experience across platforms. India boasts an impressive number of social media users:

- Facebook: 385.7 million users
- YouTube: 467.0 million active users
- WhatsApp: 535.8 million users, making it the most used mobile messaging app globally
- Twitter: 15.0 million active users
- LinkedIn: Over 127 million members
- Instagram: Leading with over 230 million users, India has the highest number of Instagram users globally

(Source: https://statusbrew.com/insights/social-media-statistics/)

These statistics highlight the immense potential social media holds for extension practitioners aiming to engage diverse audiences. With its continuous expansion into rural areas, social media has become a powerful tool to reach farmers, farm families, and rural youth. This broadened reach allows for higher impact in delivering agricultural knowledge, promoting best practices, and encouraging community development. Social media platforms are not just urban-centric but have become an integral part of rural life, making them invaluable for achieving widespread dissemination of information.

Various social media platforms commonly used for extension and scientific purposes.

Type of Platform	Examples
Social networking sites	Facebook
Blogs	AESA Blogs
Microblogs	Twitter, Instagram
Professional networking	ResearchGate, Academia.edu, LinkedIn
Socially integrated messaging platforms	Whatsapp, Facebook messenger
Content communities	Video (YouTube), Podcasts

The Role of Social Media in Extension Services

Social media platforms offer unprecedented opportunities for the dissemination of agricultural and veterinary information. Extension scientists and agents can share information in a variety of formats, such as text, images, audio, video, and web links, making it easier to communicate with a wide and diverse

audience. The unique features of participation, openness, conversation, community, and connectedness (Mayfield, 2008) help foster a rich and engaging user experience across platforms.

1. **Information Dissemination**: Social media platforms like Facebook, YouTube, and WhatsApp are widely used to share agricultural and veterinary knowledge. Extension practitioners use these platforms to share best practices, guidelines, and updates in real-time.
2. **Farmer Engagement and Communication**: Social media facilitates direct communication between extension workers and farmers, enabling timely advice and feedback loops. Real-time interaction is easily possible, allowing for instantaneous, cost-effective communication that transcends physical distances, fostering social capital in the form of trust, engagement, and community involvement (Newbury *et al.*, 2014; Mains *et al.*, 2013, Stanley, 2013). Social media also supports long-term engagement in extension programs, empowering farmers through networking opportunities and enabling them to form valuable social connections that contribute to their success (Neill *et al.*, 2011).
3. **Training and Education**: Social media is increasingly being used for online training programs and webinars. Platforms like YouTube and Facebook Live enable video content, podcasts, and interactive sessions that cater to various learning needs. This allows extension services to provide continuous education on critical agricultural and veterinary topics.

Principles for Effective Use of Social Media in Extension Services

1. **Engage and Involve**: The primary objective of any social media strategy should be to foster active engagement with clients and stakeholders. Successful communication hinges on creating ongoing, meaningful interactions that keep audiences involved over time.
2. **Establish Organizational Social Media Policies**: Clearly defined guidelines are essential for distinguishing between personal and professional interactions online. By implementing a social media policy, organizations can ensure that users maintain a professional image while freely exchanging information and address ethical considerations when using social platforms.
3. **Comprehensive Information Sharing**: Extension services aim to promote better livelihoods through the exchange of valuable knowledge. A social media strategy should encompass a broad spectrum of relevant information, while also catering to specific needs of the target audience to support learning and action.
4. **Adaptability**: Social media strategies must be flexible, evolving in response to changing client needs and platform dynamics. What begins on one platform, such as Facebook, may expand to include other platforms as required, adjusting content and delivery to remain effective and responsive.
5. **Moderation and Content Control**: To ensure the relevance and focus of discussions, facilitators should be designated to monitor and guide the flow of information. This gatekeeping role helps filter out irrelevant or repetitive content, ensuring that information remains useful and on-topic without stifling communication.
6. **Encourage Direct Interaction**: Social media empowers extension organizations to act as facilitators, creating a collaborative environment where stakeholders—including rural community members—can interact directly. This approach minimizes the need for centralized control and fosters peer-to-peer communication, enhancing engagement and knowledge sharing.

Social Media Platforms for Extension Services

Social media includes a variety of dynamic Internet-based and mobile communication applications that can be selected according to target audience, purpose, or personal preference. Stakeholders mostly the farmers, Extensionists, NGOs, businessmen, administrators amongst others that uses social media to get updated information. The popularity of social media platforms like Twitter, Facebook, WhatsApp etc. is constantly expanding in rural areas that improves the scope of interaction among the stakeholders. It also provides a simple and cost-effective way for opinion mining to discuss different farmers' issues regarding agricultural aspects. Let's discuss few of these social media platforms here:

Facebook

In 2015, the Global Forum for Rural Advisory Services (GFRAS) conducted a global survey to assess the use of social media in agricultural extension and Rural Advisory Services (RAS). The survey, which included 226 respondents across 60 countries, revealed that Facebook was the most popular platform among RAS actors. With over 1.87 billion monthly active users globally (We Are Social, 2017),

Facebook offers vast potential for extension professionals to reach and engage diverse audiences. Several individuals, professional networks, and extension organizations have begun leveraging Facebook as a tool to disseminate information, share best practices, and foster knowledge exchange within agricultural communities. User behavior on Facebook can be unpredictable, as people often engage only with content that resonates with their specific interests. Saravanan and Bhattacharjee (2014) noted that participation in agricultural Facebook groups is often limited. They suggested that improving user engagement requires timely responses to queries, active participation in discussions, and thoughtful comments on others' posts.

Example of facebook group:
1. Bhartiya Pashu Palan: 27K Followers
2. Department of Animal Husbandry and Dairying: 135K Followers

WhatsApp

WhatsApp has emerged as a widely popular messaging app, especially in rural areas, where its simplicity and accessibility make it an ideal tool for sharing agricultural and livestock-related information. As an internet-based messaging platform supporting text, audio, video, and document sharing, WhatsApp provides a cost-effective solution for extending advisory services and overcoming geographic barriers. The app's real-time communication capabilities allow for instant information sharing, which is critical during emergencies in agriculture and animal husbandry. WhatsApp groups enable direct communication with farmers, providing a space for extension workers to share tailored advice, respond to queries, and offer timely guidance on issues like pest outbreaks, disease control, and livestock management. Often, farmers themselves contribute to discussions, offering peer-to-peer support, which enhances community engagement and learning. By facilitating direct interaction, WhatsApp helps maintain ongoing relationships between extension workers and farming communities. Real time video chatting has also been integrated recently, making it more popular among users. Currently there are more than one billion users of the app in 180 countries. Though initially used for personal messaging, it is gaining more popularity among agricultural professionals and practitioners to share information, which is aided by the group messaging feature. There are few hundred thousand WhatsApp groups created for agricultural extension and advisory services in India. Many agricultural development departments and projects in India, have leveraged WhatsApp to establish stronger linkages with farmers, enhancing the dissemination of best practices and new technologies. WhatsApp's widespread reach and versatile functionality make it a highly effective tool in agricultural and veterinary extension, helping to create more connected and resilient farming communities across rural India. With the recent updated feature in WhatsApp an organization can also create a channel over the platform and reach unlimited number of followers.

Example of WhatsApp groups:
1. *Shetkari* Whatsapp Group
2. *Pashu Palan* Whatsapp Group

YouTube

YouTube has emerged as an invaluable platform for the dissemination of scientific and practical information on animal husbandry. Various stakeholders, including news channels, agricultural research institutes, and non-governmental organizations, have actively contributed by uploading educational videos that cover a range of topics relevant to farmers. These videos have attracted substantial viewership, reflecting their popularity and usefulness. Available in Hindi and other regional Indian languages, they cater to the diverse linguistic needs of rural communities across India. The rapid growth in viewership of these agricultural videos—experiencing increases from 228% to as high as 2308% within a single year—underscores YouTube's potential as a transformative tool in agricultural extension. The platform addresses a key gap, providing high-quality, regionally relevant agricultural content that has historically been scarce. YouTube has effectively become a dynamic space for farmers to access up-to-date knowledge on best practices, new technologies, and innovative solutions in farming. As the third most visited website globally, with over 3.25 billion videos watched every month, YouTube's reach and accessibility make it a critical platform for extension services. More than half of the views come from mobile devices, reflecting the platform's suitability for rural users, who often rely on smartphones for internet access. Extension professionals and organizations are leveraging this platform to host tutorial videos, webinars, virtual farm tours, and step-by-step guides on farming practices and animal care. The visual nature of YouTube content allows for more interactive and practical learning, helping farmers better understand and adopt new techniques.

YouTube Shorts

YouTube Shorts, the platform's short-form video feature, is an excellent tool for delivering bite-sized educational content. Designed for quick consumption, these 60-second videos are ideal for sharing succinct and focused messages about agricultural practices, animal care tips, and even quick demonstrations of techniques. With the increasing popularity of short-form content, YouTube Shorts offers an opportunity to reach younger farmers and rural youth who prefer fast, engaging content on their mobile devices. Shorts can be used for a wide array of extension services, including quick tips on pest control, seasonal reminders, or short tutorials on specific farm tasks. They also allow extension workers to maintain regular contact with farmers, delivering information in a format that is easy to digest and share.

Example of YouTube Channels:

- KVK, ICAR-IVRI Izatnagar, Bareilly: 12.9K Subscribers
- National Dairy Development Board: 109K Subscribers
- IVRI- Deemed University Educational Channel: 6.8K Subscribers

Twitter

Twitter is a microblogging platform used for real-time updates and news. The word limit for 25000 for paid users (Blue Tick Accounts) but 280 characters for unpaid accounts. This platform is used for real-time updates and news. It is one of the most popular social media platform globally with 320 million users. On a social context, it has been one of the major catalysts used for creating public opinions and for organizing people into groups. In agriculture too, it is one of the most used platform and some of the examples are as follows:

1. Department of Animal Husbandry and Dairying (twitter.com/Dept_of_AHD) and Ministry of Fisheries Animal Husbandry and Dairying (twitter.com/min_fahd): (121K & 30K Followers respectively)
2. Agriculture India (https:// twitter.com/AgriGoI) 526K Followers: This is the official twitter handle of Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers Welfare, Government of India. With all its focus on Indian agriculture and farmers' development, the twitter handle shares information related to the sector and gives opportunity to people to share their views and ideas to influence policy and development.
3. IFFCO (https://twitter.com/ IFFCO_PR) (34.7K): Indian Farmers Fertilizer Cooperative Limited (IFFCO) is one of India's largest cooperative society with an amalgamation of over 36,000 Indian cooperatives with diversified business interests. The Twitter handle is a platform for initiating dialogue and engaging with stakeholders on topics related to health, agriculture, and cohesive growth.

Instagram

Instagram, a social media platform known for its emphasis on visual content—photos, infographics, and short videos—has been rapidly gaining traction in the field of agricultural extension services especially among younger audiences who are more accustomed to visual media. The platform's ability to share compelling imagery and short-form video content makes it a powerful tool for showcasing success stories, best practices, and innovative farming techniques. By using Instagram, extension professionals can connect with farmers, agri-entrepreneurs, and the general public in a more personal and engaging way.

