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CYBER EXTENSION: INFORMATION TECHNOLOGY AND AGRICULTURAL DEVELOPMENT *(SYSTEMATIC LITERATURE REVIEW)*

(Cyber Extension: Teknologi Informasi Dan Pengembangan Pertanian (Tinjauan Pustaka Sistematis))

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ABSTRACT

Cyber extension is an innovative approach in agricultural counseling that utilizes information and communication technology (ICT) to increase access and dissemination of information to farmers. With the development of digital technology, cyber extension allows farmers to get the latest information about agricultural practices, resource management, and market trends quickly and efficiently. This article discusses the role of cyber extension in agricultural development, including benefits such as improving farmers' skills, community empowerment, and efficiency in the counseling process. In addition, the challenges faced in implementation include accessibility of technology and digital literacy. By identifying opportunities for integrating new technology, cyber extension is expected to contribute to increasing the productivity and sustainability of the agricultural sector in the future.

Keywords: cyber extension, information technology, agricultural development, access to information, agricultural extension.

INTRODUCTION

Agriculture is an important sector for the economy and food security in various countries. However, many farmers still face obstacles in accessing the latest information about good agricultural practices. Cyber Extension as a solution to bridge this information gap, by utilizing the internet, mobile applications, and social media platforms, agricultural extension can be carried out more widely and effectively (Emeana et al., 2020).

Communication and information technology (ICT) are growing very fast. Information Technology provides a wide variety of alternative ways and procedures to help human needs. Therefore, everyone needs to keep up with technological developments and develop creativity related to problems in various fields. This development also affects a paradigm shift in the field of agricultural extension to provide information to the public. Access to information can be obtained in a short time and quickly now (Fangohoi et al., 2018).

Major changes in people's lives today occur in line with the development of information and communication technology (ICT) that continues to develop, especially the advancement of mobile phones and the internet. Warner dan James (2009) that this reality has led society into a more decentralized and democratic way of communication. Data from the Indonesian Seed Technology and Farmers Association shows that 22 percent of Indonesian farmers

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have used smartphones to get agricultural information (Rizkiansyah et al., 2022).

Cees Leeuwis (2009) emphasized that new variations of communication media are integrated with each other, so that the boundaries between these media are reduced. For example, it has been widely acknowledged that telephones and the Internet are beginning to replace the mass use of radio and television in interacting with a group of audiences. Furthermore, the improvement of the rural economy mainly depends on agricultural production. Farmers need to be informed about the latest scientific agricultural innovations to increase agricultural production. The dissemination of agricultural information and technology to farmers provides opportunities for self-development, improving existing knowledge, and skills and improving their abilities (Burman et al., 2013).

The current development of ICT in agriculture is beneficial for the development of agricultural information systems, especially as a medium of communication for new innovations in agricultural work. The use of ICT in agricultural development requires a certain educational process and capacity building due to some technical difficulties and lack of skills to implement it (Mulyandari, 2011). This information is more done through counseling. Menurut Jones (1997), Agricultural extension is an important mechanism for the delivery of knowledge and suggestions as input for modern agriculture. The need is a shift in focus from the delivery of technology to the delivery of knowledge and information. This is made possible by the use of information and communication technology that can make agricultural extension a more diversified and knowledge-driven system to meet farmers' information needs on demand. However, agricultural extension has limitations in the form of (1) yradisional extension requires a large cost. (2) Traditional counseling takes more time and energy. (3) poor communication capacity of the existing extension system. (4) Traditional extension system, quantum modification and high lost message. (5) The client area coverage capacity of the traditional extension system is very limited. (6) lack of extension workers in general and unqualified and educated workers in particular. (7) lack of timeliness to incorporate new visions and ideas into the existing extension system (Arulraj, 2006).

ICTs can continue to introduce a newer set of information services to the agricultural market where farmers can have better control. Access to such new sources of information is an essential requirement for the sustainable development of agricultural systems. Cyber extension is one of the information systems that can be used as a driver for the mechanism of management, dissemination, documentation, re-search, and synergization of agricultural innovations needed by agricultural development actors so that they can support the development of sustainable agricultural innovations (Amin et al., 2014). With the existence of cyber extension-based information technology, farmers are faced with a variety of information choices from their sources that can be accessed directly so that they can be used for the decision-making process in farming.

Cyber counseling is the expansion of agricultural development with the help of Information and Communication Technology through cyberspace. Cyberspace is an imaginary space behind a computer network

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through telecommunication means. This kind of powerful information-sharing network is made possible through the power of networks, computer communication, and multimedia interactivity (Ahuja, 2011a). The availability of information and communication technology is an important key to building a farming community in communicating effectively, because in addition to overcoming space and time, it can also empower a person in terms of providing information, knowledge, and learning opportunities for the community and allowing a person to express concern effectively participate in the decision-making process (Asian Development Bank, 2004).

Cyber extension can support extension revitalization programs, especially in carrying out the development of cooperation and agricultural extension work networks with related agencies (Departemen Pertanian 2009) (Sri &Mulyandari, 2011.).

The development of a cyber extension work system is one of the mechanisms for developing a programmed and effective agricultural development information communication network. Cyber extension needs to be implemented to bring together research, development, and assessment institutions with innovation disseminators (extension workers), educators, farmers, and other stakeholder groups who each have needs with different types and forms of information so that they can play a synergistic and complementary role (Sumardjo, et.al 2010). Thus, it is interesting to study cyber extension in developing information technology and agricultural development to analyze the concept, role and system of cyber extension in Information Technology and Agricultural Development, as well as identify strategies in developing effective innovation communication systems through the implementation of cyber extension.

