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How Does Information and Communication Technology (ICT) Affect Oil Palm Agricultural Practices?

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Abstract

This study investigates the factors influencing the adoption of Information and Communication Technology (ICT) among oil palm-independent smallholders and assesses their perception of the use of ICT in agricultural practices. Through personal interviews with 384 independent smallholders, this research examines the relationship between respondents' demographic characteristics and smartphone usage, identifies the factors influencing ICT adoption among oil palm independent smallholders (ISH), and evaluates the extent of ICT usage perceived by ISH. The analysis of the Chi-square test showed a significant difference $p<0.05$ between the education status of farmers and their use of smartphone brands, the time spent on social media, and the experience with the smartphone. The findings reveal a widespread agreement among smallholders on the value of smartphones, reflecting their recognition of the importance of ICT. However, the study highlights that accessibility to ICT facilities emerged as a significant factor with the lowest mean score, indicating a lack of adequate infrastructure in the surveyed areas. Furthermore, respondents expressed dissatisfaction with the current state of ICT facilities. Conversely, most respondents emphasized the significance of accessing online information on fresh fruit bunch (FFB) prices and demonstrated an eagerness to obtain agricultural information online. This study also emphasizes the need to understand the factors driving ICT adoption among ISH and underscores the importance of enhancing accessibility to ICT facilities and improving satisfaction with existing infrastructure. Empowering ISH to leverage ICT tools effectively can enable them to access vital information and establish efficient connections with potential markets in the digital era. Smartphones as ICT tools have revolutionized the agricultural sector by improving access to information, financial services, and advanced farming tools, thereby fostering higher efficiency and sustainability in agricultural practices.

Keywords: Agricultural practices, extension service, information and communication technology, smallholders, smartphone

Introduction

Information and communication technology (ICT) encompasses all types of computer and communication devices and software utilised to generate, design, store, transmit, interpret and manipulate information in its diverse representations. ICT tools encompass a wide range of devices, including personal computers, laptops, tablets, mobile phones, radios, television and transportation systems (Aker, 2011). It also involves the associated services and functions, such

as web portals, email, short message service (SMS), video conferencing, etc. Various studies have examined farmers' access to and utilization of ICT tools in food crops and poultry (Swanzy et al., 2020). However, most smallholders primarily rely on non-ICT sources to obtain information, particularly about their oil palm production and marketing activities in Ghana (Swanzy et al., 2020). For instance, Agwu and Uchechi (2019) defined online communication tools have allowed smallholders to share their stories and directly market their products to a broader audience. The benefits of ICT have yet to reach all farmers. Many farmers, especially marginalised or sharecroppers, need to receive these services due to poor economic conditions and social restrictions (Rotz et al., 2019). Other contributing factors include illiteracy, language barriers, and a reluctance to adopt new technologies. A new trend in agricultural development is emerging in both developing and developed countries. The overall development of the rural sector is taking a new direction, challenging the traditional ways of delivering services to citizens and transforming traditional societies into knowledge-based ones. Applications of ICT as E-connectivity are central to this new social order. It is necessary to develop the capacity to generate, absorb, disseminate and protect knowledge and use it as a powerful tool for social transformation (Banerjee, 2011). ICT can enhance the functionality of social organisations and agricultural productivity, serving as a potential catalyst for change. An agricultural extension now includes sectors beyond agriculture, including health, rural business studies, and agricultural marketing, and is taught by professionals of various disciplines. With the help of ICT, agricultural extension can become more diversified, knowledge-intensive, demand-driven, and more effective in meeting farmers' information needs (Kountios et al., 2023; Samadder & Rao, 2023).

In recent years, the field of extension services has undergone a digital transformation, moving away from traditional methods towards digitizing services. ICT has garnered significant attention from smallholders and stakeholders at national and international levels to enhance agricultural production and foster sustainability (Zhang et al., 2016; Morrar et al., 2019; Jere & Maharaj, 2017; Gómez-Chabla et al., 2019). The widespread belief is that digitalization holds excellent potential for delivering productivity and sustainability benefits to the agricultural sector (Fielke et al., 2020). Digital tools offer numerous advantages to smallholders, enabling them to receive real-time weather updates, share adaptation strategies, maintain digital records of risk management practices, access relevant information, and obtain guidelines for effective risk management. Additionally, these technologies facilitate communication and collaboration among smallholders, extension workers, and relevant agricultural agencies. With ICTs, smallholders can stay informed about the latest farm management practices, enhancing their knowledge and decision-making capabilities (Milovanovic, 2014).

ICT solutions offer significant relevance and remarkable potential. It is undeniable that smallholders have already embraced various ICT tools, including online communication platforms, as an integral part of their daily lives (Ali et al., 2018; Samsuddin et al., 2016) with notable penetration in the agricultural sector (Islam & Grönlund, 2012). Online communication tools, such as mobile phones, have become commonplace among smallholders, and their positive attitude towards these tools is steadily increasing, driven by the substantial benefits they offer in agricultural practices. According to Jere and Maharaj (2017), ICT-based interventions have tremendous potential to improve profitability, production, and efficiency for smallholder farmers, ultimately contributing to food security. However, the lack of timely awareness regarding agricultural risk management perpetuates a cycle of poverty among resource-poor smallholders, resulting in limited food availability, food insecurity, and various socio-economic challenges (Hansen et al., 2019). Additionally, the existing agricultural extension and advisory systems, designed to assist smallholders with diverse farm-related

issues, are struggling to meet the information needs of the growing smallholder population (Maqsood, 2015).