Some of the popular Agriculture related Instagram channels include:

- Agriculture India: 118k followers with 7427 posts.
- NDDB India: 6926 posts, 1504 posts
- Agriculture Extension in South Asia: 109 Follower 66 posts.

LinkedIn

LinkedIn has become a pivotal platform for building professional communities in the agricultural and veterinary sectors by facilitating networking, knowledge sharing, and collaboration among industry professionals. Through specialized groups and networks, individuals can connect with peers, mentors, and industry leaders to discuss trends, share job opportunities, and exchange best practices. The platform also serves as a hub for disseminating research, articles, and case studies, contributing to ongoing professional development. Niche communities focused on specific areas, such as sustainable agriculture or veterinary public health, allow for targeted discussions and advocacy. Additionally, LinkedIn enhances the visibility of these sectors, enabling professionals to raise awareness on critical issues like animal welfare, food

security, and climate change, thereby attracting talent and resources to the field. By fostering a collaborative and informed environment, LinkedIn supports the growth and advancement of the agricultural and veterinary professions.

Some LinkedIn groups include:

- International Livestock Research Institute (ILRI): 95000 Follower
- CII-FACE: 7000Followers
- Department of Animal Husbandry and Dairying: 7000 Followers

Blogs

Blogs contain detailed information on specific topics. They create and facilitate in-depth discussion on any issue through comments from the readers. With increased popularity, many blog competitions are also organized worldwide for rural youth to encourage them start a discussion about farming. Even organizations like World Bank, Food and Agriculture Organization (FAO) and International Food Policy Research Institute (IFPRI) have their own blogs not just to discuss issues but announce their new publications like policy papers, working papers, reports and so on; communicate summaries of important publications; and to increase awareness and discussion on important issues related to agriculture and rural development. Some interesting blogs that can be followed by extension professionals are:

1. aesa (Agricultural Extension in South Asia) blogs: https://www.aesanetwork.org/category/blogs/
2. Tamil Nadu Agricultural University (TNAU) Blogs: https://agritech.tnau.ac.in/blogs.html

Targeted Use of Social Media for Different Stakeholders

Stakeholder	Preferred Platforms	Rationale
Policymakers	LinkedIn, Twitter	▪ LinkedIn is a professional network where policymakers can connect with experts, access research, and participate in discussions on agricultural and veterinary policies. ▪ Twitter allows for quick dissemination of policy updates, engagement in public debates, and monitoring of trends and public opinion.
Agricultural & Veterinary Professionals	LinkedIn, YouTube, Facebook	▪ LinkedIn provides networking opportunities, access to job opportunities, and sharing of professional knowledge. ▪ YouTube is valuable for accessing in-depth tutorials, webinars, and professional development content. ▪ Facebook groups enable professionals to engage with communities, share experiences, and collaborate on projects.
Smallholder Farmers	WhatsApp, Facebook, YouTube	▪ WhatsApp offers direct, real-time communication and is highly accessible even in rural areas. ▪ Facebook allows farmers to join communities, receive updates, and share experiences with peers. ▪ YouTube provides visual, easy-to-understand content on farming techniques and animal care, which is crucial for those with limited formal education.
Agribusinesses and Cooperatives	LinkedIn, Instagram	▪ LinkedIn for networking, partnerships, and showcasing business achievements. ▪ Instagram for branding, marketing agricultural products, and engaging with consumers**.**
Academics and Researchers	LinkedIn, ResearchGate, Twitter	▪ LinkedIn and ResearchGate allow researchers to share their work, collaborate on studies, and stay updated on the latest research in agriculture and veterinary sciences. ▪ Twitter helps in disseminating research findings, participating in academic discussions, and following trends.

Social Media Metrics/Analytics

Social media analytics refers to the process of collecting, analysing, and interpreting data from social media platforms to assess performance, understand user behaviour, and inform strategic decisions.

For major social media platforms like LinkedIn, Facebook, Twitter, YouTube, and Instagram, key analytics include:

1. Engagement metrics: Engagement metrics measure the interaction between users and content, in the form of like, share and comments.
2. Reach: Reach refers to the number of unique users who have seen your content. It indicates how far the content is spreading across the platform, helping to assess the potential audience size.
3. Impressions: Impressions measure how often content is displayed, regardless of whether it was clicked or not. This metric reflects the total number of times content is viewed by users, including repeat views by the same user.
4. Follower growth: Follower growth tracks the increase or decrease in the number of people who follow or subscribe to a social media account over time. It indicates the account's popularity and ability to attract new followers.
5. Click-through rates (CTR): CTR is the percentage of users who click on a link or call-to-action within a post or advertisement, compared to the total number of users who viewed the content. It is a key indicator of content effectiveness
6. Video views: Video views measure the number of times a video has been watched. This metric helps evaluate the popularity and reach of video content.

In the context of agricultural extension services, institutions can leverage these metrics to refine content strategy, enhance user engagement, and ensure the information reaches the target audience. For instance, improving content relevance through audience segmentation, utilizing multimedia formats to increase engagement, and consistent monitoring of analytics can help institutions fine-tune their approach, ensuring that critical information is effectively communicated to farmers, policymakers, and other stakeholders.

Developing an Effective Social Media Strategy

A well-crafted social media strategy is essential for maximizing outreach and engagement, particularly for agricultural extension universities or service providers. A systematic approach to social media posting helps to garner more traction than random, unplanned posts. Although no single strategy fits all organizations, a thoughtful and customized approach is key. Here's a look at using LinkedIn as an example how to build an effective strategy that supports outreach goals, communication objectives, and audience engagement.

1. Profile Optimization

Optimizing the LinkedIn profile is crucial for enhancing visibility and attracting opportunities. For individuals, a complete and well-optimized profile increases discoverability and engagement. Start by filling out the profile fully, including a professional picture, a compelling headline, and a detailed summary highlighting the services of the organization. Incorporate relevant keywords to improve search rankings and boost the visibility amongst the relevant stakeholders. Use the Features section to showcase notable projects, articles, or endorsements that demonstrate organizations' expertise. Regular activity, such as posting articles and engaging with content, further amplifies one's presence and maintain prominance within your network. For organizational LinkedIn pages, optimization focuses on presenting a cohesive brand image and showcasing organizations' values, culture, and achievements. Ensure the page includes a clear and engaging banner image, a concise description about the organization, and regularly updated content that reflects industry expertise and news. Highlight key projects, client testimonials, and employee successes to build credibility and attract potential stakeholders. Consistent engagement through posts, updates, and interactions with followers will enhance your brand's visibility and foster a strong online presence, setting your organization apart in the professional network.

2. Content Types

The type of content shared is crucial in ensuring audience engagement. The type of content that can be posted on the social media platform includes:

- PDF Carousels: Perfect for sharing detailed information in a visually engaging way.
- Pictures: For grabbing attention quickly, especially in feeds where users scroll through rapidly.
- Infographics: For breaking down complex information into digestible, visually appealing formats.
- GIFs: Used to simplify and animate key messages in an engaging and shareable manner.
- Short Video: Powerful tools for conveying messages in an engaging and succinct manner.

- Incorporating visuals into social media posts can significantly increase engagement. Agricultural universities can u0se visuals to explain modern farming techniques, research findings, or success stories from extension projects. A diverse content mix ensures that different types of users, from policymakers to students, can engage with the information according to their preferences.

3. Target Audience

Identifying and understanding your target audience is vital. Agricultural universities should tailor content to specific audiences such as farmers, students, government agencies, and industry players. Understanding their interests and needs will help tailor messaging effectively. To generate leads and engagement on LinkedIn, start by defining your ideal client profile based on industry, job title, company size, and location. Research competitors to gain insights into potential clients and their interests. Utilize LinkedIn's advanced search feature to narrow down prospects and participate in relevant groups to connect with and understand your audience better. Analyzing LinkedIn analytics will help you assess how well your content resonates with your audience and adjust your strategy accordingly.

4. Timing and Frequency of Posts

The timing of your posts can significantly impact their success. Analyzing data to identify when your audience is most active helps ensure maximum reach and impact. Finding the optimal posting times on LinkedIn can be challenging due to its global user base and varied activity patterns. Generally, weekdays, especially Tuesdays, Wednesdays, and Thursdays, are considered prime times for engagement. HubSpot recommends posting between 9-12 am, 12-3 pm, or 3-6 pm, while Sprinklr highlights mid-morning and lunchtime hours. Buffer points to specific times like Monday at 4 pm and Tuesday at 4 pm as particularly engaging. Given the evolving nature of work schedules and the rise of remote work, traditional 9-to-5 posting times may not always be ideal. Experimenting with different times and analyzing LinkedIn analytics will help you uncover patterns specific to your audience, allowing you to optimize your posting strategy. The frequency of posts should be consistent but not overwhelming. Regularity helps keep your audience engaged, but it's important to balance volume with value.

5. Understanding the Algorithm

Understanding the algorithm of a social media platform is crucial for optimizing your content strategy and maximizing visibility. Social media algorithms determine how content is ranked and displayed based on factors such as engagement, relevance, and user behavior. By grasping how these algorithms work, you can tailor your posts to align with their preferences, increasing the likelihood that your content will reach a broader audience. The LinkedIn algorithm, for instance, categorizes posts into clear, low-quality, and spam categories, then evaluates them based on engagement, recency, and composition signals. Engagement signals include likes, comments, and shares, recency signals prioritize fresh content and regular updates, and composition signals assess the post's length, multimedia inclusion, and author connections. To maximize visibility, focus on creating engaging, timely content, using relevant keywords and hashtags, posting consistently, and actively participating in the LinkedIn community.

6. Defining Communication Objectives

Clear communication goals are necessary to ensure that content is aligned with broader objectives. These objectives guide content creation and posting schedules, ensuring that posts are aligned with institutional priorities. Agricultural universities might have different goals, such as increasing farmer engagement with sustainable practices or encouraging students to explore research opportunities. Defining these goals helps shape content, messaging, and audience engagement.

7. Communication Plan

A well-thought-out communication plan outlines the platforms and formats used. Agricultural institutions may choose platforms where their target audience is most active. Regular interaction, clear call-to-actions, and user-friendly interfaces enhance the effectiveness of the communication plan.

8. Localization and Language

Local languages are key to effective outreach. Agricultural institutions should create content in regional languages to reach farmers and stakeholders who may not be comfortable with English.

9. Encourage Two-Way Communication

Always include a clear call to action, such as "Share your thoughts" or "Join the conversation," at the end of posts. Social media strategy should focus on fostering engagement by inviting users to participate in discussions and share feedback. Remember, effective two-way communication is about

asking for input, not just delivering information. Actively encourage users to comment and engage in dialogue to create a more interactive and community-driven environment.

