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Information Communication Technology Tools for Animal Husbandry Technology Dissemination

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ABSTRACT

In the Indian economy, the livestock sector contributes 4.9% of the overall GDP, accounting for around 30.13 per cent of the country's agricultural GDP. India has the worlds largest livestock population, but the average animal productivity is low; yet demand for livestock products is rising steadily, and customers' awareness of quality has also increased. Therefore, it is necessary to refocus the production system by figuring out what information cattle farmers currently need. The animal husbandry department can only meet some livestock farmers' information needs. A multi-stakeholder online network across the livestock value chain is required to meet these information needs. Systems with ICT capabilities are better suited to deal with these problems. Radio,

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television, mobile, fixed, computer and network hardware and software, satellite systems, and video conferencing are all considered part of information and communication technology (ICT), a broad term covering any communication device or application. These include delivering information in the form of audio, data, video, and images, among other things. It is very beneficial for boosting the economy, creating jobs, developing rural areas, and reducing poverty. In modern times, ICT has become essential to the development of cattle. This article discusses using ICT technologies to spread animal husbandry technology among Indian farmers.

Keywords: Information needs; livestock; mobile telephony; social media.

1. INTRODUCTION

The livestock sector in India has undergone a significant transformation, transitioning from a subsidiary component of agriculture to a vital source of livelihood in various regions across the country. This sector is increasingly recognised as a means to enhance the livelihoods of rural populations and peri-urban livestock keepers. The livestock sector is a significant source of income and employment for many individuals residing in rural and peri-urban regions [1]. Livestock keeping offers an additional advantage in terms of household nutritional outcomes. It is common practice in India to rear livestock within mixed farming systems, wherein animals typically serve diverse functions. In previous eras, they represented affluence and played a crucial role in facilitating agricultural endeavours. Recently, the utilisation of draught animals in agriculture has significantly declined due to mechanisation. Consequently, the primary purpose of raising cattle and buffalo has shifted towards milk production.

Nevertheless, in regions where agricultural mechanisation has yet to be implemented, bovines remain a significant provider of draught power, dung, and milk. Livestock activities are typically incorporated within established farming systems, wherein animals can graze on fallow land and browse on hedges. Additionally, they use crop residues as feed sources, generate milk and meat products, and manure for biogas production and power for traction purposes. Sheep and goats are typically maintained in grazing systems with minimal reliance on supplementary feed derived from domestic food waste. In most instances, women assume the role of caretakers for sheep and goats within the household, with children frequently participating actively in their supervision. Engagement in backyard poultry is a significant endeavour for women residing in rural areas, as it contributes to generating monetary resources and offers employment prospects. Simultaneously, it enhances the accessibility of meat and eggs, augmenting household nutritional status [2].

2. THE ECONOMIC SIGNIFICANCE OF LIVESTOCK

The current livestock population in India stands at 536.76 million, indicating a growth rate of 4.8 per cent compared to the livestock census conducted in 2012. According to FAO [3] report, the total cattle population is 193.46 million. The buffalo population is 109.85 million, while the sheep population is 74.26 million. The goat population is 148.88 million, and the poultry population is significantly higher at 851.81 million. Lastly, the swine population is noted to be 9.06 million. The aggregate milk production within the nation amounts to 221.06 million tonnes. According to Ingavale [4] report, India holds the top globally in total milk production. Milk production has experienced a growth of 5.29 per cent compared to the preceding year. According to the latest data from FAO [3], the per capita milk availability in India for 2021-22 was 444 g per day. The poultry industry has experienced significant growth due to favourable government policies supporting commercial poultry production and the emphasis on the family poultry system, effectively addressing livelihood concerns. In 2021-22, the aggregate egg production in India amounted to 129.60 billion. According to Ingavale [4] India holds the third position globally regarding overall egg production. In the year 2021, egg production has grown 6.19 per cent compared to the preceding year. In India, eggs' annual per capita availability is reported to be 95. The aggregate meat production within the nation amounts to 9.29 million metric tonnes. India is the eighth most significant global contributor to total meat production [4]. Meat production has experienced a 5.62 per cent increase in 2021-22 compared to the preceding year. The annual per capita meat availability is 6.82 kilograms.

The livestock industry can offer financial opportunities, generate employment, and enhance nutritional well-being for many farmers, a potential that remains to be mainly explored [3]. In the year 2021-22, the livestock industry in India accounted for 4.9 per cent of the Gross Value Added (GVA), representing a significant portion of 30.13 per cent of the GVA within the agricultural sector. While the agricultural and allied sector's contribution to the national Gross Domestic Product (GDP) has experienced decline over the past few decades, the contribution of the livestock sub-sector has remained relatively consistent [3]. Bhattu et al. [5] asserts that the dairy sector in India exhibits a significant presence of cattle but suffers from low productivity. India has the largest dairy animal population; however, the average productivity of these dairy animals remains relatively low. Nevertheless, the country has a consistent and growing demand for milk. To achieve this, it is necessary to enhance the current annual growth rate of milk production from 2.5 per cent to 5.0 per cent [6].

Empirical evidence suggests that livestock play a significant role in the agricultural system, offering an additional source of income and nutritional support to a considerable portion of the rural population, particularly those belonging to disadvantaged and impoverished households [7-10]. According to Taneja and Birthal [11]; Ali [12] the equitable nature of livestock distribution, as a form of liquid asset among impoverished households, surpasses land. The current growth trajectory in the livestock sector indicates the necessity of reorienting the production system to meet the increasing demand for livestock-based products in domestic and global markets. This entails improving efficiency and fostering a focus on quality. According to Verbeke, [13], the heightened consumer apprehensions regarding the safety of animal-based food products have resulted in a surge in the need for comprehensive information and transparency within food supply chains. These concerns have played a pivotal role in driving the advancement of traceability systems. According to Adhiguru et al. [14], farmers seek diverse sources of information to effectively perform their production and marketing responsibilities and guarantee safe and high-quality products to consumers.