The impact of natural disasters, especially floods, on smallholder production, agricultural land, and overall progress in Malaysia has been significant (Austin et al., 2012). For example, earthquakes can cause damages that hinder traditional farming practices (Epstein et al., 2017). Climate change also negatively affects smallholders' resilience (Irham et al., 2021). These disasters emphasize the vulnerability of smallholders and the need for effective strategies to mitigate risk. Risks can vary based on location and resources available to cope with them (Alam et al., 2012). To ensure sustainable development, it's crucial to implement innovative technologies and strategic policies as soon as possible (Bekhet & Latif, 2018). Empowering farmers with the use of ICTs as online communication tools can effectively mitigate anticipated risks in the agricultural sector (Mittal, 2012). Various ICT tools can assist farmers in proactive preparation and risk assessment, and mobile phone services have enabled farmers to access vital information about markets, weather conditions, transportation, and agricultural techniques while also connecting with relevant agencies and departments (Aker, 2011; Öspina et al., 2014).

ICTs offer promising solutions to enhance the resilience of smallholders in Malaysia. By utilizing geographic information and ICTs, smallholders can receive crucial information related to agriculture, climate, and disaster risks, leading to improved livelihood security and climate change adaptation (Haworth et al., 2018). Additionally, adopting ICTs such as mobile phones and the Internet can revolutionize existing extension systems and support the sustainability of smallholder farming systems (Mapiye et al., 2021). ICTs can play a vital role in mitigating risks for Malaysian smallholders by providing timely information for decision-making, improving productivity, and facilitating market access. For example, ICT-based interventions can integrate smallholders into higher-value agricultural value chains, addressing their constraints (Okello et al., 2010). Moreover, adopting ICTs can enhance the dissemination of agricultural information and services, ultimately boosting productivity and resilience among smallholders (Mapiye et al., 2021). Despite attempts to facilitate knowledge transfer in agriculture through mobile phone usage, the outcomes have been unsatisfactory due to the inadequate provision of services, particularly in remote areas (Javaid, 2017).

Consequently, the integration of ICT, especially online communication tools, has the potential to benefit the agricultural sector greatly. However, Malaysian smallholders still face challenges in adopting ICT tools to access agricultural information, and the extent of their implementation remains largely unknown (Khan et al., 2019). The limited adoption of ICT tools among oil palm smallholders is influenced by high startup costs, lack of expertise, inadequate infrastructure, perceived lack of benefits, and low education levels (Mahata & Mhagama, 2022; Ahmad et al., 2025). These factors hinder the adoption of these tools, as they may not see immediate benefits and may reluctance to change traditional farming practices (Adnan et al., 2022; Bondzie, 2023). Over time, the traditional delivery of extension services has evolved into digitizing such services. However, Malaysian smallholders still lag in adopting ICT tools as well as smartphones for accessing agricultural information. Therefore, the paper explores the factors influencing the adoption of ICT among oil palm-independent smallholders and reveals their perceived extent of ICT usage.

Review of literature

Oil palm independent smallholders

According to the Malaysian Palm Oil Board (MPOB) Licensing Regulations 2005, an independent smallholder is defined as someone who owns land less than 40.5 hectares

individually or in aggregate. As of December 2021, there were a total of 228,702 independent smallholders (ISH) in Malaysia, covering a land area of 863,360 hectares (MPOB, 2022). This accounted for approximately 15% of the overall oil palm planted area in the country. Small-scale production operations characterize the oil palm-independent smallholder sector and have often been perceived as less efficient and productive compared to the larger-scale production system of the estate sector.

Independent smallholders of oil palm in Malaysia encounter significant knowledge-related challenges. They receive limited institutional, technical, and financial support and face a lack of information regarding best practices and new technologies (Nagiah & Azmi, 2012). Smallholders must receive targeted and practical assistance to access expanding markets, financial resources, and high-quality management consulting services. This will help them effectively address the growing issues they face. With this knowledge, smallholders can cultivate appropriate agricultural products and secure their incomes. Increasing palm oil production is crucial to improve the well-being of smallholders and to increase the competitiveness of the country's exports. To achieve higher revenues, oil palm smallholders must adopt modern farming and harvesting technologies to increase productivity (Awang et al., 2016).

Extension services in farm management

The integration of ICTs in agricultural extension practices has progressively facilitated communication between extension workers and farmers, enabling the provision of information and dissemination of new technologies over long distances. This improved access to information empowers farmers to enhance their production, income, and overall quality of life. Research conducted in Nigeria (Agwu & Uchechi, 2019) reveals that many extension personnel have access to computers, radios, telephones, televisions, and video recording equipment, which, with the appropriate training, infrastructure, and funding, could be effectively utilized in their activities. Extension officers have observed positive transformations in adopting ICTs and recognize that these technologies have significantly reduced the challenges of reaching farmers. Although the full integration of ICTs into all aspects of extension work has not yet been achieved, there is optimism that these technologies will be widely embraced and incorporated into most extension duties on a larger scale in the coming years.

Agricultural extension programs are crucial in addressing rural poverty and promoting food security. These programs serve as effective platforms for transferring technology, supporting adult learning in rural areas, assisting farmers in problem-solving, and actively involving them in the agricultural knowledge and information system (Christopolos & Kidd, 2000). By facilitating the exchange of knowledge, providing support, and encouraging farmer participation, agricultural extension programs empower farmers to enhance their practices, adopt new technologies, and overcome challenges. As a result, these programs contribute significantly to poverty alleviation efforts, increased food production, and overall food security in rural communities.

