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Inequality and Preference: Leveraging Digital ICT Applications for Knowledge-Intensive Agriculture

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Abstract: *Digital ICT plays a strategic role in transforming input-intensive to knowledge-intensive agriculture. Its use hypothetically correlated to the farmers' characteristics. This study analyzes the farmers' features and the intensity of utilizing various digital ICT applications/platforms. It uses an explanatory sequential mixed methods design combining quantitative and qualitative approaches. The survey was conducted on 150 smartphone-using farmers from Boyolali District, Central Java Province, Indonesia, accompanied by interviews and online observations. This research identifies digital divides and inequalities in leveraging Android farming applications, Facebook groups of farmers, WAG of farmers' groups, Internet/Google information resources, and YouTube. The correlation test indicates a significant correlation between gender, age, education, farming size, farm income, Internet quota budget, the availability of PC/Laptops (besides smartphones), and participation in farmers' groups with the intensity of leveraging some digital ICT applications. These correlations are unique and reflect farmers' receptions and preferences for using digital ICT applications. This novelty is crucial for developing knowledge-intensive agriculture that emphasizes the strategic role of development communication to facilitate knowledge sharing, involvement, and capacity development among farmers. Without understanding farmers' characteristics and vulnerabilities, the digital divide and inequality among farmers will continue to be reproduced.*

Keywords: *agricultural applications, farmers' characteristics, farmers' community on the Facebook group, farmers' WhatsApp groups, Internet and YouTube information resources*

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INTRODUCTION

The sector of agriculture encounters many critical issues due to shrinkage in the quantity and quality of the land resource base (Gomiero, 2016) and climate change (FAO, 2017); this sector will remain a key pillar of rural people's livelihoods in developing countries (Giller, Delaune, Silva, Descheemaeker, & Ven, 2021). The emerging challenges require more innovative and knowledge-intensive agriculture (KIA) since the capacity of the agricultural workforce becomes decisive (Ra, Ahmed, & Teng, 2019). Because new technologies in agriculture are more knowledge-intensive, knowledge and information are essential for farmers to face these challenges. The demand for more accurate, relevant, and timely information is increasing (Deichmann, Goyal, & Mishra, 2016).

KIA involves applying advanced knowledge and information to increase productivity and profitability across agricultural food systems while managing and mitigating risks (ADB, 2018). Using digital and modern information and communication technology (ICT) in KIA can optimize the development and adoption of the latest varieties,

agricultural production inputs and operations, and post-harvest management (ADB, 2018; Ra, Ahmed, & Teng, 2019). ICT use can minimize the risks associated with climate change, promote climate change adaptation to reduce the risk of agricultural failure, and offer essential avenues to increase food productivity and expand agribusiness (Zougmoré & Partey, 2022). ICT acts as a multiplier for connecting people and places, improving supply chains and collaboration (Verdier-Chouchane & Karagueuzian, 2016) so that agriculture becomes more networked and resource utilization more efficient (Basnet & Bang, 2018). Finally, digital ICT in agriculture and e-agriculture applications increases new research fields (Singh, Ahlawat, & Sanwal, 2017).

Using digital ICTs in the agribusiness value chain, particularly smartphones, has created a set of new solutions, changed agricultural processes, and benefitted both small and large-scale farms. Smartphones have features found in personal computers and combine mobile phone utilities and PDAs into a single device of minicomputers with telephone connectivity (Barbosa et al., 2020), therefore, facilitating users to perform voice communication, text messaging, data processing, and connection to Internet (Barh & Balakrishnan, 2018). Smartphones expand the boundaries of communication to reach farmers and previously marginalized rural communities (Dlodlo & Kalezhi, 2015) and act as catalysts for social mobilization through better communication, therefore, providing possibilities for rural farm households to address the digital divide (Barh & Balakrishnan, 2018) and the information gap when regular extension services do not reach them at the right time and place (Swaminathan & Swaminathan, 2018).

Mobile phones can, among other things, improve the circulation of information in interpersonal networks, improve farmers' access to "public" information, and improve the coordination of input and output supply chains (Aker, Ghosh, & Burrell, 2016). In India, mobile phone interventions influence the speed, quality, and quantity of distributing extension services, farmer knowledge, and credit access (Fu & Akter, 2016). Most farmers in Nagaur Rajasthan district include accessing information on pesticides and weed remedies, seeds and seeding, market conditions and prices, fertilization, harvesting, and storage via mobile phones (Kailash, Mishra, Singh, Verma, & Kumar, 2017). In Ghana, the ownership and use of mobile phones significantly increase the productivity of maize farmers by at least 261.2 kg/ha per production season (Issahaku, Abu, & Nkegbe, 2018). Among well-known fruit-producing farmers in Khyber Pakhtunkhwa, Pakistan, it shows that the introduction of smartphones technology and its availability to local farmers has empowered farmers to understand market and price information and helped increase farmers' incomes (Rabbi, Idrees, Ali, Zamin, & Bilal, 2020). In Indonesia, among others, members of the farming community of the coastal area Bugel Village, Panjatan District, Kulon Progo Regency, Yogyakarta (Subejo, Untari, Wati, & Mewasdinta, 2019) indicated that new media, such as the Internet and short message service through mobile phones and smartphones has become increasingly popular among coastal farmers who grew commercial horticultural crops, particularly to access market information and new innovative technologies.