RESEARCH METHOD

The procedure of systematic review

The study of Cyber Extension was carried out using the Systematic Literature Review (SLR) method with a qualitative approach. Systematic Review Literature Review is carried out by collecting, synthesizing, and analyzing research articles on a specific topic (Memon et al. 2020). Based on a review of literature sourced from primary sources such as scientific journals, as well as secondary sources in the form of archives, and news. Furthermore, the results of the search and study are analyzed to build a proposition regarding the role of cyber extension for information and support agricultural development.

Data Analiysis

Data analysis was carried out by collecting journals related to cyber extension, information technology, participatory extension and agricultural development using science direct and Mendeley applications to obtain research relevant to the topic of cyber extension.

RESULTS AND DISCUSSION

Table 1. Article Review Overview

Researchers	Research Topics	Findings
(Cahyono et al., 2020)	Adoption of Cyber Extension by Agricultural Extension Workers (PPL) and Factors Affecting	Cyber Extension has been introduced in Boyolali Regency since 2010, to be used as a source of agricultural extension information. In accordance with the Grand Design Cyber Extension issued by BPPSDMP, in order to effectively manage and implement the development of Cyber Extension at the central, provincial and district levels, an administrator must be appointed. Therefore, in Boyolali Regency, Mrs. Amriyah Sofiatun Rohimah SPt was appointed as the administrator of Cyber Extension

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		Adoption is a behavior/action carried out by a person, in the context of an information technology system, behavior is the actual use of technology. Based on the results of the study, 98.7% of PPL Boyolali has adopted Cyber Extension even though not all of the functions expected from the Cyber Extension are used, namely the function to interact with the main actors (farmers). The data also shows that counseling is carried out with a combination of Cyber Extension (virtual extension) and conventional extension (real extension). There is an influence between variables in the adoption of Cyber Extension by PPL Boyolali Regency. The influence between these variables is that experience has a significant effect on the perception of usability and the perception of convenience in the use of Cyber Extension. Complexity has a not significant effect on the perception of usability, but has a significant effect on the perception of convenience. The perception of convenience had a significant effect on the perception of usability, but did not have a significant effect on the attitude of using Cyber Extension. The perception of usability has a significant effect on the attitude and intention to use Cyber Extension. The attitude of using Cyber Extension has a significant effect on the intention to use Cyber Extension and the intention to use Cyber Extension has a significant effect on adoption.
(Gultom, 2017)	Strategi Pemenuhan Kebutuhan Informasi Pertanian Melalui Pemanfaatan Cyber Extension DI Provinsi Lampung	The communication behavior of horticultural farmers is positively influenced by individual characteristics, supporting environmental factors, the potential for cyber extension and the potential for conventional information sources. The fulfillment of agricultural information needs is influenced by communication behavior in using ICT-based information sources and conventional information sources The development strategy for meeting agricultural information needs is carried out through strengthening all aspects of communication behavior by first strengthening aspects of cyber extension potential, conventional information source potential, individual characteristics and environmental factors
(Praza, 2016) .	Optimalisasi Cyber Extension Dalam Pembangunan Pertanian Di Era Mea	Future extension is expected to make a great contribution to agricultural development in Indonesia, because the process of disseminating agricultural information and technology is in the main task of extension workers. Agricultural information and technology are developing at any time, requiring qualified, reliable and globally minded extension workers. In the MEA era, which prioritizes the speed of access to information and technology, it needs to receive attention from extension workers. Optimizing cyber extensions can be done in several ways, including training in computer and internet skills for extension workers, so that extension workers become more competent in using information technology. Then in terms of facilities, extension workers can be provided with office facilities in the form of computer devices and internet networks to make it easier for extension workers to find the latest information about agriculture. The spirit of sharing must also be developed, because if there is no sharing of experiences among successful extension workers, there will be no new strategies that can be followed by other extension workers
(Fangohoi et al., 2019)	Model Penyuluhan Pertanian dalam Agribisnis Kakao "Cyber Extension"	An effective cyber extension-based development extension system is a prerequisite for changing thinking patterns, attitude patterns and moving for all parties to the importance of developing agribusiness as an effective source of agricultural business. Cyber extension-based counseling is a process of awareness, learning and action in the context of early prevention of those who use the internet for their business activities effectively and efficiently. The development counseling process on the benefits, functions and roles of cyber extension as well as the possibility of development in agribusiness activities is a need for cyber extension-based learning. The community empowerment program through cyber extension-based empowerment by paying attention to environmental factors managed independently by farmers in West Papua, including in Manokwari Regency, but in its implementation several weaknesses and advantages were found
(Rizkiansyah et al., 2022)	The comparison between cyber extension and traditional interaction in the farmers environment during pandemic	The pattern of *cyber extension* in the farming community in Bangil occurs through social media and farmer mobile applications. Young farmers easily receive and implement information from cyberspace, while farmers who are not young prefer communication through counseling. Most of the farmer features and information add information to farmers in increasing their farming skills. However, unlike product marketing features, farmers feel that the sales and income system is still difficult to implement. The results of Arifiyani and Guntur's research show that information exchange through cyberspace can be carried out if the