Use of smartphones in extension services

Agriculture is undoubtedly an information-sensitive sector (Deloitte, 2012), and Opara (2008) emphasized the increasing importance of information in agriculture for farmers' effective decision-making. Some argue that information should be considered a public good and made widely available (Ferris et al., 2014; Ugochukwu, 2020). Thus, it is essential that farmers have access to trustworthy information sources (Manfre & Nordehn, 2013). Extension practitioners increasingly promote ICT-enabled services as an alternative to traditional face-to-face

extension approaches. These services encompass a range of options, such as radio programs with additional features, television shows, mobile technology services, and the Internet. ICTs are considered cost-effective and can provide timely, relevant, and actionable information to farmers in remote areas and diverse populations. They are particularly seen as a valuable tool for delivering extension services to rural farmers, especially women, who are economically disadvantaged (Manfre & Nordehn, 2013). The information provided through ICTs covers various aspects, including specific technologies, market access, price information, weather updates, and early warnings of droughts, floods, and diseases. This empowers farmers to make more informed decisions regarding crop selection and improvement of agricultural practices.

The increasing ownership of mobile phones among the rural population in developing countries presents an opportunity to deliver essential agricultural services to smallholder farmers through mobile-enabled extension messaging (Kamal & Bablu, 2023). To bridge the digital divide and ensure sustainable agricultural growth, new ICTs must be disseminated among end-users to facilitate the timely transfer of information. Changes in agriculture's structure, the emergence of new farming technologies, limited public budgets, decentralization efforts, and advancements in information and communication technologies (ICT) have led to pluralistic and, in some cases, cost-effective extension and advisory services. These services combine both public and private mechanisms for financing and implementing extension activities (Norton & Alwang, 2020).

The role of farmer groups and virtual networks in technology diffusion is growing, and extension services can leverage these networks by utilizing the latest ICT approaches (Norton & Alwang, 2020). Therefore, there is a need for more effective extension services to address agricultural challenges, especially in meeting the information needs of impoverished smallholder farmers in developing countries. In response, agricultural extension experts and institutions worldwide are promoting the utilization of ICT by agricultural extension and education agents. ICTs can expedite agricultural technology transfer from research and development institutions to farmers. By supporting farmer learning, problem-solving, and facilitating access to profitable crop markets, ICTs enhance agricultural technology adoption (World Bank, 2011). The dependence of smallholder farmers on interpersonal sources and their limited access to information have been identified as significant constraints that continue to hinder their participation in markets. The lack of market information places smallholder farmers at a disadvantage and makes them susceptible to exploitation when interacting with better-informed market participants (Magesa et al., 2015).

To effectively employ farmer groups and virtual networks for extension services, several problems need to be overcome. Extension services frequently encounter limitations regarding personnel, financial resources, and infrastructure, which can impede the efficient utilisation of farmer groups and virtual networks (Agoda et al., 2017). Sufficient resources are crucial for the construction and upkeep of these networks. Farmers may have insufficient digital literacy abilities to effectively utilise information and communication technology tools and virtual networks (Rai, 2023). To tackle this challenge, it is necessary to offer training and support to improve the digital skills of farmers and guarantee their active involvement. Geographical barriers such as rugged terrain, isolation, and lack of technological infrastructure can hinder the delivery of extension services to farmers (Pun, 2022). It is essential to overcome these geographical obstacles to guarantee fair and equal access to information and assistance for all smallholders. The lack of extension personnel can hinder the efficient execution of extension services via farmer groups and virtual networks (Mojaki & Keregero, 2019). Expanding the quantity of well-trained extension personnel is crucial to offering sufficient assistance and direction to farmers. The long-term viability of extension programs that depend on farmer groups and virtual networks is contingent upon the dedication and capability of

volunteer trainers, as well as the efficacy of governance structures (Kiptot & Franzel, 2015). Securing the long-term sustainability of these programs is crucial for their effectiveness.

Mobile technology allows smallholders to access agricultural extension services remotely, enabling them to contact hotlines for technical advice, receive market information, and stay current on best practices (Mojaki & Keregero, 2019). Social media platforms and digital spaces can also serve as valuable sites for extension services, facilitating interactive communication, knowledge exchange, and virtual advisory services (Klerkx, 2021). These platforms enable real-time interactions, discussions, and sharing of relevant agricultural information. Furthermore, integrating radio, e-media, and other ICT tools into national agricultural policies can significantly enhance the reach and impact of extension services (Manda & Chapota, 2015). By utilizing diverse ICT platforms, extension services can effectively communicate with farmer groups, disseminate vital information, and provide timely support to smallholders. These approaches improve the accessibility of agricultural information and advisory services, empowering smallholders to make informed decisions and adopt sustainable agricultural practices. Additionally, adopting ICT in extension services can help overcome constraints such as inadequate training, limited resources, and low farmer-to-extension worker ratios (Agoda et al., 2017). Using ICT tools and virtual networks, extension services can improve their effectiveness in reaching and supporting smallholder farmers. Furthermore, using ICT-supported extension services in conservation agriculture can improve information access and knowledge sharing among smallholders (Cox & Sseguya, 2015).