Capacities Required

Effective social media communication for agricultural extension services requires both technical and organizational capacities. This includes equipping extension workers with the knowledge and skills to use social media tools, create engaging content, and analyze metrics. It also requires strong institutional commitment, as social media engagement is not a one-time effort but an ongoing process. Organizations must ensure that farmers, extension personnel, and other rural stakeholders are familiar with social media platforms. Providing basic technical support, particularly on how to use social media on internet-enabled devices, is essential. Training should be tailored to the specific needs of different target groups – extension workers, researchers, and academics will require different training compared to farmers or grassroots stakeholders. It's also crucial to have a deep understanding of the rural community's needs, agricultural practices, and information-sharing habits. To maintain engagement, regular interaction is necessary. This can be achieved through direct messaging, responding to comments, and showing support by liking or sharing posts from farmers and other stakeholders.

SWOT (Strength Weakness Opportunities and Threat) Analysis

Despite many advantages, the use of social media is still lacking in Agriculture Extension Service Delivery in India. Let's understand the present scenario of social media usage in India with a SWOT analysis.

Strengths, weaknesses, opportunities, and challenges

Strengths	**Weaknesses**
▪ Highly cost effective ▪ Simultaneously reaches large numbers of people ▪ Location and client specific, problem-oriented ▪ User-generated content and discussion among the community of members ▪ Easily accessed from mobile phones ▪ Increases internet presence of extension organisations and their client reach ▪ Democratisation of information ▪ Brings all stakeholders onto a single platform ▪ Can measure impact and success by tracking number of visitors, friends, followers, mentions, Facebook 'likes', conversation index, and number of shares	▪ Limited ICT and online facilities in rural areas ▪ Only suitable for educated and online clientele ▪ Lack of awareness and readiness to accept social media by some farmers and extension professionals ▪ Internet privacy issues ▪ Relevancy of information ▪ Success of social media depends on commitment level of community of members ▪ Misinformation and Information overload
Opportunities	**Challenges**
▪ Few social media apps are available without internet ▪ Forming local/regional interest groups is possible ▪ Reaching one to many ▪ Greater engagement and dialogue ▪ Allows for integration of a wide range of stakeholders ▪ Can act as catalyst for resource mobilisation (technological, organisational, and financial)	▪ Quality control and monitoring of posts ▪ Ensuring participation ▪ Internet and IT infrastructure issues ▪ Satisfying heterogeneous users ▪ Institutionalising social media ▪ Continuous engagement ▪ Skilled human resource to maintain social media ▪ Measuring the impact – lack of capacity for tools and analytics that help monitoring and assessing the value of information ▪ Creating awareness about social media's potential at the organisational level ▪ Allocating time to update content ▪ Encouraging stakeholders to access resources through social media links

Source: Saravanan *et al*; 2015

Conclusion

Social media platforms have revolutionized agricultural extension services by enabling real-time communication, knowledge dissemination, and engagement on a scale that was previously unimaginable. Platforms like Facebook, WhatsApp, YouTube, and Twitter offer extension agents the ability to reach large

and diverse rural audiences, sharing information in various formats such as text, images, videos, and web links. With the rapid growth of internet penetration and mobile connectivity in rural India, social media has become an invaluable tool for improving agricultural practices, enhancing livestock management, and fostering sustainable rural development. The unique features of social media such as participation, openness, conversation, and community creation, presents opportunities for farmers and extension workers to engage in meaningful dialogue, receive timely advice, and collaborate on solutions to common challenges. LinkedIn and Twitter, for example, allow for professional networking and the sharing of industry insights, while platforms like Facebook and YouTube support community building and practical, visually rich training content. Despite challenges such as limited ICT access in rural areas, information overload, and the need for skilled human resources, the potential of social media in agricultural extension services is immense. By integrating these platforms effectively, extension services can disseminate information, foster collaboration, and contribute to greater food security, economic empowerment, and climate resilience. As social media continues to evolve, its role in agricultural and veterinary extension will only expand, making it an essential component of rural transformation and sustainable development.

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Use of AI, ML, IoT & other advanced tools for supporting farmers

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ABSTRACT

This chapter introduces advanced precision farming tools include artificial intelligence, machine learning, Internet of Things, blockchain, AR/VR and haptics, all of which have enormous promise for a wide range of farming applications specially, in animal science. While every effort has been made to provide all relevant information on the tools and procedures in this chapter, there may be certain restrictions for which readers are referred to recently published literatures. The chapter delves into the overview of each technology followed by its applications in data recording, animal identification, disease prediction, feeding and breeding management, environment enrichment among various other important applications. It should be noted that although a lot of discussion is on animal science aspect, the chapter's goal is to give readers a general understanding of these instruments and methods so they may plan and carry out research projects in their respective fields utilizing these techniques.

Keywords*: precision farming, livestock, automation, blockchain, smart systems and digitalization*

Introduction

The intersection of agriculture and technology has ushered in a new era of farming, characterized by precision, efficiency, and sustainability. Advanced tools such as artificial intelligence (AI), machine learning (ML), the Internet of Things (IoT), blockchain, among others are now being increasingly used in the farming sector and is revolutionizing the way farmers manage their operations, from crop monitoring, livestock farming, product yield prediction to resource optimization. AI, a broad field of computer science that aims to create intelligent agents, has found numerous applications in agriculture. AI-powered systems can analyze vast amounts of data, including satellite imagery, weather patterns, and soil conditions, to provide farmers with valuable insights. For instance, AI algorithms can accurately predict milk yield, enabling farmers to make informed decisions about feeding, health and udder management. Additionally, AI-driven robots and drones can automate several routine tasks reducing labour costs and increasing efficiency. To develop such precision systems, Machine learning, a subset of AI, is often used which involves the training of algorithms on large datasets collected from the farm over time. These data sets are used to recognize patterns and make predictions, for timely farm maintenance activities. ML models can be used to identify diseases, predict body weight, analyze animal sound signals, calculating breeding time, managing herd, and monitoring health. By leveraging ML, farmers can improve animal health and reduce the chances of mortality, thereby increasing their revenue. Another important class of ICT tools that has come up in a big way is the Internet of Things. IoT consist of a network of interconnected devices that collect and exchange data, and has played a crucial role in modern agriculture. IoT sensors can be deployed throughout farms to monitor various parameters, such as temperature, humidity, soil moisture, and light levels. IoT-enabled devices can also be used to track livestock, farm record maintenance, monitor their health, and improve feed management.

In addition to AI, ML, and IoT, other advanced technologies are also being used to support farmers. For example, blockchain technology can be used to track the provenance of livestock food products, ensuring transparency and traceability throughout the supply chain. Virtual reality (VR) and augmented reality (AR) can be used to provide farmers and even academicians with immersive training experiences and enhance their understanding of agricultural practices. As these technologies continue to evolve, it is essential for farmers, researchers, and policymakers to collaborate and explore new opportunities to harness their full potential. Therefore, the purpose of this chapter is to provide an overview of the aforementioned technologies along with their applications in the farming sector with special emphasis on livestock farming while exploring their potential to enhance productivity, reduce environmental impact, and ensure food security.

Overview and applications of AI

AI intends to provide computers, software and machines with the ability to do operate and perform activities while functioning similar to that of a human brain. AI technology learns and improves from

patterns and features in data through iterative processing and algorithmic training, much like humans. AI systems are made to behave and think as humans do. They are intended to learn and solve problems in a manner that is similar to how the human mind functions. While the reasoning domain is concerned with choosing the optimal method to accomplish a certain goal, the learning portion is on acquiring data and creating rules or algorithms for converting ambiguous input into valuable knowledge. While AI's self-correction feature works to continually improve algorithms and ensure that they provide the most exact results, the creative domain uses neural networks, rules-based systems, computational approaches, and other AI techniques to generate new texts, pictures, and ideas. As a result, it permits human-like interactions with software and offers direction for specific task selections.

AI systems generally take in a large amount of labelled training data, look for patterns and trends in the data, and use these patterns to predict future states. An image recognition program learns to identify and describe items in photos by analysing millions of examples, much way a chatbot trained on text situations would learn to have realistic conversations with humans. Text, images, audio, and other media may be produced with realism using generative AI techniques. The main subfields and technologies that enable and support artificial intelligence (AI) systems are machine learning (ML), neural networks, deep learning (DL), computer vision, natural language processing (NLP), graphical processing units, internet of things (IoT), advanced algorithms, and application programming interfaces (APIs). Python, R, Java, C++, and Julia all offer characteristics that are favoured by AI professionals, yet no one programming language is exclusively associated with AI. The application of AI to livestock farming is a subject of study that spans many disciplines including IT experts, agricultural engineers, animal and environment science researchers and statisticians. AI based experiments in sensors, data transmission and interpretation, artificial neural networks (ANN), ML, DL, and other fields have been conducted in recent years in an effort to address issues with animal identification, behaviour detection, disease monitoring, environment control, and several other producers' demands. AI as a platform has tremendous capability to handle the control of infections, behaviour, and the environment as well as address the needs of sustainable production. Modern day world is experiencing an exponential growth along with rapid increase in amount of data across the globe. Even a tiny piece of information is becoming quite relevant and contextual in daily life, setting new grounds for the applications of AI from computer science research labs to real-world problems (Jordan & Mitchell, 2015). In contemporary times, AI has transformed key disciplines of our societies, such as industrial works, energy, healthcare, agriculture and livestock sector causing a tremendous non-linear change at an unprecedented rate.

1. AI-based systems for monitoring animal behaviour and health

The health of animals and the financial success of livestock operations could benefit from the implementation of a number of different ICT interventions that would make it possible to monitor animal health indicators and so detect, prevent, or better cure diseases and accidents. Drones, cameras, and other intelligent monitoring systems powered by artificial intelligence can help producers keep track on the well-being of their livestock. The early identification of diseases and injuries in farm animals through data analysis using AI-powered imagery can have a significant impact on the farm productivity. By minimising the need for costly diagnostic tests and treatments, IoT in animal husbandry can also assist to bring down the overall cost of animal healthcare. Improved animal health and lessened reliance on antibiotics are two ways in which the Internet of Things (IoT) in animal husbandry is predicted to cut down on the price of food production. The constant observation of animal behaviours using a camer, microphone, and accelerometer is done to examine the health and wellbeing of the animals. The camera-based system is often positioned on top of the animal activity zone. The visual or audio data from the captured pictures is translated or classified into specific behaviours using software (e.g., Python, Matlab, Tensorflow, etc.) and algorithms (e.g., CNN, ML, DL, etc.). The majority of an animal's behaviours, including eating, serve as crucial health status indicators. Water metres offer precise information about how much water is consumed and are regarded as a quick and easy way to keep track of animal health. Video surveillance or video recorders are employed to automatically monitor the individual eating and drinking behaviours of the group-housed pigs and ruminants (Yang *et al.*, 2017).