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		YouTube application or content is in accordance with the experience of farmers' users. However, this study also shows that user experience is not enough, there is a need for information sources that bring farmers closer to cyber agricultural information. The sources come from the real world such as counseling or peers. Meanwhile, the results of the research in Bangil show how communication through extension can be a bridge between farmers and the internet
(Wijaya et al., 2019)	Cyber Extension: Penggunaan Media dan Kelancaran Pencarian Informasi di Kalangan Penyuluh Pertanian Kabupaten Bogor	The results of the study in Bogor Regency show that the performance of extension workers in the use of cyber extension: 1) making accessibility to cyber extension (seeking information, providing feedback, conveying information), 2) utilizing cyber extension information materials for extension activities, and 3) introducing cyber extension to farmers is included in the very low criteria for each indicator. Factors that directly affect the performance of extension workers in the use of cyber extension are the socialization of cyber extension to extension workers, communication between extension workers and district cyber extension administrators, and the perception of extension workers towards cyber extension. Factors that do not directly affect the performance of extension workers in the use of cyber extensions are supporting factors for cyber extension, the quality of cyber extension information, and the characteristics of extension workers. Communication between extension workers and district cyber extension administrators is the most influential factor in the performance of extension workers in the use of cyber extension. The ability of extension workers to access Cyber Extension is relatively good, most extension workers are able to operate computers for internet access, access the latest information, use email, and communicate with fellow extension workers. The availability of facilities for internet access is still felt to be lacking. This is due to the lack of wifi and modem facilities to support smooth internet access. Operational costs are still felt to be lacking, existing costs are considered uneven and sufficient to meet the needs of extension workers in searching for information through the internet. The stages of searching for information on the Starting, Chaining, Browsing, Differentiating, Monitoring, and Extracting indicators are generally in the current category

Cyber Extension Working Concept and System

Cyber Extension is an innovative approach to agricultural extension services, utilizing Information and Communication Technology (ICT) to facilitate the transfer of agricultural knowledge and technologies. This method has proven to be not only efficient but also highly scalable. Once educational materials are uploaded to an online platform, they become accessible to users globally, creating opportunities for widespread knowledge dissemination. This approach contrasts with traditional, in-person extension services that are often constrained by geographic limitations (Isard et al., 2015). Cyber Extension encompasses a broad range of ICT tools, including websites, mobile applications, and social media platforms, to provide farmers with essential information related to agricultural techniques, market prices, weather updates, and other critical aspects (Ayisi & Kozári, 2021).

In addition to providing information, Cyber Extension enables dynamic interaction between farmers and extension workers, creating a two-way communication channel that is crucial for understanding and addressing local needs. Through forums, chatbots, and social media groups, farmers can exchange experiences and advice, fostering a sense of community and mutual support (Kaur & Kaur, 2018). This interaction is essential for addressing the complexities of modern farming, where farmers often face rapidly changing conditions, from market shifts to climate changes.

Cyber Extension in Indonesia has been in practice since 2010, but its full

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potential has yet to be realized. Although the country has begun to embrace ICT as a tool for agricultural development, it faces significant challenges in making Cyber Extension a sustainable and effective tool for improving farmers' livelihoods. The lack of infrastructure in rural areas, limited digital literacy among farmers, and the initial costs of setting up ICT systems are just a few of the obstacles that need to be addressed (Bhattacharjee, 2016). Nonetheless, it is widely recognized that Cyber Extension can play a transformative role by complementing traditional extension methods and overcoming geographical barriers.

Cyber Extension leverages the vast reach of digital technologies, including the internet, mobile phones, and multimedia tools, to bring valuable information directly to farmers. According to Wijekoon et al. (2009), this extension method uses networks and interactive multimedia to create a seamless flow of agricultural knowledge from experts to farmers, bypassing the traditional face-to-face extension process. This is particularly beneficial in regions where physical access to agricultural extension services is limited, either due to distance or a lack of trained personnel. Furthermore, Cyber Extension encourages the creation of an interactive, participatory learning environment where farmers can contribute their knowledge and experiences, thus enriching the collective understanding of agricultural practices.

Sumardjo et al. (2010) describe Cyber Extension as an all-encompassing development tool, extending its influence not only to farming techniques but also to farm management, marketing, and rural development activities. It provides a comprehensive communication model that centralizes information from various sources and adapts it to the local context by using local languages and multimedia formats, including text, images, and videos. This ensures that the information is easily digestible and accessible for farmers at all levels of literacy. This approach significantly increases the effectiveness of the communication, as farmers can engage with the information in a format they find most convenient and understandable (Sri & Mulyandari, 2011).

The Black Box Theory offers an insightful perspective on how Cyber Extension functions as an agricultural communication system. This theory emphasizes the importance of both desired and undesired outputs, helping to identify areas for improvement and optimization (Mulyandari et al., 2010). By analyzing the system's inputs (such as technological tools, information sources, and infrastructure) and outputs (the effectiveness of knowledge transfer and application by farmers), Cyber Extension can be continually refined to meet the evolving needs of the farming community.

Despite the promising prospects of Cyber Extension, several challenges impede its widespread adoption and full potential. One of the primary challenges is the accessibility of technology, particularly in remote and rural areas where internet connectivity is often unreliable or unavailable. Many farmers in developing countries, including Indonesia, still lack access to the basic infrastructure necessary to engage with digital platforms. Even when technology is available, there are significant gaps in digital literacy, as many farmers have limited experience with computers and smartphones. This creates a need for targeted

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training programs to help farmers develop the skills necessary to utilize these technologies effectively.

Another challenge is the sustainability of Cyber Extension programs. While the initial costs of setting up ICT infrastructure can be high, the long-term benefits of these systems are immense. However, sustaining Cyber Extension initiatives requires ongoing investment in both technology and human resources. This includes regular updates to the digital platforms, training for extension workers, and the continuous development of new content that addresses the changing needs of farmers. Without support from government bodies, private sector stakeholders, and international organizations, the effectiveness of Cyber Extension could be compromised (Sobb & Turnbull, 2020).