Research findings indicate that ICTs contribute to improving the productivity and livelihoods of impoverished smallholder farmers (Munyua et al., 2009). Research and extension play a significant role in the adoption and diffusion of agricultural technology among farmers. It is crucial for extension workers to actively engage in farmers' activities and assume a central role in teaching and disseminating information and communication technologies. Farmers can swiftly access information on weather conditions, marketing opportunities, and other advisory services by harnessing the potential of mobile phone cellular technology. Ilahiane (2023) asserts that cellular technology has revolutionized how farmers share information and communicate with markets and urban areas, enabling them to obtain relevant information for decision-making. Mobile phones can serve as a medium for disseminating timely information on various aspects, including optimal farming practices, seed availability, crop planning, weather forecasts, fertilizer usage, market updates, organic farming techniques, vaccination information, insurance alerts, livestock diseases, different breeds (exotic and indigenous), livestock management practices, and government schemes for the agriculture and allied sectors (Panda et al., 2019; Shrestha et al., 2020).

In developing countries like Malaysia, where the oil palm industry significantly contributes to the gross domestic product (GDP), it is essential to acknowledge its importance in an era of rapid transformation. Information technology is crucial in providing users with accurate and timely information in the most suitable format. The generation and application of agricultural knowledge are becoming increasingly vital, particularly for small and marginal farmers who require relevant information to improve, sustain, and diversify their farm enterprises. The Internet is a mass medium and a global platform capable of reaching individuals worldwide. It is a unique channel for mass communication that has challenged and even altered some fundamental concepts associated with traditional mass media (Ohiagu, 2011). The use of information technology is a fundamental component of agricultural extension, as highlighted by (Raghuprasad et al., 2012).

Social media

Social networks are platforms that facilitate interaction among individuals. Kaplan and Haenlein (2010) provide a definition of social media as "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0 and allow the creation and exchange of user-generated content." Social media has revolutionized various aspects of our lives, transforming how we communicate, read, search, think, converse, consume media, and even spark political or social movements. Social media is more than just technology; it encompasses the sociology and psychology of communication.

Engaging in social networks involves activities such as creating online profiles, posting comments or messages, sharing photos and videos, reacting to or liking others' posts, sharing links, tagging content, creating and sharing game modifications, remixing existing content, and sharing it further. According to Walsh (2022), the planet has 4.65 billion social media users. That's 58.7% of the global population, many of whom use social media as a primary source of information. These include Facebook (with over 2.90 billion monthly active users), YouTube (with 2.2 billion monthly active users), WhatsApp (with 2 billion monthly active users), Instagram (with 2 billion monthly active users) and TikTok (with 1 billion monthly active users).

Social media platforms have profoundly impacted various aspects of our daily lives. They present significant challenges to traditional institutions like mass media and government authorities (van Dijck & Poell, 2013). Over the past decade, ICT-based extension delivery mechanisms have emerged as innovative ways to provide agricultural extension services. These mechanisms combine convergence-based approaches with farmer-friendly, crop-specific, enterprise-specific, and market-led extension services. Social media has become an increasingly important medium for sharing information and raising awareness. Platforms such as Facebook, WhatsApp, Twitter, YouTube, and blogs are being utilized to engage with diverse audiences and disseminate relevant information. These platforms offer new avenues for communication and knowledge sharing in the agricultural sector.

Smartphone

Smartphone technology offers unique characteristics compared to basic mobile phones. While basic telephones are limited to text messaging and voice calls, smartphones allow users to customise their devices by installing various applications. This transforms smartphones into versatile tools, such as navigators, dictionaries, personal schedulers, and digital cameras, making them essential for superusers (Böhmer & Krüger, 2013). As smartphones have become perceived as a necessity by consumers, individuals tend to develop a strong dependence on their devices and engage in continuous usage, integrating smartphones into their everyday lives (Tian et al., 2009). A study conducted Lazim & Sasitharan (2014) confirmed that perceived usefulness plays a significant role in driving smartphone technology acceptance among young adults in Malaysia.

Several mobile phone companies operate in Malaysia, including Celcom, Maxis, Digi, U-mobile, TM-Unifi, XOX, and YES. These companies provide 4G and 5G technologies, enabling customers to access the internet on their mobile phones. However, smallholders face significant constraints in terms of access, efficiency, and affordability of agricultural information, which hinders their ability to enhance agricultural productivity (Muriithi et al., 2009). The use of cellular mobile phone technology offers a convenient and cost-effective means for farmers to access relevant information. Chisita (2010) highlights the immense potential of ICTs in disseminating agricultural information. Through social networks, telecentres, and other ICT-driven communication devices, smallholders can share knowledge

and experiences. It is crucial to recognize the benefits of information technology in the current information age, as digital and communication technologies have influenced nearly every field. Tantisantisom (2011) suggests that using ICTs in farmers' native language to learn new techniques and profitable agricultural production methods can encourage their adoption of advanced practices and improve agricultural production. Information and communication technology encompasses various technical tools and resources that are utilized to communicate, disseminate, store, and manage information.