The significance of information and knowledge has experienced a notable rise within the food and agriculture domain, specifically in the livestock-oriented high-value agriculture sector. The dynamic nature of the environment requires incorporating information and knowledge as essential elements in making effective decisions [14-15]. Most developing nations widely regard access to improved agricultural technologies and practices as a public good. The public sector commonly utilises agricultural extension services as a prominent approach to disseminating knowledge [16]. However, the need for more emphasis on the distribution of knowledge of livestock production has been a recurring issue within centralised extension services in developing countries [17]. In India, the public sector has been responsible for providing veterinary services. However, state governments' financial constraints have hindered efforts to increase reach on livestock services and improve the quality of service delivery [18-19].

3. INFORMATION NEEDS OF LIVESTOCK FARMERS

Conventional methods such as pamphlets, posters, and folders are currently being utilised to distribute livestock-related information to farmers. Within this particular system, there exists a temporal discrepancy in the transmission of information to agricultural practitioners. The exponential expansion of Information and Communications Technology Systems has fundamentally transformed the landscape. Connecting two computers from any global location has become a straightforward endeavour. Numerous information and communication technology (ICT) projects have been initiated by governmental entities, non-governmental organisations (NGOs), and private enterprises. The progressions in Information Communication Technology (ICT) have the potential to enhance and support extension initiatives aimed at facilitating the transfer of technology. Farmers possess distinct information requirements. The primary objective of information and communication technology (ICT) in the animal husbandry domain revolves around addressing farmers' informational requirements. The subsequent needs are several essential requirements of farmers that appear to be crucial for the advancement and progress of livestock [20].

- The continuous progression of technology leads to the development and enhancement of livestock machinery and techniques. Staying informed about the latest advancements in animal husbandry technologies is crucial for facilitating growth and development.

- ICTs provide comprehensive information regarding government initiatives aimed at animal husbandry and rural development for the intended beneficiaries of these programmes. Regions that experience droughts, floods, or other natural disasters are often granted financial assistance and subsidies by the government. Knowledge acquisition about these programmes is relevant to small-scale and economically disadvantaged farmers.
- Weather forecasting provides up-to-date data about atmospheric conditions, including temperature, humidity, and precipitation forecasts. During the monsoon season, there is a higher prevalence of diseases such as Haemorrhagic Septicemia (HS), Foot and Mouth Disease (FMD) and Brucellosis (BQ), emphasising the importance of early detection and effective disease management strategies.
- The significance of post-harvest technology and storage education is comparable to that of pre-harvest education. Farmers are becoming increasingly cognizant of incorporating value-added food processing techniques.
- Input prices and availability: This section encompasses data about the accessibility of livestock inputs such as improved breeds, fodder seeds, health supplements, deworming and vaccination drugs, and other related items, along with their corresponding prices.
- Comprehensive overview of Livestock Insurance: Elaborate insights into various livestock insurance schemes, inclusive coverage of damages, compensation packages, and associated premium obligations, among other pertinent details.
- Market information: Daily updates on agricultural and animal husbandry commodity prices in neighbouring districts. Farmers prioritise receiving price updates from markets outside their villages to compare prices and make informed decisions about where to sell their produce.

The resolution of these information needs necessitates collaboration between multiple departments and involvement of experts in animal husbandry. Establishing an online network comprising multiple stakeholders within the livestock value chain is imperative to effectively address the information requirements of farmers, both present and future. Information and Communication Technology (ICT) enabled systems are better suited to meet the information requirements of various client groups.

4. ROLE OF ICT IN ANIMAL HUSBANDRY

ICTs are crucial in facilitating effective communication and knowledge exchange among animal husbandry researchers, extension agents, and farmers. This integration helps to bridge the gap between these stakeholders and ultimately leads to improvements in livestock production [21].

- Promoting environmentally sustainable farming practices can be facilitated by utilising ICTs. These technologies enhance accessibility to climate-smart solutions and provide farmers with the necessary knowledge to implement them effectively.
- ICTs are crucial in disaster management and early warning systems by delivering timely and practical information to communities and governments. This information enables proactive measures for disaster prevention and offers guidance on effective risk mitigation strategies.
- ICTs are crucial in improving market access by enabling easier entry into markets for inputs and products. This is achieved through various means, such as facilitating the marketing and trade of goods and services.
- ICTs are crucial in enhancing food safety and traceability by facilitating the delivery of more efficient and reliable data to meet international traceability standards.
- ICTs are crucial in enhancing financial inclusion by facilitating access to financial services for rural communities. This increased accessibility enables individuals to safeguard their savings, obtain affordable insurance, and acquire tools that enhance their ability to manage risks effectively.
- The utilisation of ICTs facilitates the expansion of local communities, particularly among women and youth, by increasing access and opportunities. This, in turn, leads to the development of new avenues for economic growth, ultimately improving the overall quality of life.

- ICTs play a crucial role in facilitating the implementation of regulatory mechanisms and policies and providing frameworks for monitoring and evaluating progress.

5. INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) CONCEPT AND IMPACT

The term "information communication technologies" (ICT) is presently employed to encompass a broad array of services, applications, and technologies that utilise diverse equipment and software, frequently operating over telecommunication networks. The significance of information and communication technologies (ICTs) lies not solely in the technology itself but also in its facilitative role in enhancing access to knowledge, information, and communication. These elements have become increasingly vital in contemporary economic and social interactions.