International examples of successful Cyber Extension implementations highlight the potential of this approach. For instance, countries like China, Kenya, India, and Peru have already established robust Cyber Extension programs that have significantly enhanced agricultural productivity and farmers' knowledge. China's early adoption of ICT in agriculture, for example, has enabled millions of farmers to access expert advice on everything from pest control to weather forecasting. Similarly, Kenya's KACE (Kenya Agricultural Commodities Exchange) program, launched in 1997, used ICT tools to connect farmers with market information, boosting their bargaining power and income (Sumardjo et al., 2010).

In Indonesia, the government and various NGOs have established telecenters in rural villages as part of the Pe-PP (Partnerships for e-Prosperity for the Poor) program. These telecenters, located in places like Pabelan Village (Magelang), Muneng Village (Madiun), and Lapulu Village (Southeast Sulawesi), have served as hubs for agricultural information and ICT access. Through these telecenters, farmers have been able to connect with extension workers, receive market prices, and learn new farming techniques, ultimately improving their productivity (Sumardjo et al., 2010). However, despite these successes, the continued implementation of Cyber Extension in Indonesia still faces barriers such as limited internet infrastructure, high initial costs, and insufficient digital literacy.

To overcome these barriers, it is necessary to focus on improving technology access, enhancing digital literacy, and ensuring the sustainability of Cyber Extension programs. Some solutions include expanding internet infrastructure in rural areas, providing low-cost smartphones or internet data plans to farmers, and offering digital literacy training programs to equip farmers with the skills they need. Furthermore, engaging local communities in the development and implementation of Cyber Extension programs ensures that the services are tailored to their specific needs and contexts (Sobb & Turnbull, 2020).

Cyber Extension tools such as email, Telnet, FTP, and websites play a crucial role in disseminating information. Email allows extension workers to send updates and answers to farmers' questions. Telnet, although outdated, is still used in some cases to access remote computers and systems. FTP is vital for transferring large files, such as technical reports and research findings, to farmers. Additionally, the World Wide Web (WWW) has become an essential medium for delivering information on a global scale, offering farmers access to a wealth of

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agricultural knowledge that can be applied to improve their farming practices (Singh, 2017). As new tools emerge, such as mobile apps and cloud-based platforms, the potential of Cyber Extension continues to grow, making it easier than ever for farmers to access information.

The development of Cyber Extension requires a systems-based approach, incorporating various stakeholders and institutions that collaborate within an agricultural information network system. These systems are characterized by seven key elements: boundaries, environment, input, output, components, storage, and interface (Mulyandari et al., 2010). The success of Cyber Extension depends on the effective interaction between these elements, ensuring that the right information reaches the right farmers at the right time. Effective communication channels must be established, and data storage systems must be developed to ensure that information is easily accessible and up-to-date.

As Cyber Extension continues to evolve, it holds the potential to revolutionize agricultural extension by making information more accessible, improving farmers' knowledge and practices, and ultimately increasing agricultural productivity. The challenges are significant, but with continued investment, collaboration, and adaptation to local contexts, Cyber Extension can play a pivotal role in transforming agriculture and improving the livelihoods of farmers worldwide.

Cyber Extension Implementation in Various Countries

Cina

In the early 20th century, large entrepreneurs began to access market information through home telegraph machines to daily traders until the end of the decade. For the development of the marketing of Chinese products in the global market, a special website was developed for products produced by China, including by China, including agricultural products. Information has been presented related to various product directories, product offer boards, services for trade, agricultural product information centers and *virtual offices* (Schaefer & Pletka, 2022). Made In China.Com China Website

Kenya

One of the projects to improve poor farmers' access to agricultural information is the Kenya Agricultural Commodities Exchange (KACE)(Irungu et al., 2015). KACE was built by a private company in 1997 to facilitate meeting sellers and buyers. As for agricultural commodities preparing marketing information in a timely manner, preparing a competitive commodity price mechanism for empowerment and increasing farmers' income in rural areas.

India

India has many technology infrastructure development projects for access to information for people in rural and urban areas that are *top-down* and *bottom-up*(Vasile & Mocan, 2019). Wireless Pony Express of Decent uses thousands of buses equipped with WIFI transceivers to obtain and transmit information via e-mail with a wireless system from village kiosks. Through this technology, Indian farmers can directly access information to find opportunities to be able to cultivate commodities that have better prices and are profitable.

Indonesia

1. CTLC -Microsoft

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The concept of establishing CTLC in rural areas is a local community development program using information and communication technology so that it can facilitate the community in accessing information on markets, agriculture, trade, education, and others; Developing Cooperation with relevant parties to build local communities.

2. Development of National and Local Agricultural Information Resources

The Poor Farmers Income Improvement through Innovation Project is a program of the Ministry of Agriculture to increase farmers' income

3. Agricia is an information vehicle regarding matters related to the development of Agricultural Communication Science. This website displays information and learning outcomes of Broadcasting Management, Agricultural Journalism, Publishing Management, Agricultural Photography and Agricultural Audio Video.

The Role of Cyber Extension in Information Dissemination

The most noticeable impact of digital technology is the transformation of farmers into individuals with technological literacy. With the increasing reliance on applications and internet services, farmers now have access to a vast array of information. The internet has become a valuable resource, providing farmers with knowledge that extends beyond their immediate surroundings. This influx of external information offers psychological benefits, such as boosted confidence, increased dignity, and enhanced motivation to engage in extension programs. Cyber-extension plays a pivotal role in educating farmers about agricultural technology by facilitating direct interaction through visuals, audio, and hands-on demonstrations. The ability to quickly disseminate the latest agricultural news globally allows farmers to stay informed in real-time, receiving timely updates that were once unavailable.