The use of mobile phones, particularly smartphones, in agriculture is widespread, and the e-agriculture platform continually showcases numerous examples of their application. Smartphones with internet connectivity and touchscreens have gained significant popularity worldwide and have become deeply embedded in contemporary societies. It is estimated that globally, 6.64 billion people own smartphones, which is expected to reach 83.40% of the global population by 2021 (Taylor, 2023). Mobile phones serve as effective tools for communication and information sharing between farmers and extensionists. By formulating appropriate messages and addressing issues such as illiteracy, farmers can be empowered to utilize mobile phones to access valuable information and adopt new technologies and improved practices. The convenience, speed, and ease of use associated with mobile phones have made them highly appreciated within farming communities. That is supported by Nyagango (2023), which smallholders are increasingly using smartphones to access agricultural information, including marketing, farm management software, crop-specific information, and digital agricultural technologies. They use smartphones to access marketing information, farm management software, data analytics, and smart irrigation systems (Gumbi, 2023). Studies have shown that mobile phone information can improve productivity in specific crops such as maize (Kisena, 2023). These smallholders use digital platforms to address production and marketing issues (Hoang, 2023).

However, mobile phones offer farmers a convenient means of communication and provide access to information on marketing and weather conditions, enabling them to make informed decisions. They also allow farmers to stay updated on weather forecasts for planning agriculture-related activities such as applying fertilizers and pesticides. Farmers can stay informed about weather forecasts, which is essential for making decisions on agricultural inputs like fertilizers and pesticides. Moreover, mobile phones have facilitated direct communication among farmers, allowing them to share knowledge and exchange information on recent advancements in the agricultural sector (Chhachhar & Md Salleh Hassan, 2012).

Smartphones have emerged as the most popular devices for accessing the internet, with a significant majority of internet users relying on smartphones for online activities (Taylor, 2023). Ultimately, smallholders utilize their smartphones to obtain a diverse array of agricultural information, encompassing marketing data, software for farm management, particular knowledge about crops, sustainable methods, digital technology, and tactics for overcoming limitations. Access to a wide range of agricultural information is essential for improving farming techniques, productivity, and general quality of life.

Factors influence ICT use in agriculture

ICT plays a crucial role in the agricultural sector by facilitating knowledge sharing among various stakeholders, including researchers, exporters, extension services, traders, and farmers (Pandey, 2017). However, challenges are associated with adopting and using ICT in agriculture, especially in rural areas where farmers often lack access to updated and relevant agricultural information. Farmers in rural areas face difficulty accessing agricultural awareness and information, leading to inadequate knowledge about high-crop production techniques. This

lack of updated information hinders their ability to make informed decisions and implement effective farming practices (Mapiye et al., 2023)

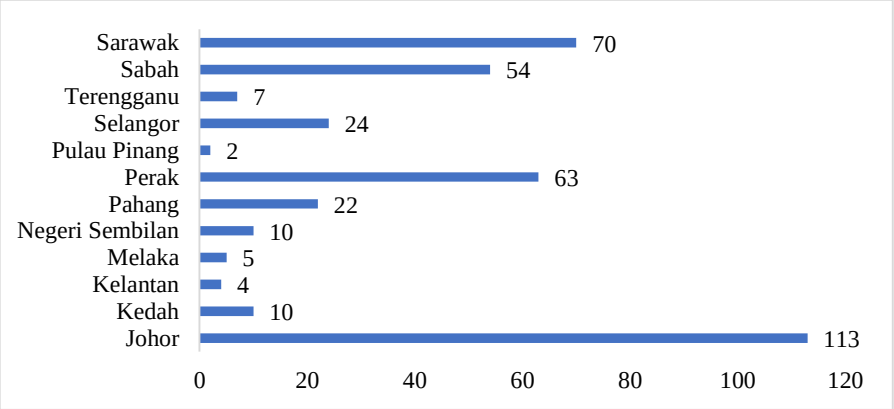
To address these challenges, strategies need to be developed to promote the adoption of ICT in agriculture and improve the availability, effectiveness, and efficiency of information dissemination in the agricultural sector (Kurtenbach & Thompson, 1999). Understanding the factors influencing the adoption and use of ICT in agriculture is essential for developing targeted interventions and initiatives. By addressing these factors, such as access to technology, digital literacy, affordability, and relevance of information, efforts can be made to bridge the digital divide and ensure that farmers, especially in rural areas, have access to the necessary information and resources to enhance their agricultural practices and productivity.

Methodology

The study involved 228,702 independent oil palm smallholders in Malaysia, according to MPOB (2022). A sample size of 384 respondents was determined using the formula developed by Krejcie & Morgan (1970), considering the desired confidence level and required study precision. The respondents of this study were selected using stratified random sampling by states (Figure 1). Data was collected through face-to-face guided interviews using a structured questionnaire divided into four parts, designed to capture information on various parameters. A Likert scale was used for five questions in the questionnaire to gauge respondents' agreement with specific statements. This study used a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to measure the level of agreement with all indicators. The parameters for data collection were based on the research objectives and literature from a study conducted by Koyu et al. (2018). Data collection involved gathering information from 384 participants, which was then analysed using the Statistical Package for the Social Sciences. Analytical tools such as descriptive statistics, chi-square test, and reliability analysis were used. The parameters for data collection were:

a) Respondent and farm information (age, education level, occupation pattern, farming experience)
b) Smartphone information (type, telco services provider, social media apps, information access, perception of smartphone benefits, website exploration, and time spent on social media)
c) Factors influencing the use of ICT among independent oil palm smallholders (knowledge and skill, language barrier, ICT availability and accessibility, costing, availability of oil palm input, and perceived usefulness)
d) Farmers' smartphone usage functions and professional applications (phone calls, messaging, camera, information, news, weed control, market data, cost, and price).