For the automated assessment of ruminant feeding behaviour, including eating, chewing, swallowing, and ruminating, sensor-based devices of nasal band pressure, accelerators, HOBO logger, and microphones are employed. To accurately create mathematical models (e.g., CNN, LSTM) and identify individual eating or drinking behaviour from video sequences, feature extraction (e.g., colour moments feature, geometric features) is a crucial step. Although it is possible to attain above 90% at the experimental level, the accuracy rates of feeding behaviour identification still need to be increased in order

to enable important feeding choices on farms. Aggressive behaviour is another crucial animal management aspect that can be monitored using AI-based systems. Abnormal aggressiveness in pigs kept in groups is the worst welfare issue since it can lead to skin injuries, illness, and even death, which increases the possibility of reducing productivity. However, there are studies on the automatic identification of hostile behaviour. Few machine vision-based research on aggressive interactions, aggressive behaviours, and motion aspects have been done recently. Further, from the data of sounds collected at farms, meaningful information extraction (i.e., audio feature extraction), and sound data categorization can be done for detection of coughing. Mel Frequency Cepstrum Coefficients (MFCC) is an approach that has been reported as an efficient auditory feature extraction tool. Comparatively, a number of deep learning and machine learning techniques have been used to incorporate contemporary developments on animal coughing detection. It might be utilised as an automatic detection indication for animal welfare and health issues to give a useful reference for vets or farmers, but only if the capability of detecting and locating on cough noises is enhanced.

2. AI in prediction of livestock weight

Bodyweight (BW) of an animal is important to monitor growth, nutritional status and health performances of livestock in a farm (Menesatti *et al.*, 2014). There are two main methods to measure the BW in livestock: (i) direct approach with weighing balance, and (ii) indirect approach with morphometric measurements and BW. Direct method of BW measurement on a weighing scale is the most commonly adapted system in most of the farms. It can be a strenuous exercise for both the animal and the stockman which may lead to unnecessary stress. The advent of image processing methods combined with CV and AI has given a reliable non-contact method to predict BW of animals using body dimensions as inputs. Major morphometric parameters taken into account are body length, paunch girth, heart girth, body length and flank measurements etc. (Banik *et al.*, 2012).

CV systems use 2D or 3D images for manual or automatic pre-processing of images and manual selection of body measurements to be used as variables in BW prediction. For automated selection of features, CV and ML combined approach is applied. However, for full automation of procedures (such as image and feature selection, image segmentation, and feature extractions etc. represented in Fig.4), CV and DL approach is implemented with CNN (Fukushima, 1980), RCNN (Spoerer *et al.*, 2017), recurrent attention model- RAM (Mnih *et al.*, 2014), and RAM with CNN (Ba *et al.*, 2014). Pezzuolo *et al.*, (2018) analysed the depth images of pig with the SPIP™, Image Metrology Inc. software to extract body length, front height, back height and HG like body parameters and predicted accurate LW with $R^2 = 0.954$. A recent investigation is also being undertaken by ICAR-IVRI for the development of a mobile application for determination of pig liveweight. The application is based on convolutional neural networks wherein a large database of pig backview images were taken for training of the algorithm. The algorithm then detects the morphology of the pigs using which the weight is predicted. The accuracy is this system is claimed to be >80% for Landrance and Landlly breeds of pigs.

Overview and applications of machine learning

ML is a subset of AI that focuses on creating models and algorithms that can automatically learn and make predictions or judgements without being explicitly programmed. Due to its capacity to analyse big datasets and draw out valuable patterns and insights, machine learning has recently attracted a great deal of interest and appeal. In this chapter, we give a general overview of the core machine learning methods that many contemporary applications rely on. Broadly speaking, there are five categories of machine learning techniques, namely, supervised learning, unsupervised learning, reinforcement learning, semi-supervised learning and transfer learning.

(i) Supervised learning: In supervised learning, each input instance is linked to a matching goal value or class label, allowing the system to learn from labelled data. The objective is to discover a mapping function that can correctly forecast the result for hypothetical scenarios. The following are typical supervised learning methods:
   (a) *Linear Regression*: The relationship between a dependent variable and one or more independent variables may be modelled statistically using linear regression. In order to minimise the sum of squared discrepancies between the anticipated and actual values, the best-fitting linear equation must be found.
   (b) *Logistic Regression:* A binary classification approach called logistic regression is used to estimate the likelihood that a specific event will occur. The link between the input factors and the binary output is modelled using a logistic function.

(c) *Decision Trees:* To generate predictions or categorise instances, decision trees are hierarchical structures that recursively segment the data depending on feature values. The leaf nodes carry the projected class or value, whereas each interior node represents a test on a characteristic.
(d) *Support Vector Machines*: SVM is a powerful algorithm for both classification and regression tasks. It finds an optimal hyperplane that separates the data points belonging to different classes with the maximum margin.
(e) *Naïve Bayes*: Based on Bayes' theorem, Naive Bayes is a probabilistic classifier. Given the class label, it makes the assumption that the characteristics are conditionally independent, which makes it computationally effective and ideal for large-scale applications.
(f) *Neural Networks:* A diverse group of models called neural networks are modelled after the structure and operation of the human brain. They are made up of linked neurons arranged into layers. Advancements in many different fields have been made possible by deep neural networks with many hidden layers. A popular class of deep learning models for image and video identification applications are convolutional neural networks (CNNs). They include several layers, including convolutional layers that take the local characteristics from the input data and extract them. CNNs have had amazing success with pattern recognition, which has allowed for the development of applications like object identification, facial recognition, and autonomous driving.
(g) *Random Forest*: An ensemble (combining multiple models) learning system called Random Forest mixes many decision trees to provide predictions. The final forecast is made by taking the majority vote or averaging among a forest of decision trees.

(ii) *Unsupervised learning*: Unsupervised learning entails discovering patterns and structures from data that has not been labelled with specific goal values. Finding hidden patterns, clusters, or correlations in the data is the main objective. Unsupervised learning methods that are often used include:
(a) *Clustering*: Clustering methods combine related instances depending on how similar their features are. Several applications employ the well-liked clustering techniques K-means, hierarchical clustering, and DBSCAN.
(b) *Dimensionality reduction*: Approaches for reducing the number of features while maintaining as much pertinent data as feasible are known as dimensionality reduction approaches. Common techniques for this include t-SNE (t-Distributed Stochastic Neighbour Embedding) and principal component analysis (PCA).
(c) *Association rule mining*: In huge datasets, association rule mining identifies intriguing links or patterns. For extracting frequent item sets and association rules, the FP-growth algorithm and the Apriori algorithm are frequently employed.

(iii) Reinforcement learning: In order to maximise a cumulative reward signal, an agent learns how to interact with its environment using reinforcement learning. The agent acts in the world, gets input, and modifies its plan in response to the rewards it sees. Robotics, autonomous systems, and game-playing agents have all found success using reinforcement learning.

(iv) Semi-supervised learning: For supervised learning models to perform better, semi-supervised learning blends labelled and unlabeled data. In order to develop more reliable representations or to take use of the underlying data distribution, it makes use of the extra unlabeled data.

(v) Transfer learning: The goal of transfer learning is to apply information gained from one work to another one that is closely related. It uses pre-trained models or learned representations to speed up learning and decrease the quantity of labelled data needed for training.

1. Machine learning algorithms for disease detection and diagnosis in animals

When it comes to identifying and diagnosing diseases in animals, the area of veterinary medicine has faced various difficulties. Traditional approaches frequently rely on subjective evaluations, which may be labor-intensive and error-prone. However, there is a significant opportunity to improve illness identification and diagnosis in animals thanks to developments in ML approaches. For ML applications in disease detection, it is first essential to gather pertinent data for the illness of interest before using the technique. This might consist of genetic data, laboratory test results, medical imaging, and clinical records. Then, to make sure the data is of high quality and suitable for analysis, data preparation techniques including cleaning, normalisation, and feature extraction are used. There are a number of issues that need to be resolved despite the potential advantages of machine learning algorithms in the identification and diagnosis of animal diseases. The accessibility of excellent and carefully managed datasets, the interpretability of ML models, and ethical issues are a few of them. In order to enhance illness prediction

and personalised treatment techniques in veterinary medicine, further research is required to investigate the integration of several data modalities such as genomes, proteomics, and environmental data.

ML approaches in animal health addresses reliable predictions and reduced errors in veterinary diagnostics and speeds up decision making and improved risk analyses. Mastitis is the most common disease affecting the economic status of a dairy farm followed by foot and mouth disease (FMD). Early diagnosis can significantly limit the severity or can even prevent their occurrence and improve the quality of treatment. ICAR-IASRI, New Delhi has been working on the collection of data on FMD cases and incorporating it into a ML-based mobile application for their detection and prevention.

Indirect approaches for detection of mastitis have also been investigated. For instance, in AMS, milk yield, milk temperature, its electrical conductivity (EC) and lactation stage can be used for early detection of mastitis by using a sensor integrated system (Norberg *et al.*, 2004). Cavero *et al.* (2008) used EC along with milk production rate, milk flow and, days in milk as input data for early detection of mastitis in cows in AMS with the help of neural networks. Mastitis was determined on the basis of SCC over 100,000/ml or SCC over 400,000/ml. ANN model was evaluated on the basis of block-sensitivity, specificity and error rate. The study concluded unsatisfactory performance of ANN with higher error rates of 51.3% and 80.5% for SCC 1 and 2, respectively. This is because of the lack of relevant parameters that could decrease the error. For example, Miekley *et al.* (2013) used additional information such as month, lactation stage, mastitis history etc. for 215 cows to analyse the efficiency of SVM, another model of AI, for the early detection of mastitis. SVM is a statistical tool for pattern recognition of biological data that focuses on algorithms capable of learning the structure of the input data based on the training dataset. The study defined mastitis as two different disease blocks on the basis of block lengths. The block sensitivity was 84·6%, while specificity was 71·6 and 78·3%, respectively for both the blocks. However, SVM cannot be directly implemented into practical conditions without further improvements in performance. An additional benefit of SVM, however, is that it does not require too many data points to operate and can be used where the data availability is limited. ML algorithms such as random forest, naive Bayes, and eXtreme Gradient boosting (Fadul-Pacheco *et al.*, 2021), neural networks (Cavero *et al.*, 2008), decision-tree induction (Kamphuis *et al.* 2010) and logistic generalized linear mixed models (Khatun *et al.*, 2018) have been used by various researchers in timely diagnosis of mastitis in a herd.

Apart from subclinical mastitis, subclinical ketosis, lameness and metritis are the common disorders whose prevention and early detection is advantageous for farms to ameliorate the negative effects in a timely manner. Morteza *et al.* (2020) identified different metabotypes in dairy cows using the decision tree, random forest, and naive Bayes while Warner *et al.* (2020) employed the K-nearest neighbor, decision tree, and MLP to identify cases of lameness in a dairy herd.