Information and Communication Technology (ICT) is a technological instrument that facilitates effective generation, retention, administration, and dissemination of information via electronic methods. Information and Communications Technology (ICT) encompasses various technologies that enable information storage, manipulation, and transmission. Information and Communication Technology (ICT) encompasses diverse technologies, such as desktop and laptop computers, software applications, peripheral devices, and access to the internet. The technologies mentioned in the study by Laurantine [22] have been specifically developed to enhance the efficiency of information processing and communication tasks. The term "Information and Communication Technology (ICT)" refers to a broad array of communication devices and applications. This encompasses various technological devices and systems, such as radio, television, cellular phones, computer and network hardware and software, and various satellite systems. Furthermore, Information and Communication Technology (ICT) encompasses various services and applications linked to these technologies, such as videoconferencing and remote education.

Sasidhar and Sharma [23] assert that adopting Information and Communication Technology (ICT) tools can significantly impact the economic landscape of India's livestock, agriculture, and rural artisans. According to Tiwari et al. [24], it is recommended that the livestock industry should focus on the development of computer software and other electronic materials that are tailored to address specific requirements, geographical contexts, and linguistic diversity. The recommended resources should prioritise topics such as the control of livestock diseases, the management of dairy herds, the production of livestock, and the marketing of livestock and its associated products. Integrating information and communication technology (ICT) in the livestock industry holds significant promise for enhancing decision-making processes and improving the quality of livestock farming systems. The importance of information is growing in many developing countries due to the expansion of crop and livestock production systems, along with the increasing market demand for animal-based products [17]. The importance of information and communication technology (ICT) enabled livestock advisory services in disseminating knowledge to farming communities, intending to facilitate informed decision-making at the farm level, has become a critical factor in the process of structural transformation and potential expansion in high-value agricultural products [25].

The potential of livestock innovations to drive progress will only be tapped if farmers embrace them and effectively disseminate them through appropriate channels to those who require them. The utilisation of contemporary information and communication technology (ICT) tools in disseminating information to farmers can enhance the farmers' knowledge, ideas, and skills. However, it is imperative to ensure that pertinent and timely information is effectively disseminated to targeted farmers [26]. Adejo and Haruna [27] categorised information and communication technology (ICT) into two main groups: conventional ICT, which includes radio and television, and contemporary ICT, which encompasses telephones and computers/internet. Information and Communication Technologies (ICTs) are the fundamental building blocks of the emerging global economy that heavily relies on information [28]. The role of these factors in driving global socio-economic growth is steadily increasing. The documented literature has highlighted the capacity and immediacy of information sharing at a minimal cost [29].

5.1 Radio

Specific communication channels may not be readily available or accessible to rural farming

communities. Community radio plays a substantial role in disseminating information to rural farmers with limited literacy skills, as it offers an affordable and easily accessible platform. The communication tool possesses significant efficacy in reaching farmers who lack consistent and reliable access to electricity, as it can function through battery power. Furthermore, due to its portability, farmers can conveniently carry this medium to their work locations, enabling them to listen to radio stations while performing tasks. According to Nirmala [30], community radio serves the diverse needs of the country's national, local, and rural populations due to its adaptability, ability to provide timely information, and significant potential. Since its establishment in 1927, All India Radio has been catering for various public needs. It operates 96 stations and is crucial in disseminating information to the farming community through its Kisanvani programme. However, a notable contemporary development is the emergence of community radio stations demonstrating commendable efficacy in disseminating livestock-related information to their respective communities. Based on the Compendium 2012 published by the Ministry of Information & Broadcasting [31], it has been reported that 126 operational community radio stations are currently broadcasting their programmes in India.

According to Anifowose [32], communication encompasses the systematic transmission of information and comprehension between individuals. Human interaction and group functioning are fundamentally reliant on this principle. Radio is a communication medium commonly utilised by development officers or experts in the field of development communication. It serves to disseminate pertinent development messages, mainly targeting rural audiences effectively. He further posits that radio possesses a multitude of facets, encompassing various functions and attributes. The utilisation of communication technology can facilitate the transmission of messages, enhance the ability to assemble and coordinate groups and organisations, expand the platform for societal discourse, effectively enhance the community's capacity to raise awareness and knowledge regarding community matters, elevate the representation of citizens within the political hierarchy, and mobilise the community to address pertinent issues. A study conducted by Ariyo et al. [33] investigated the impact of mass media on the diffusion of agricultural technologies among farmers in the Kaduna North Local Government Area of Kaduna State. The study's findings indicated that the participants exhibited varying access levels to different forms of mass media, including radio, television, telephone, internet, and newspapers/bulletins. Nevertheless, it was discovered that radio proved to be a more readily available and primary conduit for disseminating livestock technologies to farmers.

5.2 Television

Television is an electronic medium that utilises audio and video to broadcast programmes to a broad audience. This medium has a global reach and is particularly effective in communicating with a large and geographically dispersed population, including those residing in remote areas. In their study, [34] found that most viewers perceived DD Kisan to be moderately effective in their efforts to obtain agricultural information. Regarding knowledge, 52.00 per cent of viewers demonstrated a high level of knowledge. Conversely, in terms of adoption, 50.40 per cent of viewers were classified within the medium adoption category. Therefore, it can be inferred that most viewers possessed a substantial level of knowledge and exhibited a moderate level of technology adoption. The effectiveness of DD Kisan was observed concerning the acquisition of knowledge and the level of technology adoption. According to research conducted by Nazari and Hassan [35], mass media platforms provide influential means of disseminating agricultural messages and relevant information, thereby contributing to the development of farmers' capacity building. The broadcast media possesses the capacity to efficiently distribute information to a vast audience, with television being a particularly prominent channel of choice among farmers. According to Omotayo [36], television possesses visual and auditory components, making it a valuable tool for extension work in demonstrating technologies and training purposes. According to Mahmood and Sheikh [37], television is significant in generating awareness and disseminating knowledge regarding the latest agricultural technologies among farmers. In a study conducted by Nazari and Hassan [35] regarding the role of television in enhancing farmers' agricultural knowledge, it was observed that there was a notable increase in farmers' awareness levels, from 3.73 to 6.26. This finding underscores the effectiveness of television as a means to elevate farmers' knowledge and

highlights its utility in disseminating agricultural knowledge to this target audience.