Moreover, cyber-extension acts as an efficient tool for the rapid transmission of information, allowing farmers to gain access to critical data within minutes. The internet enables farmers to stay updated on agricultural issues, weather forecasts, harvest predictions, and market trends. Through online platforms, farmers can check real-time pricing information, helping them make better decisions about selling their products. By staying connected to market trends, farmers can also adjust their production strategies accordingly. Additionally, the internet aids farmers in finding innovative ways to manage surplus production by diversifying their agricultural products or exploring new markets.

With the growing digital literacy of farmers, there is a clear shift in how agricultural knowledge is disseminated. Traditional methods of extension services are being supplemented with digital tools, allowing for more efficient and widespread outreach. By providing farmers with timely and accurate information, cyber-extension is creating opportunities for improved productivity and more sustainable agricultural practices. As farmers adapt to these technological changes, they not only increase their efficiency but also gain a deeper understanding of global agricultural trends.

The integration of digital tools in agriculture also supports farmers in managing risks. With access to up-to-date weather forecasts and market analysis,

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farmers can make better-informed decisions about planting, harvesting, and selling. This predictive capability allows them to plan more effectively, reducing the risks associated with unpredictable weather patterns or market fluctuations. The ability to act on timely information gives farmers a competitive edge in the agricultural sector, empowering them to make choices that align with both local and global trends.

Additionally, the widespread use of mobile applications and internet services in agriculture is fostering greater collaboration among farmers, extension agents, and agricultural experts. These digital platforms create spaces for knowledge exchange, enabling farmers to share experiences, solve problems collectively, and access expert advice. This collaborative environment is key to building a more resilient and adaptable farming community. By embracing digital technology, farmers are not only enhancing their agricultural practices but also contributing to the broader transformation of the agricultural industry.

The role of extension workers in the context of cyber extension in Indonesia is as a manager of information both sourced from agricultural innovation communication network subsystem institutions, from the central and regional or from outside the system (global information sources) as well as from farmers (indigenous knowledge). The innovations obtained are then processed into material to support the implementation of assistance in the process of sharing farmers' knowledge in a language that is easier to understand. Extension officers carry out the process of disseminating agricultural innovation information through interpersonal media with traditional institutions and local languages. Extension workers also facilitate access to information quickly and accurately for problem solving. In addition, agricultural extension workers can collect indigenous knowledge and problems in the field (Thoriq Maulana et al., 2015).

The role of local institutions in the socialization of IT-based agricultural innovation (Guntoro et al., 2022) is crucial in managing and disseminating agricultural information effectively. These institutions serve as filters for information from various sources, both national and global, that are accessible via the internet. They are responsible for ensuring that only relevant, useful, and valid information reaches the farmers, thereby preventing the spread of misleading or harmful data. In this context, local institutions act as trusted mediators who curate and forward reliable agricultural knowledge to farming communities.

Local institutions also function as platforms for sharing information and knowledge, facilitating communication between farmers, agricultural experts, and other stakeholders. These institutions help farmers access new technologies by acting as intermediaries that guide them in testing and adopting innovations. With the support of information technology, farmers can engage in the testing and evaluation of accessible technologies, enhancing their capacity to make informed decisions and improve their agricultural practices. In this way, local institutions play a vital role in bridging the gap between advanced agricultural technologies and the farmers who can benefit from them.

Moreover, local institutions maintain important relationships with relevant stakeholders, including government agencies, agricultural researchers, and technology providers. These relationships

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enable them to stay updated on the latest developments in agricultural technology and share this knowledge effectively with farmers. They also help ensure that farmers receive timely support and resources, allowing them to implement new technologies with greater confidence. By working closely with stakeholders, local institutions can better understand the needs of farmers and tailor their outreach efforts to suit the unique challenges faced by different farming communities.

Finally, local institutions manage the information accessed through information technology and package it in a simple, user-friendly format that can be easily understood and utilized by farmers. This may include creating accessible media such as community radio programs, instructional videos, or printed materials. By packaging complex information in an accessible manner, local institutions ensure that farmers can effectively integrate new knowledge into their daily practices. These efforts contribute to the overall empowerment of farmers, enabling them to make informed decisions and improve their agricultural productivity(Guntoro et al., 2022)

Cyber-extension will affect how the younger generation is involved in agricultural activities. Today, young people tend to be more familiar with internet technology than their parents. Their mastery in the field of technology is the capital to develop agricultural innovation. The use of agricultural and rural cyber extensions is beneficial in consulting researchers about agricultural activities. It helps to improve community learning in certain countries. This will help not only researchers and farmers but also all stakeholders through the use of immersive modern internet, computer and multimedia networks.