Furthermore, digital ICT allows for building platforms (such as WhatsApp or Facebook Groups) that bring together farmers, extension workers, and researchers to share valuable information and respond quickly (Nyarko & Kozári, 2021). Digital ICT applications can play

a role in helping farmers when engaging them directly with many opportunities so that they can choose that suit the situation and factual conditions in the field. By integrating digital ICT in sustainable agricultural development through capacity development, farmers have the potential to encourage them to think, communicate, and work on their businesses differently.

The researchers suggest the importance of contributing individual factors to the use of digital ICT among rural farmers. Socioeconomic factors are the main determinants of ICT use and adoption (Tata & McNamara, 2016). Among the factors related to mobile phone use by farmers are gender, age, education, family size, farming experience, farming land area (farms size), land tenure status, gadget ownership, farm income, and organizational membership (Anunobi & Anunobi, 2018; Chikaire et al., 2015; Lubis & Sulistiawati, 2021), but have not taken into account the Internet quota budget for connectivity and access to digital ICT applications.

Based on the background of the research problem, this study formulates the research questions: Firstly, what are the characteristics of farmers who use digital ICT? Secondly, to what extent are inequalities in the utilization intensity of digital ICT applications/platforms among farmers? Thirdly, is there a correlation between farmers' characteristics and preference for adopting digital ICT applications/platforms? Firstly, this study aims to analyze the individual characteristics of farmers who use digital ICT. Secondly, this study analyzes inequalities in leveraging digital ICT applications/platforms among farmers. Thirdly, it studies the correlation between farmers' characteristics and preferences towards utilizing digital ICT applications/ platforms among farmers.

To date, however, scholarly discourse on ICT use in agriculture and rural communities in developing countries, including in Indonesia, has been, for the most part, limited to the conventional discussion regarding the gap that exists between the "haves" and the "have nots," often referred to as the digital divide (Onitsuka, Hidayat, & Huang, 2018). As state of the art, this study explores the extended use of smartphones among farmers to fulfill agricultural information and knowledge sharing, hence not only identifying digital divides in various ICT applications but also describing inequalities in leveraging various digital ICT applications and explaining the relationship between farmer's characteristics and their preferences toward various digital ICT applications.

When understanding the phenomenon of inequality in the use of digital ICT among farmers, this study considers the Resources and Appropriation Theory (RAT) of diffusion, acceptance, and adoption of new technologies. The core concepts of RAT are (1) Several inequalities of personal categories (individual characteristics) and positional categories in society; (2) The distribution of resources relevant to this type of inequality; (3) Several types of access to ICT, and; (4) Several areas of participation in society (van Dijk, 2017). As explained in the Uses and Gratification (U&G) theory, we can also understand digital inequality due to differences in the motives of digital ICT users. As users of digital ICT, farmers are assumed to be active and deliberately choose media to receive various types of information and share information and knowledge to meet their needs. U&G theory also provides an appropriate framework for investigating farmers' preferences towards ICT and enabling critical discussions about the suitability of ICT in extension systems (Narine, Harder, & Roberts, 2019).

METHOD

Referring to Creswell (2014), this research uses an explanatory sequential mixed methods design combining a quantitative approach with a survey method accompanied by interviews and online participatory observations to understand the behavior of digital ICT utilization among farmers in Boyolali Districts, Central Java Province, Indonesia. We used the sampling technique with multistage cluster random sampling. A total of 150 farmers participated in this study, consisting of those from Mojosongo Sub-District (50 respondents), Sawit Sub-District (50 respondents), and Selo Sub-District (50 respondents). Data collection using questionnaires, interviews, and observation instruments was mostly done from July 2021 to May 2022. Observations were made online on several Android-farming applications and WAG of farmers' groups.

Quantitative descriptive statistical analysis and Gamma correlation test using IBM SPPS Statistics 26. A positive Gamma value (i.e., above 0) indicates the direction of a positive relationship, which means that if the value of one variable rises, then the value of the other variable also surges, and vice versa. A negative Gamma value (i.e., below 0) indicates the direction of a negative relationship, which means that if one variable's value rises, the other variable's value goes down, and vice versa. Rea & Parker (2014) suggest association strength intervals based on Gamma values as follows: 0 (no association), 0.01-0.09 (very weak and negligible), 0.10-0.29 (soft), 0.30-0.59 (moderate), 0.60-0.74 (strong), 0.75-0.99 (very strong), and 1.00 (perfect).

RESULTS AND DISCUSSIONS

The Characteristics of Farmers Using Digital ICTs

As advised by many scholars (e.g., Anunobi & Anunobi, 2018; Lubis & Sulistiawati, 2021), the characteristics of farmers who use smartphones analyzed in this study include gender, age, education, family size, farming experience, farming size (farming land area), estimated farm income, Internet quota budget, PC/laptop ownership, support for digital ICT access, and participation in farmers' groups.

Figure 1 presents the characteristics of farmers who use digital ICTs in the Boyolali District. Of the 150 respondent farmers who participated in this study, the majority were men, namely 139 farmers (93 percent), and only 11 people (7 percent) were women because most of the heads of farmer households were men. Women were also part of the farmer households. This study identified some respondents' women actively organizing the farmer women's groups. The gender characteristics of the farmers using digital ICT are similar to the previous findings (Astuti & Hadiyanto, 2018; Beza et al., 2018).