5.3 Touch Screen Information Kiosk

The touchscreen monitor is outfitted with educational modules centred on livestock farming, comprising textual content, visual images, graphical representations, and audio files. Users are able to access up-to-date information of all facets of livestock production and management. The multimedia content of the user interface presents information on a visually appealing screen, accompanied by a voice interface to cater for individuals who cannot read. This feature is available in English and local language [38]. A study by Ramkumar [39] revealed that introducing touch screen information kiosks at the Veterinary Institution of Pondicherry yielded positive outcomes for farmers. These demand-led information deliveries facilitated disease prevention and improved animal health, resulting in time, labour, and financial savings for this marginalised population. Various information kiosks developed by veterinary organisations are Information Kiosk on Dairy Management, CVAS, Mannuthy; The Livestock Guru, Orissa; Dairy Information System Kiosk(DISK), Anand; Information Kiosk on Livestock Production Management-SVVU [38-41].

5.4 Multimedia Modules (CD/DVD)

The acquisition of scientific knowledge through training is of paramount importance for the success of any enterprise. Successful dissemination of knowledge and widespread adoption of technology necessitates the use of effective communication strategies. To enhance the knowledge of dairy farmers regarding the adoption of an innovative approach, practical communication tools are essential for extension workers to address the challenges posed by illiteracy and traditional practices prevalent among farmers with limited resources [42]. The CD-ROM is a storage medium that, when used in conjunction with a microcomputer, provides expedited access to a substantial amount of data, including text, sound, computer graphics, animation, slides, and motion video, all of which are synchronised. CD-ROMs possess several additional benefits, including their substantial storage capacity, robustness and data security, convenient portability, user-friendliness, and notably affordable cost, making them suitable for various stakeholders. The multimedia CD-ROM, also known as compact disc-read-only memory, is a widely utilised electronic medium that facilitates enhanced learning experiences through its engaging, multisensory nature, resulting in a lasting impression on the learner. Moreover, it possesses the capability to decrease both the cost and time associated with the activity above. As a pedagogical tool, it facilitates the dissemination of precise information. When these resources are meticulously prepared, they can be efficiently replicated and disseminated for educational purposes among more significant segments of the population within a relatively brief timeframe. In a study conducted by Vidya and Manivannan [43] regarding creating an educational interactive video CD-ROM focused on dairy health management practices it was evident that the video CD-ROM effectively fulfilled its objective of enhancing the respondents' awareness and knowledge. The average knowledge score prior to exposure was 7.98, while the average knowledge score following exposure nearly doubled, with a mean value of 14.91.

According to findings of Madhu and Verma [44], there was a significant increase in the knowledge score of the respondents from 5.74 ± 0.14 to 12.68 ± 0.14 after being exposed to a CD on calf management. This result suggests that the CD was effective in facilitating educational gains. Singh [45] conducted a study in which participants were exposed to a CD-ROM on dairy enterprises. The initial score reported was 10±0.48, and the final score was 15.42 ± 0.4. Additionally, the study found that the average impact of learning from the CD-ROM was 58.12±6.07. According to the findings by Block [46], who created a CD-ROM on nutrition, approximately 80% of the participants (n = 284) indicated that they acquired new knowledge regarding nutrition. According to Nirmala et al. [10], there was an observed increase of 71.66 per cent in knowledge pertaining to various aspects of dairy farming.

5.5 Interactive Expert Systems

Numerous institutions globally have undertaken inquiries into the application of information technology, particularly expert systems, in disseminating information and knowledge related to livestock management, with a specific emphasis on animal management and the dairy industry. The Interactive Expert module facilitates the acquisition of domain-specific expertise by involving human experts. The acquired knowledge undergoes analysis and subsequent

processing to derive the most optimal conclusion for the specific problem at hand. The knowledge that has been obtained is subsequently conveyed to experts in information systems for validation and transformation into a programme for an expert system. Following the validation of knowledge acquired from domain resources by experts in information systems, it is subsequently transferred from the Interactive Expert module to the expert system programme module in order to be transformed into an expert system programme. Expert systems are computer programmes that are specifically developed to tackle problems or offer guidance in specialised domains [47]. In the realm of animal husbandry, a computer programme has been developed to methodically store the specialised knowledge possessed by an expert in the field of disease. This software application enables users, including farmers and extension workers, to input symptoms in textual or digital images. The computer assists the user in diagnosing the issue and subsequently provides recommendations for appropriate preventive and curative measures, considering the severity and stage of the problem. Expert systems possess the capacity to be employed in both online and offline modalities. Within the realm of online platforms, users possess the capability to interact with expert systems that esteemed research organisations have developed. The primary purpose of these systems is to diagnose issues encountered in the field and offer valuable guidance to farmers. Several ICAR institutions are presently involved in creating specialised expert systems designed for particular animal species to support field personnel. Two expert systems have been developed at the Indian Veterinary Research Institute, Izatnagar, for animal health management, specifically for animal disease diagnosis. These systems include an interactive software designed for Para-Veterinarians and stockmen, titled "Animal Health Information System in English," as well as another type of software developed for farmers in Maharashtra, titled "Health information system for dairy animals" in Marathi [48]. The Expert System for Dairy Cattle Management developed by KVK, ICAR-CTRI in Rajahmundry, the Poultry Expert System from the College of Veterinary Science in Hyderabad, and the Information System on Organic Livestock Farming (ISOLF) are notable examples of expert systems in the field of livestock management. Another relevant system is the Dairy Rationing System for the Tropics (DRASTIC) [49-51].