Expert systems, which is a branch of AI, has also been developed that extensively mimics human expert knowledge to solve problems (Giarratano & Rile 2005). A mobile expert system with Fuzzy Inference System (FIS) Tsukamoto for disease diagnosis has been developed based on six clinical signs to assess the level of risk of endometritis in cattle (Nugroho 2017). Tsukamoto fuzzy logic provides crisp individual output for easy identification of functional relationship between the input vector and system output. The study concluded that detection and treatment of endometritis in cattle with mobile expert system was more efficient with an accuracy of 100% in diagnosing endometritis in 12 sampled cattle. Researchers have also evaluated treatment of metritis and tested seven ML models with the best results offered by a random forest classifier with a generalization ability and sensitivity, specificity, accuracy, and precision of 83.33%, 84.62%, 84.21%, and 71.43%, respectively (de Oliveira *et al.* 2021). Automatic monitoring of livestock collects considerable information on rumination, physical activity, and feeding behaviour in a farm which can be coupled with data pooled by AMS such as DMY, parity, season and EC of milk etc. to draw fruitful inferences.

2. Pattern recognition and anomaly detection using machine learning techniques

Pattern recognition and anomaly detection tasks have been transformed by machine learning approaches across a variety of fields. Unsupervised learning methods find innate patterns or detect abnormalities in unlabelled data, whereas supervised learning algorithms enable the detection of particular patterns based on labelled data. Models like CNNs and autoencoders have excelled in pattern recognition and anomaly detection applications thanks to advances in deep learning. These methods will become more and more important as machine learning develops, improving our capacity to spot patterns and identify abnormalities in large datasets. This application is more associated to animal health and disease monitoring and is often associated with IoT sensors. For instance, in poultry farming, early warning of disease outbreaks, is essential to prevent further spread of infection. Different researchers are exploring different

technologies to facilitate rapid detection and diagnosis of poultry diseases. ML possess the ability to analyses different variables having nonlinear connections, which helps in broiler health prediction (Milosevic *et al.*, 2019). The machine learning algorithms tried for predicting disease include Newcastle disease, avian influenza, infectious bursal diseases, Infectious bronchitis, salmonellosis and *E. coli* prediction (Milosevic *et al.*, 2019).

3. Machine learning models for predicting feed consumption, growth, and production efficiency

In animal husbandry, it is essential to maximise production efficiency, accurately estimate growth, and effectively use feed. Models for ML have become effective predictors and optimizers of these parameters. ML models may improve prediction accuracy in animal production systems by analysing vast information and spotting complicated linkages.

For ML models to be reliable and generalizable, proper assessment and validation are crucial. The effectiveness of the models is evaluated using methods including cross-validation, model comparison, and performance indicators such as accuracy, precision, recall, and F1-score, the details of which can be found elsewhere. In real-world animal production situations, the prediction capability of the ML models is frequently validated using independent validation datasets or randomised controlled trials.

Overview and applications of Internet of Things (IoT)

IoT is a network of gadgets that establishes connections between actual physical sensors and the internet and may be used for data analysis or realization. IoT technology has the advantage of being able to gather vast amounts of data at almost any time, location, and environmental condition. As this technology makes it simple to analyse and assess the condition of the objects being monitored, it can be used extensively in livestock farming. IoT devices contain three major sensors programmed to collect data, process it to extract desired information, and actuation to execute required task. In IoT, each sensor is equipped with a unique IP (Internet Protocol) address to transfer data from sensor to storage. The performance of IoT devices depends on the sensor used, medium of connectivity, range, processing ability, data rate, battery and memory.

Use of IoT has the potential to ease complex and laborious routine operations in the farm ultimately not only helping in reduction in the overall cost of management in the long run but also improve animal health and consequently quality and quantity of animal food. IoT enables the interconnection of various intelligent things/objects in our surroundings, with the ability to accumulate process and communicate data (Lee *et al.*, 2017). IoT has enormous applications in almost every facet of livestock management, be it animal health, environmental monitoring, feeding, storage of fodder, prediction/forecasting of production/estrous cycle, tracking/traceability, automated applications (maybe feeding, watering, etc), documentation, and optimization of farm, man-power resources and so on. All these applications are possible through a systematic approach which involves a framework containing IoT devices, gateways, communication/network technologies, and cloud infrastructure (involves collection, storage and decision making). IoT devices, better known as “things” involves variety of sensors, buzzers, actuators, and hardware (known as Physical layer); gateways, which perform several critical functions of translating protocols to processes, encryptions, management and filtering of data. Communication/network technologies including 4G/5G, WIFI, Bluetooth, Zigbee, etc, cloud set-up via several apps, programmes, helps manager/farmer in decision making in real time, based on highly precise data, and has potential to change the way livestock farms are currently being managed. IoT has applications in the management of all variety of livestock, whether cattle, buffalo, sheep, goats, poultry, and even pets.

1. IoT for real-time monitoring of animal health, temperature, and environment

Without physical presence, farmers can inspect the entire farm from anywhere in the world and take quick, real-time decisions (Bhayani *et al.,* 2016) and/or direct support staff for the requisite action. This livestock monitoring is possible through wearable sensors and devices. IoT can be used for monitoring of stress. The negligence of stress in animals not only causes economic loss but also poses a considerable threat to the consumer’s food safety (Farooq *et al.*, 2022). Livestock show different signs and behavior changes with increasing stress levels which translate to poor/low production (as in milk, weight gain (meat), or faulty/inferior eggs). With IoT sensors and wearable technologies, it is possible to overcome these challenges. For example, cattle health related end-points such as stress level, body, and various environmental parameters, were identified and measured through IoT sensors and accordingly suitable action was taken which has been shown to result in significant rise in milk production and lowered insemination expenses (Saravanan and Saraniya, 2017). To cite another example, excessive level of stress

in sheep and goat during transportation to the slaughterhouse and static meat defects were successfully shown to be reduced by using a wearable stress monitoring system (WSMS) during their transportation (Cui *et al.*, 2019). Another application of IoT involved the monitoring of environment in animal barn/shed: Several IoT-based techniques have been proposed to monitor the environment around animals for their safety and sound health. Not only this, few researchers have proposed use of these techniques for stray animals by assigning an intelligent stray animal tag (ISATAG) architecture for their unique identification (Huang *et al.* 2015). With such tags, living environment and physiological conditions could be monitored by the veterinarians and/or NGOs/stakeholders. In a poultry farm, indoor environmental conditions affect the chicken production performance, mortality and welfare. Temperature, relative humidity and length of exposure have major impact. Chickens are sensitive to heat stress due to absence of sweat glands. Broilers are highly sensitive because of increase in metabolic rates due to intense selection for growth and limited development of cardiovascular and respiratory system. Temperature and relative humidity sensors are used to collect information regarding change of environmental temperature and humidity. Such sensors provide constant access to information about the present temperature and humidity. However correct height positioning of the sensors is important to get the exact values. Placing the sensors on walls or in an elevated area may not give the correct picture. Air velocity and ventilation rate affect the temperature and relative humidity conditions of the farm. These measurements by using appropriate sensors will provide better information. Light has significant impact on growth, productive and reproductive performance of chicken. Automated lighting system will provide better chicken performance and also reduce electricity consumption, which is a significant cost of production. High levels of gases carbondioxide and ammonia also affect the performance of chicken. For broilers reared in deep litter system ammonia gas concentration may exceed the tolerable levels (<25 ppm), if there is water seepage and improper litter management. Increase in ammonia levels reduce growth rate and also affect bird`s respiratory system and health. Nowadays sensors are available to provide real-time ammonia concentrations in the farm and provide alerts. In large farms air flow can be increased or conveyor mechanism can be activated to remove litter to reduce the ammonia concentration. Similarly high CO_2 concentration also affect the birds performance which can be monitored by using CO_2 sensors.

Monitoring of diseases can also be done using IoT. Since most of the animal diseases are contagious, it is necessary to identify them as early as possible to protect rest of the animals on the farm. Therefore, an automotive health monitoring system is necessary. When animals are suffering from diseases, their habits/behavior changes which can be easily caught and collected by mounted or wearable sensors and farmers can get alerts over messages or phones or by other means. Researchers have proposed different models to detect diseases using IoT sensors, for example, Vyas and co-workers have proposed a model to detect mastitis with sensors (Vyas *et al.* 2019). In poultry, gait and lameness can be detected in the farm (Ojo *et al.*, 2022).

2. Data collection, transmission, and analysis in IoT-enabled animal farming

To cut down manpower, to ensure optimum animal health, prevent and/or check diseases, and thus, to ensure high production, farmers/livestock managers have been increasingly preferring the use of various IoT sensors/devices meant for collection and transmission of livestock data on-farm in terms of pulse rate, respiratory rate, temperature, digestion, heart rate, gesture and host of other health and wellness indicators. Table 1 shows some of the sensors available in the market along with their functions. Some salient sensors used for livestock farms have been discussed here in brief. For instance, temperature sensor are capable of determining the temperature of animals, shed/barn, weather, etc. LM35 is the most commonly used sensor that is integrated with Arduino devices such as microcontrollers and Raspberry PI and measures temperature between -55 °C to +150 °C (Yadav *et al.*, 2020). Similarly, heartbeat sensor: The heartbeat range in a healthy cow is 48-84/minute. Heart rate fluctuation is attributed to the uneasiness and diseases which is sensed by the means of a heartbeat sensor (Farooq *et al.*, 2022). Pulse sensor is another simple, plug and play, small IoT device that measures the heartbeat by giving digital values. After connecting the sensor to power source, it starts giving animal pulse according to the pulse rate (Yadav *et al.*, 2020). IoT gesture sensing devices assesses physical gesture of the animal which is divided into two categories i.e., stationary and travelling. Stationary activities consist of standing, sleeping, and sitting; whereas, traveling activities are walking, running, and grazing (Vázquez *et al.*, 2015). To determine animal's gesture behavior, Saravanan and Saraniya (2017) have deployed accelerometer sensor. Humidity sensor helps in evaluating the stress level of animals. Animals experience no stress if the humidity level is between 1-72%, however with humidity level >72%, animals will have severe stress (Meenakshi and Kharde, 2016).

Data can be stored centrally in a data warehouse or in distributed storage systems, which store data on multiple servers. Consistency and continuous availability of data are important for distributed storage systems. Even if one server fails it should not affect the availability of data and also routine livestock operations. After data collection, data must be extracted from different sources and integrated into a platform that allows for analysis (Ojo *et al.*, 2022). Initial data preprocessing is important to reduce duplicate and redundant data which will help in improving the analysis. Data analysis is done by incorporating data from various sources to make key insights in the data that can be incorporated in decision support systems leading to developing alarms/ alerts or automated response in feeding, watering or other management decisions (Astill *et al.*, 2020).

3. IoT-based automated feeding, watering, and waste management systems

Water and feed are vital from animal's nutrition and productivity point of view as well as from the animal welfare angle. Water troughs which get automatically filled with water through a pressure line is a commonly used IoT technique. Similarly, sensors that deposit precise amount of feed in the feed trough based on each animal's requirement which can avoid overfeeding as well as under-feeding (Salem and Smith, 2008) are not only important from the perspective of animal nutrition but also helps check cost and economizes whole livestock operations by reducing wastage of water as well as feed.