The distribution pattern of farmers' age data on digital ICT users shows that most farmers are 30 to 60. These findings confirm previous studies (Ali, Man, & Muharam, 2019; Beza et al., 2018; Hasan, Rahman, Hoque, Kamruzzaman, & Azizur, 2019; Lubis & Sulistiawati, 2021; Nurrahmah & Sulistiawati, 2022). In the findings, young farmers under 30 years old were only 6 percent, while elderly farmers (over 60 years old) were 9 percent. Interviews with representatives of farmers' group administrators in the study area revealed that elderly farmers tend to find it challenging to adopt agricultural innovations, which has implications for the lack of digital ICT applications to meet agricultural information needs, share knowledge, and improve their farming practices. As he mentioned, the term "old-fashioned farmer" is attributed to the characteristics of farmers resistant to innovation and technological

stuttering. It is unlikely to take on the potential benefits that digital ICT applications facilitate when individual farmers resist agricultural innovation. Within the age of 36 to 57 years old, older farmers were 2.9 percent less likely to use smartphones (Ma, Grafton, & Renwick, 2018); however, the age of 15-35 years old positively and significantly influences the use of smartphones regardless of geographical location (Adams, Omari, & Ransford Teng-Viel, 2020).

Most farmers who use digital ICT have a formal education in Senior High School (53 percent), and those with a secondary-level education amount to 18 percent. Other interesting findings were that 17 percent of the farmers pursue higher education, either a diploma, undergraduate (S1), or magister (S2). These findings prospectively give the optimal use of digital ICT for capacity

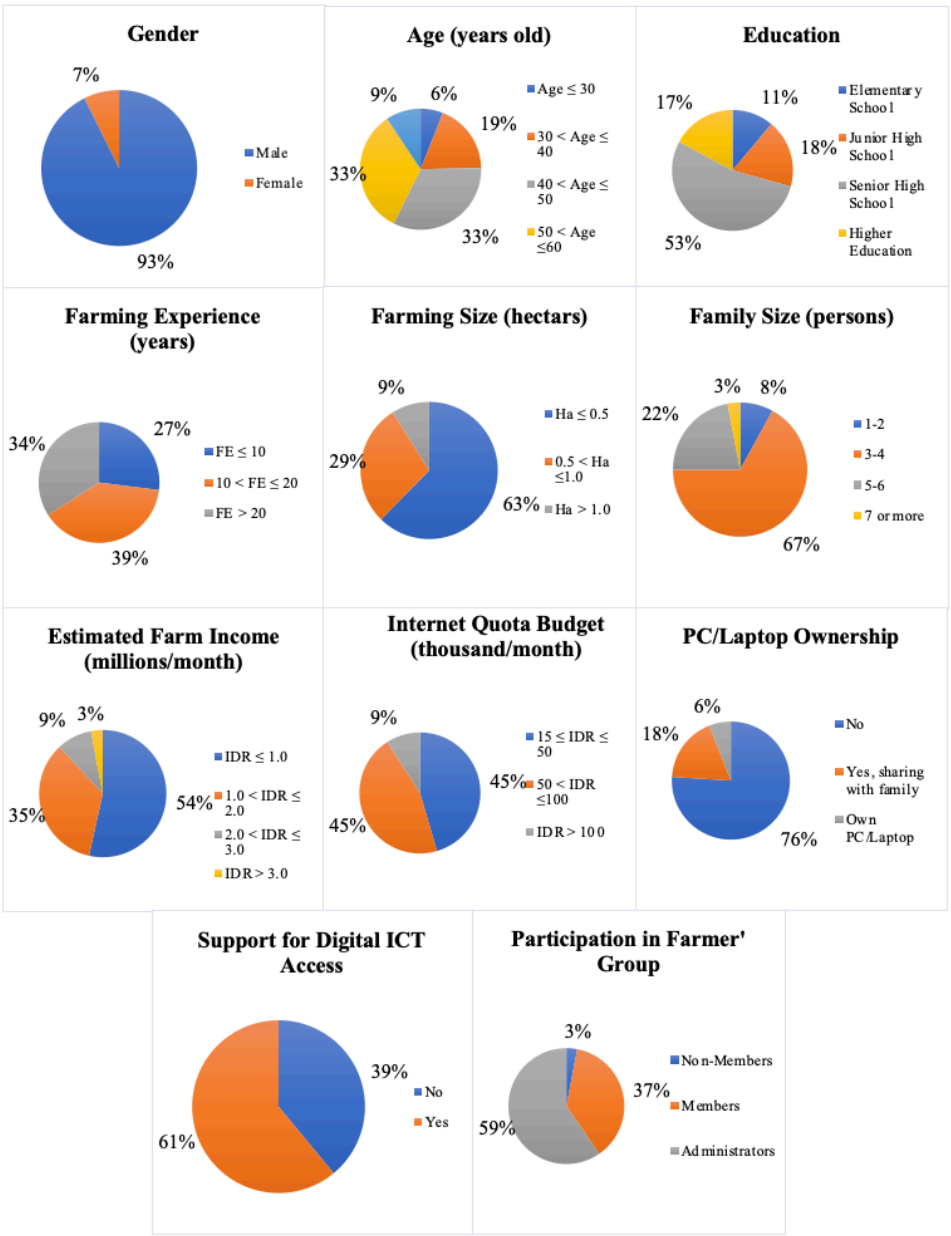


FIGURE 2. Characteristics of Farmers Using Digital ICTs in Boyolali District
Note: USD 1.00 approx. equals to IDR 15,139.92 (Buy)
and 15,292.08 (Sell) (BI rate, 2/14/23)
Source: Based on IBM SPSS 26 output, primary data (2022), N = 150.

development among farmers. However, this study also found that as many as 11 percent of the farmers who use smartphones only study in elementary school. When the farmers have access to digital ICT applications, they should at least read and write as a prerequisite for digital literacy.