Figure 1. Distribution of respondents by states



Reliability Analysis

Reliability refers to the internal consistency of a study instrument. One commonly used measure of internal consistency is Cronbach's alpha, which estimates reliability based on the inter-correlations of observed indicator variables. In the case of instruments developed using multiple Likert scale statements, reliability analysis is often employed to determine the scale's consistency. Reliability analysis helps assess the extent to which a measure is free from error and capable of producing consistent results (Tanveer et al., 2012). In this study, Cronbach's alpha coefficient was used to evaluate the inter-item consistency of the measurement items. It allows researchers to assess the positive correlation among the studied items (Sekaran & Bougie, 2016). A higher Cronbach's alpha value indicates greater internal consistency, with an ideal value of 0.70 or above (Hair et al., 2010). As shown in Table 1, all variables exhibit Cronbach's alpha values greater than 0.80, except for the cost variable, which has an alpha value of only 0.489. These results indicate that the variables are generally suitable for further analysis.

Table 1. Cronbach's Alpha

Variables	Cronbach's Alpha	No. of items
Knowledge and skills	0.901	3
Language barriers	0.820	3
Access to ICT	0.867	3
Cost	0.489	4
Availability of palm oil information	0.872	3
ICT application	0.930	6

Results and discussion

Demographic profile of respondents and farm information

Table 2 presents the frequency distribution of gender, age, ethnicity, household size, and educational background among the respondents. Out of the 384 farmers who completed the survey, 80.0% were male and 20.0% were female. The participants were distributed across various age groups, with the majority (7.0%) being younger farmers under the age of 32, followed by those aged 33-42 (16.0%), 53 years (53.1%), and 43-52 (24.0%). The average age of the respondents was 53 years. Around 63% (241 participants) were farm owners who worked full-time on their farms. The average farm size was 1.71 hectares. In terms of ethnicity, the Malay independent oil palm smallholders accounted for the majority (52.9%), followed by Chinese (17%) and Bumiputra Sarawak (15.7%). Most respondents (61%) had households with 4-6 members, with an average household size of 5 members per respondent. Regarding education, a significant proportion (48.8%) of farmers had attained secondary education, while 35.4% held skills certificate/diploma qualifications. Additionally, 21.4% had completed primary education, and four respondents possessed a master's or PhD degree. During the site study in 2022, the average age of the oil palm trees was 11.37 years. Limited studies have explored the impact of sociodemographic factors such as gender, age, and education on the smartphone adoption process, which could provide valuable insights for marketing personnel (Kang et al., 2014).

Table 2. Demographic profile of respondents and farm information (n=384)

Variables	Frequency	Percentage	Average
Gender			
Male	307	80	
Female	75	20	
Age			
22-32	28	7	
33-42	62	16	53
43-52	92	24	
>=53	202	53	
Education Background			
No attending formal school	7	1.8	
Primary school	67	17.5	
Secondary school	187	48.8	
Skills Certificate/Diploma	82	21.4	
Degree	36	9.4	
Master/PhD	4	1.0	
Ethnic			
Malay	202	52.9	
Chinese	65	17	
Indian	8	2.1	
Bumiputra Sabah	42	11	
Bumiputra Sarawak	60	15.7	
Others	5	1.3	
No. of household			
1--3	88	23	
4--6	236	61	5
7--9	54	14	
>=10	6	2	
Marital status			
Never married	27	7	
Married	341	89	
Widow/widower	13	3	
Divorced	3	1	
Farm ownership and operation status			
Owner and full-time operator	241	63	
Owner and part-time operator	129	34	
Tenant and full-time operator	11	3	
Tenant and part-time operator	3	1	
Acreage (Ha.)			
<1	164	43	
1--2.99	175	46	1.71
3--4.99	24	6	
>=5	21	5	
Palm Age (year)			
1--10	192	50	
11--20	139	36	11.37
>=21	53	14	

Smartphone users

Table 3 shows the usage of smartphones among the respondents. Out of the total respondents, 348 (91%) owned one smartphone, while only 36 (9%) smallholders owned two smartphones. Smallholders choose smartphones because they can access the internet using apps such as WhatsApp, Facebook, and WeChat. However, smartphones also have interesting features such as camera functions and music/video players. The preferred smartphone brands among the smallholders were "HTC" with 94 (24%) users, followed by "Oppo" with 89 (23%) users, and "Samsung" with 73 (19%) users. The smartphone prices have allowed smallholders to buy devices with similar features to those of preferred brands. Malaysians prefer affordable prices more than preferred brands (Haque et al., 2009). HTC, Oppo and Samsung are known for its innovative features, such as advanced camera technology and fast charging, which appeal to tech-savvy users looking for high functionality.