When IoT technologies are implemented in poultry production systems, a variety of internet-connected devices will be used to improve device communications. As a result, some farm operations will be automated, leaving humans only in charge of monitoring farms and handling tasks that require high level of intelligence (Wolfert *et al.*, 2017). The capacity for sensors and devices to communicate with one another is the fundamental benefit the IoT offers the poultry sector. Automation of processes is important for automation of tedious jobs and improve the effectiveness of management practices (Banhazi, 2009). Simple communications might lead to the automation of numerous activities. For example, low levels of feed in the feed trough will signal for start of automatic feeder, high temperature may trigger start of sprinkler system or high levels of ammonia may activate fans to increase ventilation etc. A temperature controlled automatic sprinkler system is installed in DPR farm. Whenever temperature exceeds the desirable level, which is monitored real time using sensor, the sprinkler system is activated and the temperature is brought down. Once the temperature reaches the desirable level, the sprinkler system is deactivated. Similarly, ammonia and CO_2 levels in the farm are reduced by using exhaust DC fans.

For automation of complex farm operations, complex routing protocols may be needed. Experimental precision feeding systems can measure broiler breeder weight before administering feed. With radiofrequency identification tags, data can be extended to include previous feeding frequency, laying frequency, and physiological indicators. Data governance, protection, and legal compliance are essential for IoT infrastructure implementation in the poultry industry.

Overview and applications of blockchain

Agri-business, specifically livestock-based business, being a complex sector, has several opportunities for the use of blockchain technology. Blockchain is a distributed or decentralized record of encrypted transactions in which each transaction establishes a node. Based on consensus from participating parties (peers), these nodes are arranged into records known as "blocks," and blocks are connected with unique hash codes to form a "chain". In other words, blockchain can be defined as a digital technology that 'chains' together 'blocks' of information in order to create a permanent and unaltered record. Every time a new transaction occurs, a new node is formed in real time to add to the blockchain with information about that transaction (Chattu *et al.*, 2019).

The rapid expansion and development of information technology, which can be ascribed to a platform of public services aimed at improving the administration of remote resources and services, has become the key to resolving product demand and supply frictions in different sectors (Leng *et al.*, 2018). Blockchain comprises of four principles i.e., distributed, transparent, immutable, and democratic, which are responsible for easy handling of resources and maintaining the trust of different involved players. The pseudonymous Satoshi Nakamoto, who invented Bitcoin to tackle double-spending concerns, revealed the notion of blockchain back in 2009. The Bitcoin network's nodes use mutually agreed-upon validations on the blockchain to carry out transactions on the ledger, which is essentially a cash book that determines who possesses data in the chain (Christidis & Devetsikiotis, 2016). Based on the network management system used and the rights granted, blockchain networks can be classified as public, private, or federated blockchains. A private blockchain is a permissioned access platform whereas a public blockchain is a permissionless open data network in which any user can add data in the form of a transaction, which is an

identification data package in the system, and these data can also be checked and copied. A federated blockchain combines the features of both private and public blockchains (Yang *et al.*, 2020). Initially, the blockchain's robust and decentralized functionality was limited to global financial systems, but now it has been extended to different sectors. In the case of livestock farming, it is applied in operations like tracking the global supply chains, which includes animal feed, feed ingredients, vaccines, medicines, animal products, and, animal and plant germplasm.

Blockchain technology is applied to livestock farming in several ways. Decentralized, automated transactions that could contribute to more efficient auditing systems for certification and regulatory organizations, system integration, organized records of chain transactions throughout the life of an animal from farm to table, and greater traceability and transparency within livestock agriculture is possible with blockchain technology (Picchi *et al.*, 2019). Block chain enabled transparent and traceable input supply chains including feed components, feeds, vaccinations, medications, and semen straws of various breeds, including sexed semen for artificial insemination, among other things, would boost livestock production. Different blockchain companies and their technologies were developed all over the world for the livestock industry.

1. Blockchain for feed supply chain governance

The agricultural supply chain is a complicated mechanism that allows agricultural products to circulate through the market (Leng *et al.*, 2018). In case of livestock farming, feed supply chain is one such chain of utmost importance which can be governed by using blockchain technology. Furthermore, feed supply and feed safety are inextricably intertwined as the raw materials, processing, handling, and storage of feed resources and variety of other market-related issues, may impact both the safety and quality of feed produced. Different actors involved in the feed chain including millers, transporters, wholesalers, distributors, retailers, and farmers make the chain geographically dispersed. Traditional system of handling such a chain is inefficient, unreliable, and lacks transparency and accountability, particularly in emerging nations. The expense of running a supply chain like this is considerable, and is prone to fraud. Blockchain technology has the ability to solve these problems. Because of the properties like transparency and immutability, a well-designed blockchain prevents tampering and provides a reliable mechanism for stakeholders to prove compliance with standards, forcing organizations to work within the rules to strengthen the feed-food nexus, protect consumers, and improve resource use efficiency (Makkar & Costa, 2020). It was recently proposed to combine blockchain with IoT for real-time monitoring and tracking of physical data based on the hazard analysis and critical control points system (HACCP) (Tian, 2017). The efficient and secure management of the food supply chain was one of the first uses of blockchain (Kamilaris *et al.*, 2019). Because byproducts of agricultural and food processing are utilized as inputs in the manufacturing of animal feed, the supply chain for agriculture, food, and feed are intertwined. For all participants involved in a feed supply chain, including traders, customs agents, government agencies, and customers, a blockchain-enabled system is intended to improve speed, visibility, security, and response.

2. Blockchain for monitoring animal production

Blockchain technology helps in keeping track of individual animals at a farm, right from its birth to different operations which involves the animal. For instance, for a meat animal, blockchain technology entails assigning a unique identification to each animal at the farm, and that unique identity would remain with that animal throughout its lifetime, allowing data to be collected on the farm(s) it has lived on, the transportation used to transport the animal from the farm(s) to the slaughterhouse, the veterinarian inspecting the animal at the slaughterhouse, the quality check following slaughter, the processing of the meat product and finally the details of packaging and distribution (Neethirajan and Kemp, 2021).

Another aspect related to animal production is forage and fodder production. In many countries throughout the world, weather and climatic extremes have a negative influence on fodder conditions, resulting in a loss of animal productivity and livelihood for farmers. Reduced livestock losses and improved resilience can be achieved by monitoring pasture conditions and building a reliable early warning system. Several systems that monitor water and pasture conditions must be established, and their interconnections utilizing blockchain technology in the form of a dynamic web-based application would improve natural resource usage efficiency and this can be more advantageous in scarcity or emergency conditions like droughts (Makkar and Costa, 2020).

3. Blockchain in maintaining animal health

Detecting and monitoring livestock disease outbreaks, such as H1N1 swine flu, foot-and-mouth and mad cow diseases in Europe, Avian influenza (Lin *et al.*, 2018), and salmonella outbreaks (Dyda *et al.*,

2020), was reported to be made much easier with blockchain technology. Sensor-enabled blockchain technology allows for safe and assured traceability of animal products from farm to table, which is a significant benefit in monitoring disease outbreaks and averting related economic losses and food-borne pandemics. Other potential applications of blockchain technology in the animal health sector includes efficient and transparent management of supply chain for veterinary pharmaceuticals, disease diagnostics, and vaccines, particularly those that need cold chain (Yong *et al.*, 2020).

4. Blockchain for livestock product traceability and transparency

Blockchain technology also helps in maintaining food security of animal origin products by improving transparency, reducing transaction costs, and giving real-time results. With the increasing awareness and health concerns of consumers, their demands for transparency regarding different aspects of the products goes on increasing and here blockchain intervention can make an impact in building the consumer's trust. Through this technology farmers will be able to provide their consumers with information on their livestock product's originated and movement without taking much of their time. Blockchain-based recordings and digitalization of different livestock management functions like monitoring of animals for behavior, feed intake, and illness would assure the consumers about managemental and welfare conditions of animals during their upbringing, ultimately making livestock farming more efficient. Marinello *et al.* (2017) highlighted the possibility of developing a conceptual framework for livestock product supply-chain traceability system involving blockchain technology with an objective of enhancing food safety and quality along with reduction in losses during the logistics process. This strategy encompasses the whole data collection and information management process for every link in the livestock product supply chain, including quality and safety monitoring, tracing, and traceability management "from farm to fork."

The emergence of augmented/virtual reality and haptics

1. Augmented and virtual reality

The field of animal science, stand to benefit from the revolutionary effects of augmented reality (AR) and virtual reality (VR). AR can provide real-time information and guidance to farmers and livestock managers, helping them identify health issues, administer medication, or perform procedures correctly. AR can overlay data and visual cues in real time during experiments, helping researchers analyze how animals interact with their environment and other animals. AR glasses equipped with sensors can be used by veterinarians to examine animals remotely, helping diagnose issues without the need for physical presence. AR can provide farmers with real-time health and activity data for their livestock, enabling them to identify problems early.

VR simulations can provide hands-on training for veterinary students, allowing them to practice procedures on virtual animals before working with real animals. Researchers can use VR to create immersive environments for studying animal behavior in their natural habitats without disturbing them. VR can be used in the rehabilitation of injured animals by creating tailored virtual environments that encourage movement and exercise. VR environments can provide mental stimulation for captive animals, reducing stress and boredom. Further, VR experiences can immerse people in the lives of animals and showcase the challenges they face, promoting empathy and understanding for animal welfare issues. In addition to this, VR models and simulations can be used as alternatives to animal testing in some research scenarios, reducing the need for live animals in experiments.

It's important to note that while the potential applications of AR and VR in animal science are promising, their implementation might require overcoming technical challenges and ensuring ethical considerations are met.

2 Introduction to haptics

Haptics refers to the technology of touch and tactile feedback. It stimulates sensations and motion which is of critical importance when dealing with physical objects from a remote location. There could be many potential applications of haptics. For instance, virtual reality training simulations for animals, such as assistance dogs or search and rescue animals, can be improved by haptic input. Animals can learn to react to many situations in a controlled setting by being exposed to genuine tactile sensations. Similar to this, haptic feedback can help wounded animals recover by leading them through movement drills. Further, haptic technology can provide the user a feeling of touch in circumstances where it is vital to manage animals remotely, such as in dangerous areas or during medical treatments. Veterinarians may therefore, diagnose and treat animals remotely using haptic feedback, which gives a sensation of touch feedback to

direct medical treatments, as part of telemedicine solutions for animals. Haptic feedback may also be used to imitate touch and track animal behaviors by researchers looking at animal-human interactions and understanding how animals perceive and react to human touch. This is crucial for training, treatment, and overall animal welfare.