For education, these findings are similar to farmers who use ICT for agricultural information in Kediri and Ponorogo District, East Java Province (Nurrahmah & Sulistiawati, 2022) and those who use Android-based farming applications in Sleman District (Astuti & Hadiyanto, 2018). Digital skills and literacy are necessary for mobile-based alternative uses (Adams et al., 2020; Mokhtar, Izhar, Zaini, & Hussin, 2022). Educated individuals are more likely to use smartphones for many purposes, and farmers' education significantly affects smartphone use (Ma et al., 2018). Lack of education affects a lack of awareness of effectively utilizing agricultural ICT services (Mishra, Yadav, Yadav, & Singh, 2020).

As many as 27 percent of the farmers who use digital ICT have carried out farming activities for less than ten years, and 73 percent have more than ten years of farming experience, confirming a previous study (Ali et al., 2019). Farming experience is crucial for acquiring tacit knowledge and reducing farm risks. However, most farmers work on narrow farm sizes, with 63 percent working on less than 0.5 hectares, 29 percent working on 0.5 to 1.0 hectares, and only 9 percent working on more than 1.0 hectares of land. The interviews with farmers' representatives illustrate the choice of cultivated plants, referring to farming experience, the carrying capacity of natural resources, the certainty of crop yields, and the perception of farming business risks.

These findings amplify that farmers in Indonesia generally work on narrow farm sizes of fewer than 0.5 hectares (Lubis & Sulistiawati, 2021; Nurrahmah & Sulistiawati, 2022) and indicate smallholder farming is paramount for the rural population. Narrow land for farming results in low production and low farm income, which will limit smartphone use to access more benefits. Farm size was the main driver of smartphone usage by rural Chinese farmers (Ma et al., 2018) and in the dairy sector in India (Rathod, Chander, & Bardhan, 2016). Ma et al. (2018) argued that farmers with larger farms are more likely to explore new information sources that may be important to manage farm risks efficiently.

Most farmer households (67 percent) consist of 3-4 family members, including in a few size categories, as found in the respondents of farmers using ICT for agricultural practices in Ishwarganj Upazila, Mymensingh District, Bangladesh (Hasan, Rahman, Hoque, & Kamruzzaman, 2019). As for the results of rice farming, as many as 54 percent of farmers who use smartphones estimate their income to be less than IDR1 million per month, and 35 percent earn between IDR1 million to IDR2 million per month because they work on a narrow rice farming land. Most farmers grow rice on less than 0.5 hectares of rice farming land. Thus, when they are not in the field, some work in other business fields, such as opening agricultural kiosks, providing online motorcycle taxi services, building workers, working as village officials, and maintaining farmer households.

For comparison, in a study by Listiani, Setiadi, and Santoso (2019), the average income of farmers in the Mlonggo Sub-District, Jepara District, per the growing season, was IDR8,924,425 per 0.5 hectares. The average income of farmers per month was IDR1,487,404. Smallholders are often trapped in a vicious cycle of low-

intensity, subsistence-oriented farming, low yields, and insufficient profits to make beneficial investments (Meemken & Bellemare, 2020), including benefits from various digital ICT applications.

In Zimbabwe, the adoption of mobile phone use for farming purposes was influenced by age, commercial farming activities, and total income (Masuka et al., 2016). Evidence from Hoa Binh province, Vietnam, also indicated that gender did not impact smartphone adoption for household agricultural production. In contrast, education and farm size positively affected smartphone adoption, and using smartphones for agricultural output helped increase the farm's financial performance (Do et al., 2023).

Although the estimated income from farming activities is relatively low, most farmers allocate a minimum Internet quota of IDR15,000 monthly. Internet quotas are essential for Internet connectivity and access and utilizing various other digital ICT applications/ platforms to increase agricultural productivity. Resource and appropriation theory (RAT) hints at the importance of material (including Internet quotas) in digital ICT access. In addition to smartphone access, 24 percent of farmers have personal computers/PCs to support their agricultural activities. This ICT device's availability provides optimism for using digital ICT applications/ platforms to support farmers' activities. However, on the other hand, as many as 51 percent of the farmers still need help accessing digital ICT applications. Van Dijk (2017) argues that having physical access becomes useless when people cannot use technology because skills and competencies are also required for digital ICTs access. Fortunately, most farmers (97 percent) become members or administrators of farmers' groups. Therefore, when farmers have difficulty accessing digital ICT applications, they may ask their fellow farmers and Field Extension Workers (PPL) for help, in addition to help from their children.

Inequality in Leveraging Digital ICT Applications/Platforms Among Farmers

The final stage of access relates to digital ICT uses (van Dijk, 2017), which can be measured by the intensity, number, and diversity of applications they use, among other things. There are many benefits of digital ICT uses in various applications/platforms which they can access through smartphones, including accessing agricultural information sourced from ICT-based extension information services (Anunobi & Anunobi, 2018; Astuti & Hadiyanto, 2018) and facilitating knowledge sharing, and consultation with experts in real-time (Burhan, Lubis, Kinseng, & Bakti, 2022; Syiem & Raj, 2015).