5.6 Video Conferencing

Video conferencing (VC) refers to conducting remote meetings between two or more individuals who are physically located in different locations. It refers to the utilisation of telecommunication technologies to conduct a videoconference. This enables individuals situated in two or more different locations to engage in simultaneous two-way communication through the transmission of video and audio signals. Similar to other long-distance communication technologies, such as telephones and the internet, this particular technology not only facilitates remote interactions but also plays a role in mitigating carbon emissions, consequently aiding in the mitigation of global warming.

The Village Resource Centre, a satellite communication application, offers several advantages compared to other mass media platforms such as radio and television. Unlike one-way communication channels, such as radio and television, the Village Resource Centre facilitates two-way audio and video conferencing, enabling farmers to receive information and actively communicate. The study's findings indicate that interactive video conferencing can significantly enhance farmers' understanding of diverse animal husbandry practices. Virtual Research Centres (VRCs) facilitated farmers in accessing reliable information directly from experts affiliated with various research centres within their village through a two-way interactive mode. This has resulted in a reduction of both time and expenses associated with travel. Similarly, rapid dissemination of location-specific new technologies to rural farmers is possible [52].

5.7 Web Portals

Web portals, also known as online portals, serve as a gateway or entry point to various information and services. The utilisation of the internet has significantly revolutionised communication among diverse individuals across the globe. The transmission of a message via the internet enables its rapid dissemination to any location worldwide within seconds. Therefore, it facilitates the acquisition of up-to-date information on contemporary occurrences. The internet provides convenient access to significant agriculture and animal husbandry information.

Additionally, the internet can be utilised for conducting livestock business transactions, including procuring and selling livestock inputs [53]. The term "World Wide Web" (WWW) denotes the assemblage of data and resources that can be accessed via the internet. The data is presented in various formats, including text, images, and audio, and is organised and stored on computer systems referred to as web servers.

Perusing the World Wide Web for necessary information is frequently employed as predominant method of accessing information on the internet. Scientists, students, extension functionaries, traders, and farmers can efficiently access necessary information within a brief period if it is readily accessible on the internet. The ICAR institutes and State Agriculture/Veterinary Universities (SAUs) are responsible for hosting and uploading information on crop/veterinary science and scientific management practices. Similarly, the relevant state or central government departments are responsible for hosting information on government programmes, projects, and schemes. All pertinent details regarding the Government of India's centrally sponsored schemes, namely "Support to the State Extension Programmes for Extension Reforms," "Mass Media Support to Agriculture Extension," and "Agri clinics and Agribusiness Centres" can be found on the website of MANAGE (National Institute of Agricultural Extension Management) at www.manage.gov.in. Other examples are TNAU agritech portal, Kerala Veterinary Animal Sciences University (KVASU) portal, KRISHI (Knowledge resources and information system hub for innovations) portal, NLM portal, APEDA portal, etc.

6. WEB PORTAL FOR MARKET INFORMATION

6.1 e-Choupal

In the Indian context, e-Choupal serves as a trading platform that effectively minimises transaction costs by establishing a connection between buyers and farmers through the utilisation of Internet kiosks. Furthermore, e-Choupal extends its services to farmers by providing valuable resources, including disseminating best practices to enhance productivity and the facilitation of price benchmarking to augment sales prices [54].

6.2 Agrisnet

The AGRISNET project, which the Department of Agriculture and Cooperation financially supports under the Ministry of Agriculture of the Government of India, aims to establish an Agricultural Resources Information System and Networking. Following this framework, a majority of the State Governments have developed agricultural websites that are abundant in information. Some examples of agricultural portals include Sikkim AGRISNET, accessible at http://www.sikkimagrisnet.org, the Andhra Pradesh agri-portal, available at http://www.apagrisnet.gov.in,and the Uttar Pradesh (UP) Agrisnet Knowledge Portal, accessible at http://agriculture.up.nic.in. Various initiatives have been implemented by the central government and state governments, such as ASHA in Assam, KISSAN (Karshaka Information System Services and Networking) and e-Krishi in Kerala, and Krishi Maratha Vahini in Karnataka [54]. These initiatives are designed to address the challenges encountered by the agricultural and allied sectors in the country. The effectiveness of these initiatives has been diverse, yielding different levels of success. In order to enhance knowledge acquisition from previous experiences, integrate on-going diverse and fragmented initiatives, and expand their scope to encompass the entire nation, the inclusion of Agriculture as a Mission Mode Project (MMP) in the National eGovernance Plan (NeGP) has been undertaken. The Department of Agriculture and Cooperation (DoA&C) is responsible for implementing this initiative. The services commonly associated with the Agricultural Mobile Messaging Platform (MMP) encompass various aspects, such as providing farmers with information pertaining to seeds, fertilisers, pesticides, government initiatives, soil recommendations, crop management, weather conditions, and marketing of agricultural produce. The Department of Agriculture and Cooperation (DoA&C) has implemented a dual approach to lead the Market Modernization Programme (MMP) implementation in the agricultural sector. This approach involves the utilisation of AGRISNET, as well as two portals known as AGMARKNET and DACNET. The AGMARKNET portal facilitates the dissemination of information pertaining to approximately 300 commodities across 2000 *mandis* (markets). The data is consistently refreshed and sourced directly from the financial markets. The DACNET portal offers subject-specific and crop-specific information sourced from multiple Directorates

operating under the Department of Agriculture and Cooperation [55].

6.3 Kisan Call Centres

The Kisan Call Centres (KCC) were established in India on January 21, 2004 by the Department of Agriculture & Cooperation (DoA&C), a governmental body operating under the Ministry of Agriculture, Government of India. The principal aim of these call centres is to provide farmers nationwide with online agricultural advice and information. Farmers can access this service through a toll-free telephone number, specifically 1551. Farmers, regardless of their geographical location within state, have the opportunity to engage with the appropriate state call centre [54]. This call centre employs experts who are proficient in the native language of the farmers, ensuring that they receive responses tailored to their linguistic needs.