The study also revealed that most smallholders subscribed to prepaid packages and used Celcom as their network provider. Over 74% of oil palm smallholders have used smartphones for over five years. On average, they spent 1-3 hours per day exploring social media. Notably, approximately 94.5% of the respondents obtained information and knowledge on oil palm management from TUNAS MPOB, indicating its significant role as a source of information for them. TUNAS MPOB can transfer technology and improve the productivity of smallholders (Awang et al., 2016)

Table 3. Smartphone users' information (n=384)

Items	Frequency	Percentage
No. of smartphones owned		
1 unit	348	91
2 unit	36	9
> 3 unit	0	0
Brand Used		
Apple i-phone	33	9
Huawei	41	11
Oppo	89	23
HTC	94	24
Samsung	73	19
Vivo	18	5
Nokia	23	6
Xiaomi	2	1
Lenovo	1	0.3
Honor	10	2.6
Subscribed Telco Company (Prepaid)		
Maxis	71	22.3
Digi	55	17.3
Celcom	152	47.8
Umobile	22	6.9
TuneTalk	3	1.9
Unifi	6	1.9
Others	6	1.9

Experience in smartphone Used		
< 1 year	19	4.9
3-5 year	79	20.6
> 5 years	286	74.5
Exploring the time spent on social media		
1-3 hours	193	50
3-5 hours	128	33
> 5 hours	63	16

Crosstab between the age of respondents and telco

Table 4 displays the correlation between the age of the respondents and their telephone service provider. The findings reveal that respondents between the ages of 43-52 years tend to use the telephone services provided by Celcom more frequently. Celcom emerges as the preferred choice among oil palm smallholders in Malaysia. Celcom is the oldest and most experienced and has numerous competitive advantages over its main rivals, Maxis and Digi (Hasnat et al., 2017). Axiata (Malaysia) Berhad prioritizes low-cost operations by reducing its call rates. Telecom companies also offer innovative products, services, and loyalty packages to retain existing customers. Notably, the acceptance of new technology is influenced by demographic variables such as gender and age, which play a crucial role in explaining changes in behavioural intentions that occur over time (Park, 2006).

Table 4. Crosstab between the age of respondents and telco

Age of respondents	Maxis	Digi	Celcom	U mobile	Yes	TuneTalk	Unifi	Others
22-32	26%	26%	32%	10%	0%	3%	0%	3%
33-42	25%	21%	41%	8%	2%	0%	2%	2%
43-52	23%	17%	51%	3%	0%	2%	2%	2%
>=53	21%	14%	50%	8%	1%	2%	2%	1%

Smallholder's most favourite social networking apps

Understanding usage patterns (calls, messaging, web browsing, etc.) would help tailor information dissemination strategies for the smallholders. Table 5 presents the favourite social networking apps used by the respondents. WhatsApp emerges as the top choice among the respondents, ranking higher than other social networking apps. This aligns with a report by Statista (2023), which states that WhatsApp has a significant share of internet users in Malaysia, with 98.7% using it as a communication application as of May 2020. According to David (2020), emerging with WhatsApp groups, as a whole, overwhelmingly benefit their livelihoods and practices. Systemic and societal change occurs when the experiences and successes of one individual are shared with a larger group – leading to rapid and shared prosperity. As each individual learns a new skill, technique, or input, the group must also learn and benefit from that knowledge. WhatsApp provides the means and the platform for this type of information exchange to occur at scale and with individuals who would otherwise be unlikely to communicate. Research has confirmed that using ICT tools such as mobile phones and WhatsApp has helped farmers enhance their livelihoods during COVID-19. Nevertheless, while some farmers had networked effectively, for many, their low ICT literacy and administrative skills would need to be enhanced (Govender, 2023).

Table 5. Most popular apps used by smallholders

Social Networking Apps by smallholder	Ranking
WhatsApp	1
FB	2
Telegram	3
IG	4
WeChat	5
Twitter	6
LinkedIn	7

Chi-square test

Table 6 summarises the results of the Chi-square test that the age group of smallholders had a significant influence (p= 0.050) on the smartphone brand, while time spent on social media and the experience used with the smartphone did not have a significant influence. The analysis revealed a statistically significant difference (p=0.000, 0.000, and 0.000) between the education status of the farmers and their use of smartphone brands, the time spent on social media, and their experience with the smartphone. According to Mohammadyari et al. (2015), the higher the education level, the more likely the person will use technologies like computers and the Internet. This is also supported by (Rashid et al., 2020), that has proven that with an increase in education level, the perceived ease of use also increases. This, in turn, leads to adaptation and use of technology.

However, there was no significant relationship (p= 0.481 and 0.825) between gender, time spent on social media, and experience with the smartphone. However, there was a statistically significant difference (p=0.083) in gender and the use of smartphone brands and a statistically significant difference (p=0.070) in states of smallholders between their experiences with the smartphone. Furthermore, the Chi-square test found no significant relationship (p= 0.864 and 0.367) between smallholders from different states regarding their choice of smartphone brand and the time spent on social media.

Table 6. Summary of the Chi-square test

Demographic	Smartphone usage	p-value	Significant
Age	Smartphone brand	0.050**	√
	Time spent on social media	0.113	×
	Experience used smartphone	0.144	×
Gender	Smartphone brand	0.083*	√
	Time spent on social media	0.481	×
	Experience used smartphone	0.825	×
States	Smartphone brand	0.864	×
	Time spent on social media	0.367	×
	Experience used smartphone	0.070*	√
Education status	Smartphone brand	0.000***	√
	Time spent on social media	0.000***	√
	Experience used smartphone	0.000***	√

Note: Statistically *significant at 10% level, ** significant 5% level, *** significant 1% level

Means and standard deviation of research variables

Table 7 displays the means and standard deviations of the research variables. All mean values are above 3.68, indicating a high level of agreement. This suggests that all seven items are seen

as the main purposes for smallholders in using smartphones. On the other hand, standard deviation is a measure used to determine the spread of measurements within a dataset around the mean or expected value. It indicates how concentrated the data points are around the mean. A low standard deviation suggests that most values are close to the mean, while a high standard deviation indicates that the values are more spread out.