Many Android-based farming applications (farming apps) are available on Google Apps and can be downloaded and installed. Table 1 presents the number

TABLE 1. Number of Farmers in the Boyolali District Installing Android Farming Applications

Number of Installed Farming Applications	Number of Farmers	
	Frequency	Percentage
0 (not installing)	127	85%
1-2 applications	21	14%
3 applications or more	2	1%

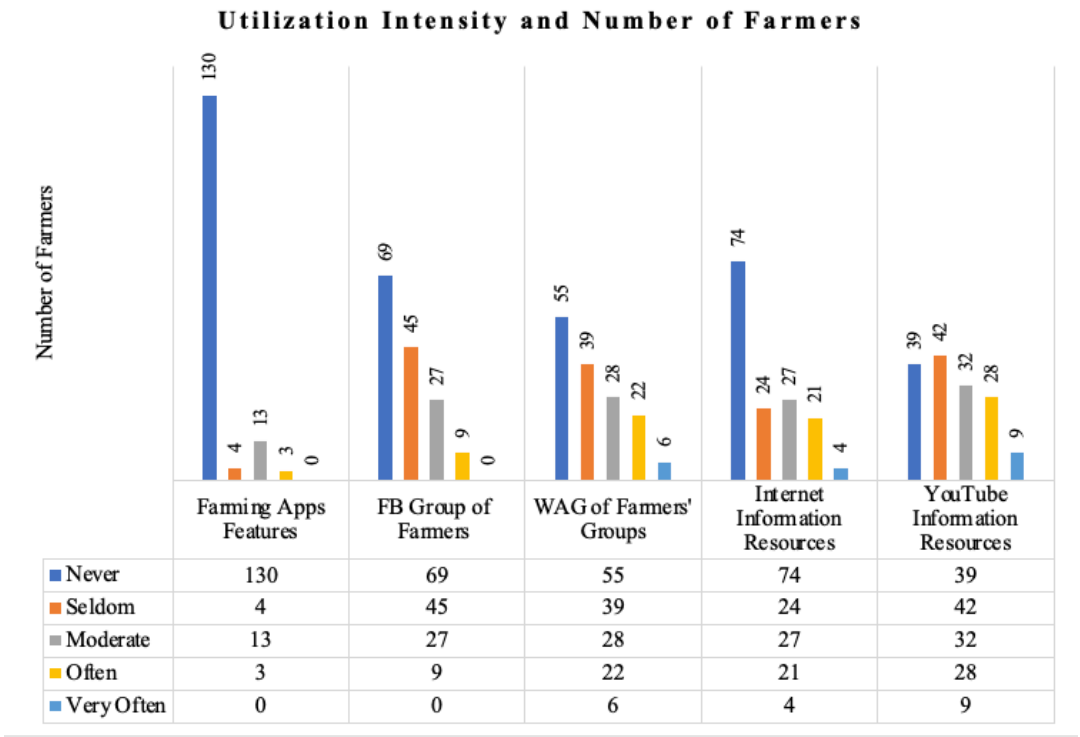
Source: IBM SPSS 26 output, primary data (2022), N = 150

of farmers who install farming apps. As many as 127 (85 percent) farmers have yet to install farming apps, and only 23 (15 percent) have installed them. It means the digital divide in access to farming apps is extreme. In addition, the study identified as many as three farmers needing to take advantage of the features available in farming apps even though they already had installed them. According to the farmer representatives in the interviews, the main reason for the unfrequented use of farming apps for agricultural decision-making is the need for more awareness and knowledge, along with the high cost of the Internet. Because of the high price of Internet access and the limited memory capacity of their cell phones, they uninstall the farming apps while maintaining others perceived as more urgent. In comparison, Thar, Ramilan, Farquharson, Pang, and Chen (2021) found that only 21 percent of smallholder farmers in Myanmar currently use agricultural mobile apps, and most (56 percent) only open them once a month. It also provides evidence of specific barriers among farmers who use smartphones for agricultural productivity (Landmann, Lagerkvist, & Otter, 2021).

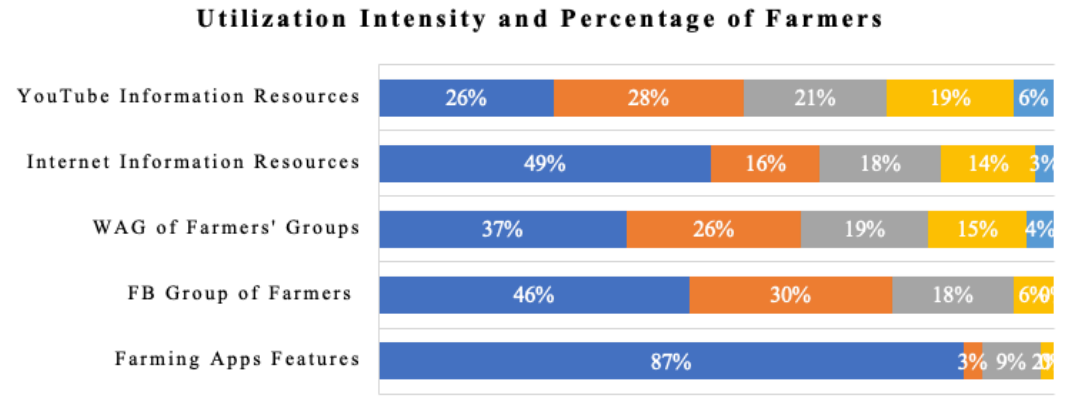
The list of Android-based farming applications used by the farmers in Boyolali District includes Petani (8 villages), Agree (Telkom STO Kebayoran), MyAgri (Balista), Pak Tani Digital (Hagatekno Mediata), Sipindo (Ewindo), Agro Jowo (Distanbun, Central Java Province), IPB Digitani (IPB). Depending on the applications, the menus/features available on the farming apps include discussion or question-and-answer forums, cultivation articles, cultivation videos, shops or catalogs, fertilizer information, fertilization recommendations, fertilizer calculators, information on types of plant diseases and pests, pesticide information, disease, and pest control, information on agricultural tools and machinery, suppliers information, market information, information of agricultural commodity prices, market place, and weather information, financing, and partnership.