The primary objective of these call centres is to address concerns raised by farmers in their native language promptly. Call centres are established in each state to manage incoming communication from various regions nationwide. These call centres are dedicated to addressing inquiries pertaining to agriculture and its related sectors. The Farmer Call Centre represents the integration of two previously distinct technologies: Information and Communication Technology (ICT) and Agricultural Technology. Both entities possess distinct areas of expertise and operate within unique organisational cultures. In order to effectively leverage the respective advantages of these systems, it was suggested to fully capitalise on the professionally managed Call Centre mechanism and integrate it with the specialised knowledge of Agricultural Scientists and Extension Officers. This integration aims to enhance the accessibility of information and services to the farming community. The proposal suggests utilising the pre-existing specialised infrastructure of Call Centres, which typically cater to high-end and often mission-critical services in various industries. This infrastructure would be made accessible to Subject Matter Specialists in fields such as Agriculture, Horticulture, Animal Husbandry, Marketing, and other related areas. The Farmer Call Centre is structured into three tiers: Level-I, Level II, and Level III. Level-I serves as the primary Call Centre interface, equipped with high-quality bandwidth and staffed by Agriculture/Veterinary Graduates proficient in the local language. Level II consists of Subject Matter Specialists knowledgeable in specific important agricultural enterprises. They are connected through reliable telecom and computer connectivity. Level III comprises the Management Group, responsible for addressing and resolving farmers' unresolved queries at Level II. This group operates in an offline mode [43].

6.4 Mobile Telephony

In order to address the information needs of livestock farmers, recent advancements in Information and Communication Technologies (ICTs) have created a favourable environment for adopting new technologies and enhancing instructional methods more effectively and interactively. Among various ICTs, mobile telephony has experienced significant growth in rural areas. Mobile phones have successfully bridged the rural digital divide, resulting in tangible economic benefits and serving as agents of social mobilisation through improved communication. A study conducted by Mittal [56] examined the impact of mobile phones on the agriculture and animal husbandry sectors, explicitly focusing on small farmers in India. The primary finding of this research indicates that mobile phones can catalyse revitalising extension services in the country.

Mittal and Tripathi [57] argue that using mobile phones allows farmers to bridge the information gap and alleviate its effects. Furthermore, the availability of mobile-enabled services holds promise for improving the extension system. Providing information through mobile phones significantly impacts farm output in areas where unfavourable biotic and abiotic conditions hinder cultivation. Gupta [58] suggests that timely interventions, facilitated by appropriate prescriptions delivered via mobile phones, can yield increases ranging from 10.00 to 25.00 per cent.

A significant proportion of livestock owners using mobile phones to acquire information and services pertaining to animal husbandry surpass that of other information and communication technology (ICT) tools. Mobile phones can potentially assume a central role in disseminating livestock-related information among livestock owners. The substitution of phone calls for travel has enhanced safety, yield time, and cost savings while mitigating the perishability of farm goods for farmers [59]. When considering factors such as cost, geographic coverage, and ease of

use, mobile phones emerge as exclusive "accessible device", compared to alternative options [60].

One of the primary benefits associated with the utilisation of mobile phones is their capacity to serve as a medium for the exchange of information through various means such as phone calls, SMS messages, and Internet connectivity. Incorporating mobile phones into daily life enhances accessibility to information while concurrently reducing the associated costs [61-62]. Using mobile phones enables farmers to obtain timely and reliable information, thereby facilitating cost and time savings and mitigating the perishability of certain agricultural and livestock products. This is particularly crucial within the context of agribusiness. It has been observed that the adoption of mobile phones by farmers leads to significant economic benefits, as they are able to optimise transportation expenses, minimise time constraints, and mitigate the spoilage of farm produce [59]. According to Chisita [63], the utilisation of mobile information and communication technologies (ICTs) has significantly influenced the accessibility of market information, weather updates, and other vital services. This is primarily due to the convenience of accessing such information through mobile phones.

Illahiane [64] noted that using mobile phones has significantly enhanced farmers' ability to access, exchange, and manipulate information. This is due to the transformative effect of mobile phones on farmers' interactions with markets and cities and their capacity to provide up-to-date and relevant information crucial for decision-making. Masuki et al. [65] further emphasise the prevalence of mobile telephony as the primary mode of communication in developing countries. They assert that mobile phones are revolutionising users' lives in these countries and are widely acknowledged as current and future technological platforms for development. Masuki et al. [65] also highlight the importance of mobile phones for development, as they offer their owners advantages such as mobility and security. Additionally, mobile phones are flexible and require only basic literacy, making them accessible to many of the population.

6.5 m-KISAN

The m-KISAN platform is a mobile-based agricultural information system that aims to provide farmers access to relevant and timely information. The KVK Kisan Mobile Advisory Services (KMAS) initiative involves using a text message platform to disseminate information to a large number of registered farmers in a district. This platform is utilised during essential livestock production periods to provide specific operational guidance and weather alert messages. According to a study conducted by Reddy [66], a total of 2436 farmers in Chittoor district were enrolled in the Kisan Mobile Service provided by the KVK. These farmers receive regular SMS messages, at a frequency of two per week, on various topics, including weather forecasts, disease alerts, and marketing information. The farmers highly value this service as it provides timely information regardless of their geographical location, enabling them to plan their agricultural activities accordingly. Consequently, the mobile advisory service effectively delivers pertinent information to the appropriate individuals at the right time and place, thereby enhancing agricultural productivity.