Information media plays a role as a media that empowers farmers. The media also promotes population engagement and provides avenues for the improvement of the agricultural/animal sector. The cyber counseling program launched by the government is intended to facilitate economic growth in rural areas. In the transition process, communication media has an important function. According to Wilbur Schramm, the role of the media in development includes advising, leading and participating in development. Overall, ICT has helped change the dynamics between extension workers and the community through the use of information technology. In the process of contact, adolescents become willing members. Smartphones to access the internet are more widely available than computers. That makes it a lot more fun to surf the internet on your phone. Through social media features, smartphones have changed the meaning of social connection. Many people use smartphones to chat, express thoughts, beliefs, and ideas(Guntoro et al., 2022)

Advantages of *Cyber Extension*

Cyber extension, though a promising tool in agricultural development, faces significant challenges despite its potential benefits. One of the main obstacles is the insufficient infrastructure in rural areas. Many villages still lack reliable internet access, electricity, and the necessary hardware for farmers to access digital resources effectively. This disparity in infrastructure creates a divide between rural and urban communities, where rural farmers are at a disadvantage when it comes to benefiting from the vast wealth of

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information available through cyber extension. As a result, the digital divide exacerbates the challenges that farmers face, preventing them from fully participating in the technological revolution in agriculture (Sumardjo et al., 2010).

Additionally, the rapid pace of technological advancement can be overwhelming for many farmers, especially those who are not familiar with digital tools. The introduction of new technologies may be intimidating for older farmers or those with limited education, leading to a reluctance to embrace these innovations. Overcoming this barrier requires focused efforts on education and training, ensuring that farmers not only have access to technology but also the knowledge and skills to use it effectively. Without these support mechanisms, there is a risk that the benefits of cyber extension will be inaccessible to large segments of the agricultural community, particularly those in remote areas with limited exposure to technology (Zscheischler et al., 2022).

The "information overload" phenomenon is another challenge associated with cyber extension. While the internet offers a wealth of information, the sheer volume of data available can overwhelm farmers who are not equipped to filter through it and identify relevant, trustworthy sources. Farmers may become confused by conflicting advice or inaccurate information, leading to poor decision-making. This issue highlights the need for better systems of information curation, where trusted sources and platforms provide farmers with tailored, actionable information that is specific to their context and needs. Extension workers can play a vital role in this process by guiding farmers through the information available, helping them navigate the digital landscape and choose the most appropriate solutions for their agricultural challenges (Tekin et al., 2021).

Another issue that arises with the implementation of cyber extension is the financial barrier. In many developing countries, farmers often face economic constraints that prevent them from investing in the necessary technology, such as smartphones, computers, or internet access. These financial limitations are particularly pronounced among smallholder farmers, who may already struggle with accessing credit or loans to invest in their farming operations. The costs associated with technology adoption, both in terms of purchasing devices and paying for internet services, can be a significant deterrent. Subsidies or government support programs are needed to help alleviate these financial burdens and make technology more accessible to farmers in low-income communities (Baseca et al., 2019).

Moreover, the quality of information provided through cyber extension is not always guaranteed. Although the internet provides a vast array of resources, not all of it is reliable, and some information may be outdated or inaccurate. For instance, some websites or online platforms may share information that is not contextually relevant to the specific agricultural practices or conditions in a particular region. Furthermore, the digital divide in terms of access to high-quality information persists, with rural areas often lacking the necessary infrastructure to access reliable online resources. As a result, farmers in remote areas may struggle to find the information they need to improve their practices, potentially hindering their productivity and income levels (Ahuja, 2011).

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The issue of illiteracy is also a significant barrier to the successful implementation of cyber extension. While digital tools offer great potential, many farmers, especially in rural or marginalized areas, have limited literacy skills. This gap in literacy can hinder their ability to navigate digital platforms or comprehend the information presented online. For cyber extension to be effective, it is crucial to address this issue by providing training programs that improve digital literacy and ensure that farmers are equipped to use technology to its full potential. Additionally, the information provided through cyber extension must be user-friendly, with simple language, visual aids, and videos that cater to varying levels of literacy (Zscheischler et al., 2022).

Another factor contributing to the limited success of cyber extension is the lack of a structured framework for collaboration among stakeholders. Successful cyber extension requires strong partnerships between extension workers, farmers, research institutions, government bodies, and the private sector. However, in many cases, there is a lack of coordination and communication between these groups, which hinders the flow of information and the implementation of effective strategies. For cyber extension to reach its full potential, there must be a concerted effort to foster collaboration and ensure that all stakeholders are working together to improve the agricultural knowledge base and provide farmers with the support they need (Sumardjo et al., 2010).

Moreover, the role of extension workers in the cyber extension system remains critical. While digital tools can facilitate communication and provide farmers with timely information, extension workers still play a vital role in interpreting this information and ensuring that it is relevant and actionable for the farmers. Extension workers are not only sources of knowledge but also facilitators who help farmers apply new technologies and practices in their daily work. Therefore, capacity-building programs are essential to enhance the skills of extension workers, ensuring they are equipped to support farmers in utilizing cyber extension effectively (Dharmawan et al., 2020).

The sustainability of cyber extension systems also depends on the continued development of digital infrastructure and support systems. For long-term success, investments must be made in both hardware and software solutions, as well as in ongoing training and support for farmers and extension workers. Without these continuous efforts, cyber extension could lose its effectiveness, and its potential benefits could be limited to a small, tech-savvy subset of the farming population. To ensure sustainability, governments and stakeholders must prioritize the development of robust infrastructure, as well as initiatives to improve digital literacy and ensure that farmers have the skills and knowledge necessary to participate fully in the digital agricultural revolution (Guntoro et al., 2022).

Furthermore, the integration of cyber extension with other forms of extension services could create a more comprehensive and inclusive approach to agricultural development. While cyber extension offers significant advantages in terms of information access and cost-efficiency, it should complement rather than replace traditional extension services. Combining face-to-face interactions with digital tools

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could enhance the effectiveness of both approaches, ensuring that farmers receive a more holistic support system that takes into account their diverse needs and learning preferences. The future of agricultural extension lies in a hybrid model that leverages the strengths of both digital and traditional methods to reach farmers where they are and provide them with the resources they need to thrive (Ahuja, 2011).