Figure 2 illustrates the utilization intensity of digital ICT applications among farmers in the Boyolali District. Firstly, related to the power of leveraging farming apps, only 13 (9 percent) farmers utilize the features of the apps in a moderate category and 3 (2 percent) farmers in an often one, 4 (3 percent) farmers in a seldom one, while 130 (87 percent) farmers have never accessed it. The access and utilization intensity of farming apps among farmers in this study is better compared to studies in other countries. For example, a study in Greece showed that most farmers (95 percent) have never used a mobile farming application for their farming activities (Costopoulou, Ntaliani, & Karetsos, 2016). It could be a lack of custom application development, applications with local content, poor quality of applications, lack of awareness of the application opportunities in target groups, and lack of adoption of such practices by agricultural stakeholders (Costopoulou et al., 2016). In addition, the utility of mobile apps depends on information, contents, and the mandate of application developers (Barh & Balakrishnan, 2018). Most applications are only helpful for specific details, while others are multi-informational. Therefore, Kenny and Regan (2021) suggest designing Android-based farming applications together with farmers to provide empathy for the values and the needs of end-users.

Secondly, this study identified 81 (54 percent) farmers had followed any of the Facebook (FB) groups of farmers while 69 (46 percent) farmers had never accessed it. The intensity of leveraging FB groups of farmers in the seldom category amounted to 45 (30 percent) farmers, moderate one at 27 (18 percent)



	Farming Apps Features	FB Group of Farmers	WAG of Farmers' Groups	Internet Information Resources	YouTube Information Resources
Never	130	69	55	74	39
Seldom	4	45	39	24	42
Moderate	13	27	28	27	32
Often	3	9	22	21	28
Very Often	0	0	6	4	9



	Farming Apps Features	FB Group of Farmers	WAG of Farmers' Groups	Internet Information Resources	YouTube Information Resources
Never	87%	46%	37%	49%	26%
Seldom	3%	30%	26%	16%	28%
Moderate	9%	18%	19%	18%	21%
Often	2%	6%	15%	14%	19%
Very Often	0%	0%	4%	3%	6%

FIGURE 2. Utilization Intensity of Digital ICT Applications among Farmers in Boyolali District
Source: Based on IBM SPSS 26 output, primary data (2022), N = 150

farmers, and often one at 9 (6 percent) farmers. Farmers use any FB groups of farmers to obtain information about pests and plant diseases and their handling, planting calendars, commodity prices, cultivation techniques, fertilizer and fertilization applications, and online sales on a limited scale. The representative of the farmer group administrator in the interviews admitted that he often makes videos with narratives related the cultivation and farming to share content on any FB groups of farmers and WAG of farmers' groups.

Thar et al. (2021) found the same level of Facebook access in Myanmar. In their study, most smallholder farmers surveyed (54 percent) were aware of information received through Facebook groups. They said that Facebook had built trust, and most smallholder farmers used the FB groups effectively. Moreover, they combined information and functionality from farming mobile apps on the FB groups and would have a more sustainable impact. Indeed, social networks such as Facebook have provided a vast space for individuals and social communities to communicate, exchange information, and engage in discussion forums (Firdausi, Prayogi, & Pebriane, 2022).

Thirdly, this study identified that as many as 95 (63 percent) farmers had joined WAG of farmers' groups, while 55 (37 percent) had not. Furthermore, farmers utilized WAG of farmers' groups in a seldom intensity of 39 farmers (26 percent), a moderate one of 28 farmers (19 percent), an often one of 22 farmers (15 percent), and a very often one of 6 farmers (4 percent). For some farmers, sharing information and knowledge through the WAG of farmers' groups is preferred because the members involved in the discussion forum are known from the same villages. In addition, they perceive that their daily communication through WAG groups is more convenient, practical, easier, and faster. These findings, consistent with the study among farmers in Himachal Pradesh, India, demonstrated that the utilization of WhatsApp in agriculture is well understood, accepted by farmers, and used successfully to generate substantial scientific user-generated information about agriculture in various formats (Thakur, Chander, & Katoch, 2018). Putra, Rachmawati, and Cholifah (2021) believed that WhatsApp benefits users for food messages. WhatsApp Network Tools through the Broadcast List send messages to several contacts at once, one message can be sent to one to hundreds of WhatsApp users, and in Indonesia, WhatsApp is widely used as private chats and group chats (Suryono, Rahayu, Astuti, & Widarwati, 2020) and most commonly used because it is the most accessible platform to carry out daily communication and allows a fast response (Sumaryanti & Yuniar, 2022).