Conclusions and perspectives

Intelligence, sustainability, and accuracy must be the main priorities of future precision farming approaches and research. While the use of existing technology to digitize the agricultural industry is an essential part of the long-term development of smart farms, this process is still in its infancy and offers a wide range of possible uses. The future expansion of livestock farming is considering cutting edge technologies such as biological sensing, image processing, sound analysis, behavior analysis, environmental perception, and image processing, among others. Digitalization is the element that comprises the integration of all these technologies. The use of smart machines is another emerging area. Some countries have reported the use of robotic dogs for herd management, automatic milking units with robotic teat cup attachment, AI powered farm cleaning robots, feed dispensers and many other technologies. Haptics and AR/VR are another developing field wherein there are infinite applications for the animal sciences. However, very limited research has been done in this field due to high technological cost which may subside in the years to come. Currently, most of the work done on digitalization is restricted to the experimental stage. So, there is a strong need of developing farmer-friendly digital models and to equip farmers with knowledge of their working. Application of digital techniques requires specialized training and skill thus orientation programs are required to help farmers adapt to the use of these advanced technologies on livestock farms. C Another point to consider during the application of digital technologies is the economy. Mostly the infrastructure of livestock farms is built in a traditional manner and it requires a considerable initial investment for its modification and implementation of new technologies. This is challenging for farmers to accept in a timely manner, especially for small-scale farmers. For instance, the initial large set-up cost of IoT is a hindrance for the farmers, but it is definitely profitable in the long run. It is the need of the hour to research and develop economical IoT based sensors and devices for the small and marginal farmers so that livestock owners in the developing countries can take benefit of the same.

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Ethical considerations for e- Extension

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ABSTRACT

The agriculture sector in rural India, which supports approximately 42.3% of the population and contributes 18.2% to the national GDP, remains a cornerstone for rural prosperity. However, challenges such as resource depletion, fragmented land holdings, and climatic variability undermine its growth and productivity. Effective information dissemination is crucial for enhancing agricultural productivity, food security, and rural livelihoods. E-extension, or cyber extension, leverages information and communication technologies (ICT) to provide timely and relevant agricultural information to stakeholders. This modern approach addresses the traditional limitations of extension services, such as the disproportionate extension worker-to-farmer ratio, by utilizing digital tools like the internet, mobile phones, and social media. Despite the advantages of e-extension, it raises important ethical considerations. These include privacy and data protection, equity and accessibility, accuracy and reliability, cultural sensitivity, accountability, and security. Issues such as ensuring user confidentiality, bridging the digital divide, and maintaining information accuracy are vital. The Digital Personal Data Protection (DPDP) Act, 2023, addresses privacy concerns by regulating data usage. Additionally, challenges related to cultural sensitivity, legal compliance, and intellectual property, including copyright and plagiarism, must be managed to uphold ethical standards. As e-extension continues to evolve, addressing these ethical issues will be essential for maximizing its benefits while ensuring fair and responsible use of technology in agriculture.

Introduction

ICT led extension approach

The agriculture and allied sectors are irrefutably the potential harbinger of prosperity of rural India due to its high share in employment and livelihood establishment. Indian agriculture sector provides livelihood support to about 42.3 per cent of the population and has a share of 18.2 per cent in the country's GDP at current prices (Economic Survey 2023-24). Further, Indian agricultural growth rate and the productivity remains low due to factors like declining of natural resource base, increasing fragmentation of holdings, frequent climatic variations, rising input costs and wide gaps in yield potential and national average yields of most commodities (Singh M *et al.* 2014). Access to adequate information is very essential to increase agricultural productivity, increasing food security and improving rural livelihoods. Extension and advisory services can play an important role in addressing many of these challenges. Further, extension workers to farmers ratio is very wide in India. This clearly indicates about the inadequate manpower of extension worker in India. All these things have made to think beyond the traditional agriculture extension and subsequently led to the increase application of ICT in agriculture.

Concept of E-extension

E-Extension is also known as cyber extension. Cyber space is an imaginary space behind networked computers through telecom means. It encompasses the use of various information and communication technologies (ICTs) mediated tools such as internet, mobile phones, expert systems, social media, and other digital platforms to timely delivery of relevant information to farmers, extension workers, research scientists & extension managers. ICTs can directly support farmer's access to timely and relevant information, as well as empower the farming community through creation and sharing of knowledge and it also plays a major role in price discovery (Bihari *et al.*, 2019).

Concept of ethics

The word "ethics" comes from the Greek word "ethos", which means character or custom. In ancient Greek philosophy, "ethos" referred to the habits or moral character of a person or society, and this concept evolved into the study of ethics—essentially the study of moral principles and how they apply to human behaviour. It pertains to our values and virtues, shaping our actions and experiences in daily life. So, when we talk about ethics today, we're discussing the principles that guide us in determining what is right and wrong. Ethics is a branch of philosophy concerned with the principles that govern human conduct. The nature of ethics involves examining fundamental questions about how we should live and what constitutes right or wrong behaviour. It focuses on what ought to be done rather than what is the case. Understanding

ethics helps individuals and societies navigate complex moral landscapes and make informed decisions that align with their values and principles.

Ethical issues in e- Extension

Ethics in e-extension, which involves the use of electronic means (like digital platforms and online resources) to extend education and information to users, is an important consideration for ensuring that these services are both effective and responsible. Information and Communication Technology (ICT) plays a crucial role in modern society, impacting almost every aspect of daily life and business. ICT has woven itself into the fabric of social life, influencing how people communicate, learn, work, and interact with the world. While it offers numerous benefits, it also presents challenges and ethical considerations that need to be addressed to ensure a positive and equitable impact on society. Here are some key ethical principles and considerations for e-extension:

1. **Privacy and Data Protection**: Privacy and data protection are critical topics in our increasingly digital world. They deal with how personal information is collected, used, and safeguarded to ensure individuals' rights and security.

   Confidentiality: Ensuring that personal and sensitive data of users, such as farmers' personal details and farm data, are protected from unauthorized access and misuse.

   Data Ownership: Clearly defining who owns the data collected through e-extension services and how it can be used.

   Anonymity: When dealing with sensitive data, anonymizing data to protect individuals' identities is important.

   Informed Consent: Obtaining explicit consent from users before collecting and using their data, and providing them with information on how their data will be used.

   Digital Personal Data Protection (DPDP) Act, 2023

   - The DPDP Act is a legal framework introduced in India to safeguard the personal data of individuals and ensure that their data is shared only with their consent.
   - It regulates the processing of digital personal data and outlines various provisions to protect individuals' privacy in the digital age.

2. **Equity and Accessibility:** e-Extension platform have high potential for dissemination of agriculture and animal husbandry related information to the farmers but due to digital divide this potential is not fully utilized. The digital divide in agriculture and animal husbandry refers to the gap between those who have access to digital technologies and the internet and those who do not. This divide can have significant impacts on efficiency, productivity, and overall progress in these sectors. Farmers and animal husbandry practitioners in rural areas often face challenges accessing modern digital tools and high-speed internet. This can hinder their ability to use advanced technologies like precision farming tools, online marketplaces and access to extension and advisory services. So, efforts should be given on to bridge the digital divide in agriculture and animal husbandry and digital platforms and resources can be designed and managed to serve all individuals fairly and inclusively.

   Inclusivity: Making sure that e-extension services are accessible to all, including marginalized and underserved communities who might have limited access to technology.

   Affordability: Ensuring that the cost of accessing e-extension services is not a barrier for smallholder or low-income farmers.

   Improving Connectivity: Expanding internet access to rural and underserved areas through investments in infrastructure like broadband and satellite internet.

   Training and Support: Providing education and training programs to help farmers and animal husbandry practitioners effectively use digital tools and technologies.

   Collaboration: Encouraging partnerships between governments, tech companies, and agricultural organizations to support digital inclusion initiatives.

3. **Accuracy and Reliability**: Ensuring that the information provided is accurate and reliable is a fundamental ethical responsibility. Misleading or incorrect information can have detrimental effects on agricultural practices and farmers' livelihoods, so it's important to ensure that content is well-researched, up-to-date, and reviewed by experts. Accurate and reliable information is foundational to the effectiveness and efficiency of any system. It supports decision-making, enhances system performance, builds user trust, ensures compliance, fosters innovation, and contributes to operational and economic success.

4. **Cultural Sensitivity**: Respecting local practices in e- Extension content is essential for ensuring that technology solutions are culturally sensitive, legally compliant, and effectively meet the needs of

users in different regions. Further, localized user interface and content make technology more accessible and user-friendly for people in different regions.

5. **Accountability and Responsibility**: In e- Extension accountability and responsibility play crucial roles in ensuring effective, ethical, and secure management of technology and data. It involves tracking who is responsible for various aspects of technology and data management and ensuring they are answerable for their actions. Further feedback mechanism should be provided for users to report any issues or concerns.
6. **Security**: Implementing robust security measures to protect against unauthorized access and cyber threats is crucial to maintaining trust and safeguarding user information.
7. **Professionalism:** Ethical behavior upholds the professionalism of e-extension services, ensuring that interactions are respectful, fair, and based on sound practices
8. **Trust Building**: Ethical practices help build trust between e-extension services and their users. Trust is essential for effective knowledge transfer and adoption of new practices.
9. **Sustainability**: Ensuring that e-extension services are designed to be sustainable and capable of continuing to serve users effectively over time.
10. **Legal Compliance**: Adhering to ethical standards helps in complying with legal requirements related to data protection, intellectual property, and other relevant regulations. Copyright is an important intellectual property right for digital tools. Copyright is a legal right that protects original works of literature, art, music, films, and computer programs, among others, in India. The Copyright Act of 1957 regulates copyright matters in India. The owner of a copyright has exclusive rights to adapt, reproduce, publish, translate, and communicate the work to the public. Department of Industrial Policy and Promotion is the nodal agency for regulating intellectual property rights in India.
11. **Plagiarism:** In the field of Information and Communication Technology (ICT), plagiarism involves the unauthorized use or replication of someone else's work, ideas, or code, and presenting it as one's own. This can have significant implications, both ethically and legally. We can avoid plagiarism by citing sources of code, ideas, or research findings. This includes acknowledging original authors in comments within code and documentation.

Conclusion:

Addressing these ethical issues requires a balanced approach, incorporating stakeholder perspectives, developing robust policies, and fostering ethical practices in the deployment of e-Extension in agriculture and animal husbandry. By doing so, it is possible to harness the benefits of technology while mitigating potential risks and ensuring equitable outcomes for all stakeholders involved.

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E-Extension Evaluation and Impact Assessment

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ABSTRACT

E-extension leverages Information and Communication Technologies (ICTs) to enhance agricultural extension services, complementing traditional methods with digital platforms such as websites, mobile apps, and SMS. This approach facilitates broader reach, faster information dissemination, and improved interaction with stakeholders. Effective e-extension programs require thorough evaluation and impact assessment to gauge their effectiveness, efficiency, and overall impact on target audiences. Evaluation focuses on assessing program performance, while impact assessment examines long-term changes in knowledge, practices, and livelihoods. Both quantitative and qualitative tools are crucial for a comprehensive impact assessment. Quantitative methods, including surveys, statistical analysis, and econometric techniques such as regression analysis and panel data analysis, provide numerical data on program outcomes. Qualitative methods, such as focus group discussions, case studies, and thematic analysis, offer in-depth insights into user experiences and contextual factors. A mixed-methods approach, integrating both quantitative and qualitative data, is recommended to capture a holistic view of the program's impact.