The growing adoption of cyber extension has also led to the rise of mobile applications specifically designed to support farmers. These apps offer practical tools for managing farming operations, such as tracking crop growth, managing pest control, and predicting weather patterns. They also provide platforms for farmers to connect with extension workers and other stakeholders, creating a more interactive and community-driven approach to agricultural development. The use of these apps represents a significant shift in how agricultural information is disseminated, allowing farmers to access expert advice and resources at their fingertips. However, the success of these apps depends on their usability, accessibility, and the ability to meet the specific needs of farmers in different regions (Dharmawan et al., 2020).

As cyber extension continues to evolve, it is essential that all stakeholders—governments, agricultural organizations, extension workers, and farmers—work together to overcome the challenges and maximize the benefits of digital tools in agriculture. This requires a commitment to addressing issues such as infrastructure gaps, illiteracy, and the need for continuous capacity building. By creating an inclusive, supportive environment for the adoption of cyber extension, the agricultural sector can take full advantage of the opportunities presented by digital technology and improve the livelihoods of farmers worldwide. With proper investment, collaboration, and support, cyber extension has the potential to revolutionize agricultural practices and contribute to sustainable agricultural development for generations to come.

Strategy for the Development of Agricultural Innovation Communication Network System through Cyber Extension

Cyber counseling plays a significant role in advancing agricultural information extension programs by leveraging modern technology to reach farmers in even the most remote areas. The government has actively supported the development of cyber extension, which is powered by Information and Communication Technology (ICT). This support aims to create a more efficient means of disseminating agricultural knowledge, making it accessible to a broader audience. By integrating ICT into extension services, the government hopes to not only improve the availability and speed of agricultural information but also enhance the competence of extension workers who are at the forefront of these initiatives. Cyber extension is designed to create a robust communication network that connects a wide range of stakeholders, including research and development institutions, educational bodies, agribusinesses, and regulatory organizations. The system works by filtering information from national and global sources and directing it to relevant parties, ensuring that only valuable and accurate data is shared with farmers. This integrated approach to information dissemination helps farmers make better-informed decisions and adapt

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more quickly to new agricultural technologies and practices.

The communication system that underpins cyber extension is carefully structured into several key subsystems. These include the information source subsystem, which involves research, development, and study institutions responsible for generating valuable content; the agricultural innovation dissemination subsystem, which focuses on educational institutions that help spread this knowledge; the end-user subsystem, which is made up of agribusinesses that apply the information; and the agribusiness support subsystem, including regulatory and financial institutions that provide the necessary infrastructure and funding. The successful integration of these subsystems allows for a dynamic exchange of information that accelerates the adoption of new agricultural innovations. By utilizing ICT tools, cyber extension can overcome geographic barriers, making it possible for farmers in remote locations to access the same information as those in urban centers. This rapid dissemination of information can improve the overall efficiency and sustainability of agricultural practices, fostering economic growth and food security in rural communities. However, the success of cyber extension in developing countries is highly dependent on the availability of supporting factors such as infrastructure, internet connectivity, and the technological literacy of farmers and extension workers.

A study by D. Gultom (2022) highlights the importance of environmental factors in determining how well cyber extension can be implemented and how it influences the communication behavior of farmers. This research focuses on horticultural farmers and their ability to access ICT-based information sources. It emphasizes that while cyber extension has the potential to enhance agricultural practices by providing farmers with real-time information, its impact is often limited by factors such as the availability of ICT infrastructure, internet connectivity, and the digital literacy of the farmers themselves. Farmers in rural areas, for instance, may face significant challenges in utilizing these technologies due to limited access to the internet or a lack of understanding of how to use digital platforms effectively. To overcome these barriers, it is essential to improve the availability of ICT facilities in rural areas, as well as to provide training programs that help farmers develop the necessary skills to navigate these systems.

One of the main benefits of cyber extension is its ability to provide better access to agricultural information. By utilizing online platforms, farmers can stay updated on the latest advancements in efficient farming practices, pest control methods, and natural resource management. This immediate access to information can help farmers optimize their farming techniques, reduce the use of harmful chemicals, and adopt sustainable practices that are better for the environment. In addition, cyber extension promotes upskilling by offering online courses and training materials that enable farmers to improve their skills without the need to attend face-to-face meetings. This is particularly valuable for farmers who may be located far from agricultural training centers or who face scheduling constraints that make attending traditional training sessions difficult. With the convenience of online resources, farmers can learn at their own

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pace and integrate new knowledge into their daily operations.

Furthermore, cyber extension supports the empowerment of farming communities by fostering collaboration between farmers, extension workers, and other stakeholders in the agricultural sector. Through online platforms and social networks, farmers can share experiences, exchange ideas, and discuss challenges they face with others in similar situations. This sense of community can provide moral support, reduce feelings of isolation, and create opportunities for joint problem-solving. In this way, cyber extension not only provides information but also helps to build networks and collaborations that strengthen the agricultural sector as a whole. As farmers gain access to better resources and support, they are more likely to adopt new technologies, improve their productivity, and contribute to the development of the agricultural industry in their region.

The role of cyber extension in bridging the communication gap between various components of the agricultural system is equally critical. Agricultural research, marketing, and farming are the three core elements of this system, and effective communication between them is essential for the growth and development of the sector. Cyber extension serves as a platform that connects these components, enabling the free flow of information and fostering collaboration among researchers, farmers, and marketers. This communication network ensures that research findings are quickly shared with farmers, allowing them to apply the latest innovations in their practices. It also facilitates better market access by helping farmers stay informed about pricing trends, consumer demand, and new marketing opportunities. With improved communication and access to real-time data, farmers can make more informed decisions that contribute to the growth of the agricultural industry and the overall economy.