Fourthly, this study identified 76 (51 percent) farmers who had accessed the Internet and used the Google search engine to meet their agricultural information needs. Otherwise, 74 (49 percent) farmers have yet to access it. The intensity of leveraging Internet information resources varies. As many as 24 (16 percent) farmers in the seldom power, about 27 (18 percent) farmers in the moderate one, 21 (14 percent) farmers in the often one, and only 4 (3 percent) farmers in the very often one. In comparison, the percentage of farmers who used smartphones to access Internet information sources in this study is much higher than those in Taulka Manjhand, Jamshoro District, Sindh Pakistan, amounting only to 5 percent (Chhachhar et al., 2014).

Fifthly, 111 (74 percent) farmers accessed Youtube information resources, while 39 (26 percent) farmers never accessed it. YouTube information resources are more accessible compared to other digital ICT applications/ platforms. Furthermore, as many as 42 (28%) farmers rarely access YouTube information sources, 32 (21%) farmers a moderate intensity, 28 (19%) farmers one, and 9 (6%) farmers very often. The representation of farmers' group administrators said that YouTube is a substantial information resource for agricultural innovations. In addition, the contents of YouTube are available in audio-visual and tutorial formats, making it easier to understand. At the same time, they are willing to share the links to the

WAG of farmers' groups. Tambade, Gonjari, and Singh (2019) inferred that YouTube channel helps to improve knowledge of farming and enhance the adoption of innovation and technologies, and improve technologies which leads to increased productivity and farm income.

Correlation between Farmers' Characteristics and the Preference for Digital ICT Applications

Table 2 describes the correlation between the individual characteristics of farmers and the utilization preferences of digital ICT applications/platforms among farmers. When obtaining information, sharing agricultural knowledge, asking questions, responding to other farmers' questions, and support farmers' activities: (1) Female farmers utilize the WAG of farmers' group more than male; (2) The older the age, the fewer farmers utilizing the FB groups of farmers (3) The higher the level of formal education, the more farmers make use of farming apps and YouTube information sources; (4) The more significant the farmers' farm size, the more farmers increase access to the FB groups of farmers; (5) The better the income level from farming activities, the more farmers make use of farming apps, Internet/Google, and YouTube information resources; (6) The higher the budget for Internet quota, the more

TABLE 2. Correlation between Farmers' Characteristics and the Utilization Intensity of Digital ICT Applications/Platforms

Farmers' Characteristics	Number of Installed Farming Apps		Utilization Intensity of Digital ICT Applications/Platforms									
			Farming Apps		FB Group of Farmers		WAG of Farmer Group		Internet Information Sources		YouTube Information Sources	
	Value[a]	Sig.[b]	Value[a]	Sig.[b]	Value[a]	Sig.[b]	Value[a]	Sig.[b]	Value[a]	Sig.[b]	Value[a]	Sig.[b]
Gender	-0.310	0.459	-0.162	0.732	-0.340	0.194	0.530	0.007	-0.282	0.344	0.092	0.717
Age	-0.225	0.129	-0.195	0.211	-0.365	0.000	-0.057	0.535	-0.196	0.055	-0.143	0.135
Family Size	-0.003	0.989	-0.049	0.813	0.056	0.670	-0.129	0.291	-0.020	0.879	0.084	0.501
Education	0.670	0.000	0.639	0.000	0.070	0.534	0.018	0.861	0.164	0.123	0.251	0.008
Farming Experiences	0.003	0.986	0.073	0.681	-0.111	0.288	0.141	0.170	-0.051	0.639	-0.049	0.636
Farming Size	0.096	0.640	0.239	0.251	0.320	0.008	0.087	0.418	0.168	0.164	0.120	0.299
Farm Income	0.370	0.046	0.510	0.006	0.219	0.054	0.025	0.821	0.262	0.012	0.328	0.000
Internet Quota Budget	0.561	0.004	0.578	0.005	0.386	0.001	0.250	0.017	0.173	0.138	0.308	0.003
PC/Laptop Ownership	0.447	0.050	0.376	0.122	0.392	0.004	0.213	0.096	0.291	0.040	0.515	0.000
Support for Digital ICT Access	-0.086	0.707	0.124	0.598	-0.090	0.514	0.075	0.558	-0.210	0.097	-0.026	0.836
Partic in Farmer Group	0.063	0.769	-0.068	0.757	0.026	0.839	0.376	0.002	-0.086	0.487	-0.011	0.920

[a] The Gamma coefficient r value represents the direction and strength of the association. Gamma values are as follows 0 (no association), 0.01-0.09 (very weak and can be ignored), 0.10-0.29 (soft), 0.30-0.59 (moderate), 0.60-0.74 (strong), 0.75-0.99 (very strong), and 1.00 (perfect).

[b] Estimated the significance of the correlation between the variables of farmers' characteristics and utilization intensity of digital ICT applications. If the value of Approx. Sig≤ 0.01, the correlation between variables is very significant, if Approx. Sig≤ 0.05, the correlation between variables is substantial, and if Approx. Sig> 0.05, the correlation between variables is not essential.

Source: IBM SPSS 26 output, primary data (2022), N = 150

farmers make use of all digital ICT applications, except Internet/Google information sources; (7) Farmers' access to PCs/Laptops further increases the number of Android-based farming apps installed, as well as increases the intensity of utilization of FB groups of farmers, Internet information sources, and YouTube information sources as well; (8) Involvement in farmers' groups, either as members or administrators increases the intensity of utilization of WAG of farmers' groups. When the Gamma value shows a significant correlation between farmers' characteristics and the intensity of using digital ICT applications, the association strength ranges from weak to vigorous. However, family size, farming experience, and the need for help accessing digital ICT applications did not correlate significantly with the intensity of utilization of all digital ICT applications/platforms.