Additionally, technology-enabled tools like digital surveys and social media analytics offer innovative data collection and analysis options. Participatory approaches, such as Participatory Impact Pathways Analysis (PIPA) and Most Significant Change (MSC), further enrich the impact assessment by involving stakeholders and capturing meaningful changes. Effective evaluation and impact assessment require careful selection of tools based on research questions, target audience, and program context. By employing a combination of methods, stakeholders can gain actionable insights to improve e-extension programs, ultimately enhancing agricultural development and farmer livelihoods.

Keywords: Evaluation, Impact assessment, digital surveys and social media analytics, Participatory Impact Pathways Analysis (PIPA) and Most Significant Change (MSC)

Introduction

E-Extension refers to the use of information and communication technologies (ICTs) to deliver agricultural extension and advisory services. This digital approach complements traditional face-to-face methods, enabling wider reach, faster dissemination of information, and enhanced interaction with farmers and other stakeholders. E-Extension encompasses various tools and platforms, such as websites, mobile apps, social media, SMS, and interactive voice response systems, to provide timely and relevant information on agricultural practices, market trends, weather updates, and other crucial aspects.

Need for Evaluation and Impact Assessment

Evaluation and impact assessment are integral components of any E-Extension initiative. They help determine the effectiveness, efficiency, and overall impact of these programs on the target audience. By systematically collecting and analyzing data, we can gain valuable insights into the strengths and weaknesses of E-Extension interventions, identify areas for improvement, and make informed decisions regarding resource allocation and program design. Evaluation primarily focuses on assessing the merit, worth, or significance of an E-Extension program. It examines whether the program is achieving its intended objectives, reaching the target audience, and delivering services efficiently. On the other hand, impact assessment delves deeper into the long-term effects and consequences of the program. It seeks to understand the changes brought about by the E-Extension intervention in terms of knowledge, attitudes, practices, and ultimately, the livelihoods of farmers and rural communities.

Tools and Approaches for Impact Assessment

Impact assessment utilizes a combination of quantitative and qualitative tools and approaches to gather comprehensive data. Quantitative methods involve collecting numerical data through surveys, questionnaires, and structured interviews. These data can be analyzed statistically to identify trends, correlations, and significant differences. Qualitative methods, on the other hand, focus on capturing in-depth insights, perceptions, and experiences through focus group discussions, case studies, and open-ended interviews. They provide a richer understanding of the context, challenges, and successes of E-Extension interventions.

- **Quantitative Tools:** Surveys, questionnaires, structured interviews, statistical analysis.
- **Qualitative Tools:** Focus group discussions, case studies, open-ended interviews, thematic analysis.

The choice of tools and approaches depends on the specific objectives, context, and resources available for impact assessment. A mixed-methods approach, combining both quantitative and qualitative data, is often recommended to gain a more holistic understanding of the impact of E-Extension programs.

Quantitative tools, such as surveys and questionnaires, offer the advantage of gathering data from a large sample, enabling comparison and statistical analysis to reveal trends and correlations. In the context of E-Extension, pre- and post-program surveys effectively measure changes in knowledge, attitudes, and practices, as well as assess satisfaction levels with E-Extension services. Structured interviews, with their controlled questions and ability to probe for specific information, are valuable for collecting in-depth feedback from key stakeholders like farmers, extension agents, and policymakers on program implementation, challenges, and perceived impact. Finally, statistical analysis identifies significant differences and relationships in data, facilitating hypothesis testing and drawing inferences, such as assessing the impact of E-Extension on crop yields, income levels, and adoption of improved practices by analyzing survey data.

Several econometric and statistical techniques are available which can be applied in quantitative impact assessment of E-Extension initiatives.

1. **Regression Analysis:** This versatile tool allows for examining the relationship between the E-Extension intervention (independent variable) and various outcome variables (e.g., crop yield, income, adoption of new practices), while controlling for other factors that may influence these outcomes.
2. **Panel Data Analysis:** When data is collected on the same individuals or units over time, panel data analysis allows researchers to control for unobserved individual-specific factors that may influence the outcome, providing a more robust estimation of the intervention's effect.
3. **Difference-in-Differences (DID)**: This method compares the changes in outcomes over time between a group that received the E-Extension intervention (treatment group) and a group that did not (control group). It helps isolate the impact of the intervention from other factors that may influence the outcome.
4. **Propensity Score Matching (PSM)**: This technique creates a comparison group that is statistically similar to the treatment group, allowing for a more accurate estimation of the intervention's impact, particularly in situations where random assignment is not feasible.
5. **Instrumental Variables (IV)**: When there's concern about endogeneity (unobserved factors affecting both treatment and outcome), IV techniques use an "instrument" that is correlated with the treatment but not directly with the outcome, helping to identify the causal impact of the E-Extension intervention.
6. **Randomized Controlled Trials (RCTs)**: Although not always feasible in the context of E-Extension, RCTs are considered the gold standard for impact evaluation, as they randomly assign individuals to treatment and control groups, ensuring that any observed differences in outcomes can be attributed to the intervention.
7. **Cost-Benefit Analysis (CBA)**: This technique compares the costs of implementing an E-Extension program to the benefits it generates, expressed in monetary terms, helping to assess the overall economic efficiency and value for money of the intervention.

The choice of specific econometric/statistical tool will depend on the nature of research questions, the data available, and the specific context of the E-Extension program being evaluated. Consult with a statistician or econometrician if needed to ensure proper application and interpretation of these techniques.

Qualitative tools, on the other hand, delve into the rich tapestry of perceptions and experiences. Focus group discussions foster open dialogue and interaction, generating valuable data on perceptions and experiences, capturing group dynamics, and shedding light on social norms, making them ideal for exploring farmers' views on the usefulness, accessibility, and relevance of E-Extension content and delivery methods. Case studies offer in-depth examinations of specific cases, providing context-rich insights and aiding in understanding complex causal relationships, proving valuable for documenting successful E-Extension initiatives and highlighting best practices. Open-ended interviews provide a flexible approach, allowing respondents to express themselves freely and uncovering unexpected insights and perspectives, particularly useful for interviewing farmers who have benefited from E-Extension to understand the impact on their decision-making, problem-solving skills, and overall empowerment. Thematic analysis, involving the systematic identification, analysis, and interpretation of patterns and themes in qualitative data, offers a structured approach to making sense of complex information gleaned

from focus group transcripts and interview data, aiding in identifying common themes, challenges, and opportunities in E-Extension adoption and impact.

A mixed-methods approach emerges as a powerful strategy, combining the strengths of both quantitative and qualitative tools. By integrating numerical data with rich, contextual insights, mixed methods offer a more comprehensive and nuanced understanding of the impact of E-Extension programs. This approach allows researchers to triangulate findings, validate data from different sources, and explore complex causal relationships that may not be fully captured by a single method alone. In the context of E-Extension, mixed methods can be used to quantitatively measure changes in knowledge and practices while also qualitatively exploring the underlying reasons and motivations behind those changes. This holistic approach ultimately empowers evaluators to make more informed recommendations for program improvement and evidence-based decision-making.

In addition to these traditional tools, technology-enabled tools such as digital surveys and social media analytics provide innovative avenues for data collection and analysis. Digital surveys, conducted online or through mobile devices, enhance reach and streamline data collection, while social media analytics allow for gauging public sentiment and identifying emerging trends by analyzing online conversations and engagement. Participatory approaches, such as PIPA (Participatory Impact Pathways Analysis), which involves stakeholders in identifying key outcomes and mapping causal pathways of change, and MSC (Most Significant Change), which collects stories of change from beneficiaries, further enrich the impact assessment process by actively engaging participants and capturing the most meaningful impacts of E-Extension.

The selection of appropriate tools necessitates careful consideration of various factors, including the specific research questions, the target audience, available resources, and the context in which the E-Extension program operates. By strategically combining quantitative and qualitative tools, tailored to the specific needs of the evaluation, we can generate robust and actionable insights into the impact of E-Extension programs, ultimately leading to improved livelihoods and agricultural development.

While impact assessment delves into long-term effects, evaluation primarily gauges merit, worth, and objective achievement. Some key tools commonly employed in E-Extension evaluation:

1. **Process Evaluation**:
   - Activity logs and tracking systems: Monitor participation, resource utilization, and program implementation fidelity.
   - Surveys and questionnaires (focused on implementation): Gather feedback from participants and implementers on program delivery, accessibility, and satisfaction.
   - Key informant interviews: Obtain in-depth perspectives from program managers, extension agents, and other stakeholders on program strengths, weaknesses, and challenges.
2. **Outcome Evaluation**:
   - Pre- and post-tests: Assess changes in knowledge, attitudes, and skills of participants directly attributable to the E-Extension program.
   - Performance monitoring and data collection: Track program indicators (e.g., number of farmers reached, adoption rates of new practices) to measure progress towards objectives.
   - Benchmarking: Compare program performance against established standards or similar initiatives to identify areas for improvement.
3. **Economic Evaluation:**
   - Cost-effectiveness analysis: Compare the costs of different E-Extension delivery methods or program components to their respective outcomes to identify the most efficient approach.
   - Return on investment (ROI) analysis: Calculate the financial returns generated by the E-Extension program relative to the costs incurred, helping to assess its economic viability.
4. **Qualitative Methods:**
   - Focus group discussions (with a focus on program experience): Explore participant experiences, perceptions, and satisfaction with the E-Extension program.
   - In-depth interviews: Conduct detailed interviews with key stakeholders to gain a deeper understanding of program processes, challenges, and successes.
   - Document review: Analyze program documents, reports, and other materials to assess program design, implementation, and monitoring processes.

5. Participatory Evaluation:

- Participatory Rural Appraisal (PRA): Engage stakeholders in a collaborative process of data collection, analysis, and interpretation to assess program relevance and impact.
- Community scorecards: Empower communities to assess and monitor program performance using a set of pre-defined indicators, promoting transparency and accountability.

The choice of evaluation tools will depend on the specific objectives of the evaluation, available resources, and the nature of the E-Extension program. A combination of these tools can provide a comprehensive picture of program implementation, effectiveness, efficiency, and relevance, enabling informed decision-making for program improvement and future planning.

Conclusion

Evaluation and impact assessment play a vital role in ensuring the success and sustainability of E-Extension initiatives. They provide evidence-based insights that inform program design, implementation, and scaling up. The findings from evaluation and impact assessment studies have implications for policymakers, extension agencies, researchers, and other stakeholders involved in agricultural development. They can guide policy formulation, program improvement, capacity building, and knowledge sharing in the field of E-Extension.

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