As agricultural extension plays a pivotal role in shaping the future of farming, it is essential to recognize the importance of ICT in modernizing extension services. Information and Communication Technology (ICT) is an umbrella term that encompasses a range of digital tools and systems that can empower farmers and extension workers. These technologies are adaptable, effective, and versatile, allowing them to be used in various contexts and helping to redefine how agricultural knowledge is shared. The rise of online education tools such as distance learning, virtual classrooms, and online training platforms demonstrates the influence of ICT on agricultural education. These tools not only increase accessibility but also offer farmers the opportunity to engage with content in ways that were previously unavailable, thereby promoting continuous learning and skill development (Guntoro et al., 2022). The integration of these ICT tools into agricultural extension systems is essential for improving the efficiency and impact of agricultural programs.

Cyber extension is especially vital in developing countries, where agricultural extension services are often limited by resource constraints and geographic isolation. As such, the role of extension institutions in disseminating IT-based agricultural innovations is crucial. These institutions help create programs that provide access to digital resources, such as social networks, mobile apps, and websites, to

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facilitate communication and knowledge sharing. By offering printed and electronic materials, extension institutions also support farmers in their learning process, making information more accessible. Furthermore, extension institutions provide the necessary facilities for managing and reprocessing information, turning it into extension materials that can be used by farmers. This comprehensive approach ensures that the information provided is not only accessible but also actionable, empowering farmers to implement best practices and adopt new technologies effectively.

Capacity building is another essential function of extension institutions. By training field extension workers, freelancers, and institutional administrators, these organizations ensure that the people responsible for delivering information to farmers are well-equipped with the knowledge and skills needed to utilize ICT tools. These trained extension workers can better engage with farmers, helping them understand complex technological concepts and facilitating the adoption of innovations. Extension institutions also act as intermediaries between farmers and other stakeholders, such as government agencies, agricultural researchers, and technology providers. Through these relationships, farmers can access critical resources, including funding, market opportunities, and technical support.

The use of ICT-based agricultural extension services also helps bridge the gap between urban and rural areas. In urban centers like Bogor Regency, where infrastructure is often more developed, the use of cyber extension is widespread. However, in rural areas, farmers may still face challenges related to internet access, digital literacy, and the availability of devices. This disparity in access can limit the effectiveness of cyber extension and prevent some farmers from benefiting from these services. As such, it is important to invest in ICT infrastructure and digital literacy programs to ensure that rural farmers are not left behind. With improved access to ICT tools, farmers in rural areas can engage in the same information-sharing networks as their urban counterparts, leading to more equitable outcomes across the agricultural sector.

The success of cyber extension ultimately depends on the availability of the right environmental factors, including ICT infrastructure, internet connectivity, and farmer engagement. Studies have shown that the effectiveness of cyber extension is closely linked to the availability of appropriate ICT facilities and the level of farmer participation. In areas where these resources are lacking, traditional methods of information dissemination continue to dominate, which can hinder progress. To overcome these challenges, policymakers must prioritize investments in digital infrastructure and develop programs that encourage farmers to embrace ICT tools. By creating a supportive environment for digital agriculture, governments can help bridge the gap between conventional practices and modern innovations.

Cyber extension also has the potential to transform agricultural decision-making by offering farmers real-time access to important data, such as weather forecasts, market prices, and crop performance. The integration of advanced technologies like artificial intelligence (AI) and big data can further enhance the accuracy of predictions, enabling farmers to make better-informed decisions. These technologies can analyze

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vast amounts of data to provide insights into crop yields, pest outbreaks, and market trends, offering a level of foresight that was previously unavailable. As a result, farmers can plan their activities more effectively, reducing risks and improving productivity. Moreover, the use of AI and big data can help farmers optimize resource allocation, manage risks, and improve the sustainability of their farming operations.

The potential of cyber extension to strengthen the agricultural sector is immense, but it requires collaboration between various stakeholders, including research institutions, universities, and government agencies. By working together, these groups can accelerate the development and adoption of new technologies, ensuring that farmers have access to the tools and knowledge they need to succeed. Collaborative efforts can also help address the challenges faced by farmers in rural areas, ensuring that they are not excluded from the benefits of digital agriculture. The continued evolution of cyber extension will depend on ongoing innovation, investment, and cooperation among all parties involved in the agricultural sector. Through these efforts, cyber extension can play a pivotal role in transforming the agricultural landscape, promoting sustainable practices, and improving food security worldwide.

CONCLUSION

Cyber Extension is a significant step in modernizing agricultural extension and supporting sustainable agricultural development. By utilizing information technology, it is hoped that farmers can increase productivity, welfare, and overall food security. To achieve its maximum potential, there needs to be cooperation between all stakeholders in the agricultural sector. Cyber extension is one of the information systems that can be used as a driver for the mechanism of management, dissemination, documentation, re-search, and synergization of agricultural innovations needed by agricultural development actors so that they can support the development of sustainable agricultural innovations. Important things that need to be considered in supporting the implementation *of cyber extension* include: (1) the availability of supporting facilities and infrastructure, (2) the human resources involved in it need to have supporting competencies, (3) the existence of a process of exchanging information that is carried out voluntarily, (4) the existence of a strong commitment from all parties involved in the implementation of cyber extension.

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