The correlation between farmers' characteristics and the intensity of digital applications is unique and reflects farmers' preference for utilizing digital ICT applications. As shown in studies in Pakistan, farmers' choice or adoption of some information resources gets influenced due to various factors, including farmers' socioeconomic characteristics and the level of perception of certain ICT benefits (Rabbi et al., 2020). Farmers' preferences for leveraging digital ICT applications/platforms indicate their choice over several digital ICT applications/platforms. For example, from the perspective of Uses & Gratification (U&G) theory, a study conducted by Narine et al. (2019) in Trinidad showed that almost all farmers (200 respondents) used text messages and mostly used multimedia and WhatsApp messages. The authors suggest that two-way ICT is contextual for communicating with farmers and highlight the importance of understanding farmers' information needs and preferences to ensure the effective delivery of extension services. While many ICT media are available, communicators should seek to take advantage of such media that are widely accessible and adopted by the target audience. Farmers require adequate ICT to use and improve their knowledge of agricultural practices (Fu & Akter, 2016).

This study was characterized by the profiles of farmers using digital ICT, mostly over 40 years old. The older the farmers, they will tend to reduce the use of all digital ICT applications, especially FB groups of farmers and Internet information sources. Most farmers have completed senior high school (53 percent) and higher education (17 percent), which potentially increased the intensity of utilizing digital ICT applications, especially farming apps and YouTube information sources. However, they were smallholder farmers with narrow farming sizes and low incomes. The variables of farming size and farm income determined the intensity of utilizing digital ICT applications, especially farming apps, FB groups of farmers, Internet information sources, and YouTube information sources. Even though income was relatively low, some farmers also worked in other business sectors, which allowed them to allocate internet quota budgets for connectivity to various digital ICT applications. From the interviews with farmers' representatives, the farmers' choices of various alternative digital ICT applications were also subject to cultivated plants and their farming experiences, ease of use of digital ICT applications, the memory capacity of smartphones, and costs to access digital ICT applications. Some farmers uninstalled farming apps for these reasons.

The use of digital ICTs in the agriculture sector in Indonesia indicated several opportunities and challenges (Burhan, 2018). For instance, Harahap

(2016) found that only 12 respondents (12 percent) out of 100 farmer households in Halongonan Sub-District, North Padang Lawas District, North Sumatra Province had Internet access (via cell phones, tablets, PDAs/smartphones) and the Internet utilization to fulfill agricultural information remained very low, especially in hill areas. Seminar & Sarwoprasodjo (2019) reported that 256 smallholder farmers had joined the WhatsApp Group (WAG) of Serikat Petani Indonesia (SPI) to discuss organic farming and support their farming activities. Lack of knowledge about digital ICTs, skills to operationalize digital ICTs, high cost of Internet access, the scale of agriculture, and access to government e-agriculture have been perceived as challenges in using digital ICTs among smallholder farmers. A survey targeting respondents below 35 years of age in the Tumpukrenteng Village, the northern part of the Turen Sub-District in Malang, also identified substantial gaps in Internet use, even among digital natives in rural areas (Onitsuka et al., 2018).

As predicted by many researchers (e.g., Park, 2017; Hargittai, Piper, & Morris, 2019; Lubis & Sulistiawati, 2021), studies on the use of digital ICT have been linked to trends in digital divides and inequality. However, our study analyzed various digital ICT applications/platforms that farmers can utilize according to their characteristics of farmers and their specific needs. Each digital ICT platform as a medium for farmers to meet their agricultural information needs and share knowledge has typical technological characteristics, features, and potentially different content and communication contexts. Farmers tend to be more receptive to information that is more accessible and relevant to their particular context (Deichmann, Goyal, & Mishra, 2016). Therefore, digital ICT applications that are user-friendly and focus on specific and localized cultivation can empower farmers, particularly those with low income (i.e., according to the needs of smallholder farmers) (Karetsos, Costopoulou, Gourdomichali, & Ntaliani, 2022). This work requires close collaboration between application developers, governments, agricultural extension workers, farmers' communities, farmers' group administrators, farmers, and other agricultural stakeholders who can support digital transformation and the development of knowledge-intensive agriculture.

CONCLUSION

This study concludes at the same time as a novelty. Most farmers who used digital ICT in Boyolali Districts, Central Java Province, are small-holders with narrow farming sizes and low farming income and substantial for agriculture development in rural areas. However, they allocated a monthly Internet quota budget, allowing them connectivity. Hence access and utilize preferred digital ICT applications/platforms to meet their agriculture information and knowledge-sharing activities. While digital inequalities remain a concern of diffusion, acceptance, and adoption of new technologies for many scholars and policymakers, this study postulates to explore the preference of farmers, especially small-holders, in leveraging digital ICT applications/platforms which fit the specific context and engaging them more efficiently and effectively through information and communication networks and media.

It also postulates the strategic roles of digital ICT applications/platforms in knowledge-intensive agriculture that consider the characteristics and vulnerabilities of small-holder farmers. Therefore, to show empathy and value to them, all agricultural stakeholders, including Android-based farming

application/platform developers, farmer communities and their administrators, agriculture extension works, agriculture experts, scholars, NGO development initiative sponsors, and government bodies should appreciate farmers' reception and preference when developing, adopting, generating contents, and engaging in digital ICT applications/platforms. We believe it makes individual farmers more active in leveraging existing and future digital ICT applications/platforms.

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