6.6 Mobile Applications

The prevalence of mobile applications has witnessed a significant increase in the contemporary digital environment. These software applications are commonly known as mobile applications. Various organisations have developed many mobile applications specifically tailored to the agricultural community in India [67]. The eNAM app, developed by the Small Farmers' Agri-Business Consortium in 2019, aims to enhance the convenience of remote bidding for traders and provide farmers and other stakeholders with easy access to information regarding arrivals and prices through their smartphones. Farmers can access a comprehensive compilation of e-NAM *mandis* categorised by state, detailed information on arrivals specific to each *mandi*, and the minimum and maximum prices currently in effect within each *mandi*. The IVRI Vaccination Guide App, developed by ICAR-IASRI in 2019, aims to provide education and training to individuals such as Graduating Veterinarians, Field Veterinary Officers, Paravets, and Livestock Owners regarding the process of vaccinating livestock. The application offers fundamental knowledge regarding livestock vaccination, encompassing a comprehensive range of bacterial and viral diseases. The App, developed by Soumen et al. [68] provides comprehensive details regarding the causative agents, available types of vaccines, strains utilised for vaccination, recommended vaccination schedules, and

commercially accessible vaccines for each disease across different species.

The KVK Mobile App was developed on December 21, 2016, through collaboration between the ICAR-Indian Agricultural Statistics Research Institute and the Agricultural Extension Division, ICAR. The primary objective of this system is to optimise the communication of information from Krishi Vigyan Kendras (KVKs) to farmers, ensuring effectiveness and efficiency in the process. The application provides a range of functionalities, including the provision of fundamental information regarding KVK facilities, the display of both upcoming and previous events organised by KVKs, the provision of guidance on animal husbandry practices, the facilitation of access to agro-meteorological advisory services, and the display of market prices for agricultural commodities [68]. Furthermore, users possess the capability to submit inquiries pertaining to farming to professionals and obtain resolutions. This mobile application is a valuable instrument for disseminating timely and pertinent information directly to the agricultural community.

The application of INAPH (Information Network for Animal Productivity and Health) is being discussed. The IT application is a desktop or Android-based system designed to effectively capture real-time and dependable data on nutrition, breeding, and health services provided to farmers directly at their location. This design aims to cater for the diverse information requirements of farmers, field technicians, and End Implementation Agencies (EIAs) such as Milk Unions/Federations, Producer Companies, analysts, and policymakers. The application can be utilised on both computer systems and handheld devices, specifically Android mobile devices, equipped with internet connectivity. The data obtained during fieldwork is stored in the central database at NDDB, Anand. When the network connection is unavailable, the system allows for the collection and storage of data, which can be synchronised with the central server later using the GPRS network. The INAPH system possesses the capability to transmit communications to farmers, delivering relevant guidance pertaining to their livestock as and when necessary. The managerial team and other decision-makers have access to web-based reports for the purpose of data analysis. The advantages of utilising this application are that the process of uniquely identifying animals and gathering information on their pedigree and lactation yields is of academic interest. They are maintaining comprehensive documentation pertaining to Breeding, Nutrition, and Health activities. This app helps to identify superior quality bulls and elite females. They monitor disease outbreaks and patterns across various species, breeds, villages, and districts. The increased health and productivity of animals have a positive impact on the financial earnings of farmers.

The e-Gopala application assists farmers in developing a well-balanced ration by utilising the feed ingredients that are currently available. This approach aims to optimise feed costs and enhance animals' productivity and reproductive performance. Additionally, the e-Gopala application assists farmers in obtaining information regarding *ayurvedic* (ethno) veterinary medicinal practises, frozen semen, IVF embryos, sexed sorted semen, and buying and selling bovines.

The Bhuvan app is an initiative undertaken by the National Remote Sensing Centre (NRSC) to develop a Geospatial Information and Communication Technology (ICT) application known as Agriculture Disease Surveillance. This application employe various open-source tools; including Open Layers, PHP, Geoserver, and Mapserver, to facilitate visualisation and uploading functionalities. The Bhuvan platform operates as a user-centric Spatial Mashup, enabling users to actively share, access, and upload disease-related information in real-time. Individuals possess the capacity to transmit data through the utilisation of the internet or mobile devices. This data is subsequently allocated geographical coordinates and exhibited within the Bhuvan Portal. Users of Bhuvan are also encouraged to provide feedback on the portal. The system functions through a crowd-sourcing methodology, enabling users to not only perceive the spatial arrangement of diseases but also to submit pertinent information concerning diseases. It is possible to upload multiple observations, although they must be uploaded individually. Presently, this tool serves as a mechanism for visually depicting reports on disease occurrence within a spatial framework. The procedure also includes provision of feedback and advisory services. Nevertheless, the implementation of these measures would rely on the identification of suitable experts. All users can access the data that the collaborators share.

6.7 Social Media

Social media encompass a range of internet-based digital platforms that facilitate the sharing and exchanging of information among individuals. The term "user-generated content" pertains to the information, opinions, videos, audio, and multimedia that are created and disseminated by users and subsequently shared and discussed across digital networks [69]. Social media platforms provide a means to cultivate interpersonal connections, disseminate information, and engage with a wide-ranging demographic that may not be encountered in person. The potential advantages of this endeavour can vary in magnitude, contingent upon the farmers' discretion in allocating their time and effort towards it.

WhatsApp provides numerous benefits in the domain of animal husbandry, facilitating both one-to-many and many-to-many forms of communication. Within this particular interest group dedicated to livestock farmers, veterinary doctors and scientists facilitate the provision of up-to-date information and schemes. Their primary objective is to assist farmers in remaining informed, particularly in instances of emergency health concerns pertaining to their livestock, by offering immediate first aid assistance. Typically, this technology consumes a reduced amount of internet data and offers convenience to even those farmers who may lack literacy skills, as it allows for communication through visual, auditory, and audiovisual messages. The tool exhibits a higher level of participation and responsiveness to user demands. The utilisation of social media tools for expanding its reach and engaging with farmers, partners, and other stakeholders has been an area of exploration for the Indian Council of Agricultural Research [70].

Singh and Khan [71] conducted a study examining the impact of Krishi Vigyan Kendra (KVK) on the dissemination of farming technologies through Information Communication Technology (ICT) tools. Their study's findings revealed that using ICT tools enables farmers to acquire information regarding various farm operations, address their concerns regarding livestock diseases, and gain immediate access to market-related information. The social media platform WhatsApp has facilitated the enhancement of digital literacy among farmers, enabling them to address agricultural challenges with increased efficiency. Most farmers indicated that the messages and advisories they received through ICT tools were comprehensible, satisfactory, and effectively addressed their challenges and issues within the expected timeframe. WhatsApp serves as a means of marketing and a platform that has fostered a support network within the farming community.

In their study, Shobha et al. [72] found that a significant proportion (96.84%) of livestock farmers relied on WhatsApp as a primary source for obtaining livestock-related information. This was primarily achieved through participation in various WhatsApp groups dedicated to livestock farming. Additionally, a substantial number of farmers (93.68%) utilised WhatsApp to converse with fellow farmers. Other purposes for using WhatsApp were also identified, albeit to a lesser extent. Farmers believed that they could utilise this particular information and communication technology (ICT) tool during their personal downtime at home or while engaged in animal husbandry activities. The study's findings indicate that a significant proportion of the participants (61.05%) expressed a positive inclination towards utilising WhatsApp to access livestock advisory services. This phenomenon could be attributed to Android phones' convenient availability, user-friendly interface, diverse information-sharing methods, and the instantaneous nature of receiving responses. Additionally, farmers are able to readily exchange experiences with their peers.

The global annual growth rate of social media users stands at 13 per cent, while in India, this rate is notably higher at 31 per cent. Within the animal husbandry sector, there has been a noticeable upward trend in the utilisation of social media platforms among various stakeholders. In contemporary times, agricultural practitioners have adopted the utilisation of various digital platforms such as Facebook, Twitter, and other analogous tools to acquire and distribute information. According to Dishant et al. [73], farmers use social media platforms such as Facebook to share visual representations of their farms, Twitter to facilitate product sales, and WhatsApp to establish connections with industry experts.

6.8 Impact Studies

According to a study conducted by Smita and Vasudha [74], it was found that a significant proportion of respondents in Pune district were knowledgeable about information and

communication technology (ICT) tools and actively employed them in their livestock farming activities. Specifically, over 70 per cent of the participants were reported to possess an awareness of these tools and effectively utilised them for the purpose of enhancing their livestock farming practices. Mobile phone, radio, television, and Whatsapp applications were identified as the predominant tools employed for information retrieval. Likewise, individuals frequently used Whatsapp and mobile devices in their daily routine. Information and Communication Technology (ICT) tools have been found to be beneficial in enhancing production by 51.66% and improving produce quality by 59.16%.

Godson et al. [75] reported that a significant majority of the participants, precisely 91.3%, possess and utilise mobile phones as a means to exchange, acquire, distribute, and transmit information. A total of 56.6% of the participants reported utilising radio as a source of information, while 60.00% indicated using the internet. Additionally, 61.3% and 41.3% of the respondents reported relying on television and newspapers, respectively. The data revealed that the participants did not extensively utilise laptops, digital cameras, and CD-ROMs, with only 37.3%, 14%, and 16.6% respectively utilizing them. This suggests that the transfer of information among respondents is facilitated by the widespread availability of information and communication technology devices in the region. ICT tools are of significant importance in the domain of livestock production, as evidenced by their mean score of 2.50, which is considered acceptable. The various roles encompassed in this context are the reduction of production costs (M = 2.80), the facilitation of livestock healthcare (M = 3.31), the tracking of animal whereabouts (M = 2.90), the provision of technical advice (M = 3.10), the dissemination of information on feeds and feeding (M = 2.80), the maintenance of record-keeping (M = 2.80), and the ability to forecast the incidence of diseases (M = 3.41), among other significant roles. The aforementioned underscores the significance of information within the realm of animal agriculture and the broader context of farming as a whole.

7. CONSTRAINTS PERCEIVED AND SUGGESTIONS MADE BY LIVESTOCK FARMERS IN UTILISATION OF ICTS

Sunil et al. [76] identifies several factors contributing to rural areas' limited adoption and utilisation of Information and Communication Technologies (ICTs). These factors include insufficient training and limited practical experience in the field of information and communication technologies (ICTs), coupled with a low level of ICT literacy, lack of awareness regarding the benefits of ICTs, inadequate skills in operating ICTs, financial constraints, unreliable power supply, low confidence in handling ICTs, expensive repair costs, limited availability of repair facilities in villages, high costs associated with acquiring ICT tools, inadequate network connectivity, insufficient support for regional specific languages, and a lack of access to diverse ICT tools.

Potential solutions to address constraints to the use of Information and Communication Technologies (ICTs) involve subsidising the procurement of ICT equipment, providing financial facilities, establishing low-cost repairing centres in rural areas, and fostering confidence through training and practical exposure to ICTs. This will significantly enhance the livestock sector's productivity, output, and profitability [76].

8. CONCLUSION

The utilisation of Information and Communication Technologies (ICTs) holds significant promise in effectively distributing substantial quantities of valuable information to farming communities. The information provided covers various subjects, such as markets, technologies, pricing, successful case studies, credit options, governmental services and regulations, climatic conditions, agricultural and animal husbandry practices, and conservation of natural resources. Knowledge acquisition and information plays a significant role in livestock production and interventions that aim to improve food security and increase livestock productivity. Several media types, such as the internet, web-based platforms, mobile telephony, and computer-mediated networks, are utilised in various initiatives across India. The primary objective of these initiatives is to provide development solutions and improve livestock productivity. To cultivate a positive attitude among farmers towards the integration and utilisation of information and communication technology (ICT) tools, it is crucial to improve their user-friendliness. Successful implementation of policy initiatives and provision of initial support play a vital role in facilitating the extensive adoption of information and communication technology (ICT) tools within the livestock farming community.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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