Table 7. Means and standard deviations

No.	Variables	Mean	Std. Deviation
1.	I use smartphone to communicate with the TUNAS officer	4.2927	.65389
2.	I understand that ICT give more benefits	4.1927	.66299
3.	I realize that ICT application can help me increase my income	3.7195	.87724
4.	I realize that ICT ease my daily activities	4.0391	.80345
5.	I realize that ICT help me save money, time and energy	3.8166	.84779
6.	I use smartphone to get information on weather forecast	3.6659	.90802
7.	I use smartphone to get the latest commodity and agricultural input price	3.9098	.85881
8.	I use a smartphone to communicate with other MSPO participants	4.1296	.76397

Note: Mean classification: 1.00-2.33= low, 2.34-3.67= moderate, 3.68– 5.00= high

Measurement of the mean score for factors that influence the use of ICT among ISH

Table 8 demonstrates the scores of factors influencing the use of ICT among smallholders independent of oil palm. The assessment used a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Six vectors are considered, including knowledge and skill, language barriers, accessibility to ICT, cost, availability of oil palm input, and perceived usefulness. Table 8 specifies the variables evaluated under each of these six vectors. The results indicate that most respondents agreed with all the variables listed in the Table. However, according to the variable mean score, the variable "Accessibility to ICT in the respondent area" under the accessibility vector received the lowest mean score of 3.00. This suggests that there is a lack of ICT facilities, and respondents are less satisfied with the ICT infrastructure available in their area. On the other hand, variables No. 8 and No. 10 under the perceived usefulness vector, which pertain to the importance of accessing online information on FFB prices and the interest in obtaining agricultural information online, respectively, obtained the highest mean scores. This implies that most respondents find accessing FFB price information online and obtaining agricultural information through online sources to be highly valuable and useful.

Table 8. Mean score measure factors influencing the use of ICT among ISH

Vector	Variable	Score Measure					
		SD	S	N	A	SA	Mean
Knowledge & Skill	1. I can easily understand the use of applications on smartphones	5	22	75	223	59	3.80
	2. I can download the apps on the smartphone	10	28	60	227	59	3.77
	3. I have the knowledge to use the application in the smartphone	8	18	81	218	59	3.80
Language Barrier	1. I understand the language used in the smartphone application	5	15	51	251	62	3.91
	2. The use of English in the phone application is easy to understand	18	61	103	160	62	3.38
	3. I can easily follow the instructions of the language used in the smartphone	9	25	69	226	55	3.76
Accessibility to ICT	1. The Internet coverage in my area is fast and wide.	28	63	107	165	21	3.23
	2. There are many ICT facilities in my area.	38	81	123	126	16	3.00
	3. The communication in my area is good.	32	54	95	179	24	4.00
Cost	1. I allocate monthly expenses to subscribe internet on a smartphone	9	26	56	244	49	3.78
	2. Internet subscription prices are reasonable and affordable.	14	37	94	205	34	3.54
	3. I am facing financial constraints to buy a smartphone	28	69	135	123	29	3.14
	4. I found that using a smartphone involves a high cost	17	52	133	130	50	3.50
Availability of oil palm input	1. I am looking for information related to oil palm through a smartphone	8	27	69	208	72	3.80
	2. Searching for oil palm related information is easier & faster through the use of smartphones	7	20	63	225	69	3.86
	3. There is a lot of oil palm related information available on smartphones	6	11	49	255	63	3.93
Perceived of Usefulness	1. I think the approach of getting agricultural information online using a smart phone is beneficial	4	15	62	238	65	3.90
	2. The use of a smartphone facilitates the management of my oil palm plantation	6	28	74	220	56	3.76
	3. I think the agricultural application offered online helps me in management and performing agricultural works	7	25	81	219	52	3.74
	4. I feel that information related to oil palm fertilization techniques is important to access online	5	22	69	223	65	3.84
	5. I feel that information related to oil palm management is important to be accessible online	5	25	63	220	71	3.85
	6. I feel that information related to pest control methods is important to access online	5	22	64	225	68	3.86
	7. I feel that information related to the list of agricultural input suppliers and contractors is important to be accessible online	4	25	59	232	64	3.85
	8. I feel that information related to current BTS prices is important to access online	2	16	46	224	96	4.03
	9. I feel that marketing agricultural products online is more effective	4	20	72	215	73	3.87
	10. I am interested in getting information related to agriculture online	3	18	47	213	103	4.03

Note: Mean classification: 1.00-2.33= low, 2.34-3.68= moderate, 3.68 – 5.00= high

Conclusions

This study highlights the significant impact of Information and Communication Technology (ICT) on the agricultural practices of oil palm-independent smallholders (ISH) in Malaysia, particularly in the context of climate change and the pressing need for improved infrastructure. Most smallholders own smartphones and are familiar with their use, primarily leveraging these devices to browse social media and networking apps for information on oil palm management. However, despite their smartphone usage, many smallholders still rely on the Malaysian Palm Oil Board (MPOB) extension services for additional support. Notably, younger smallholders are more inclined to be heavy smartphone users than their older counterparts, utilizing their devices for communication, entertainment, social networking, and information seeking. The findings of this research indicate that education significantly influences smartphone usage patterns among smallholders. Those with higher levels of education tend to have greater access to technology, demonstrating a better understanding of smartphone functionalities and a propensity to use applications that enhance their farming activities. Smallholders perceive that smartphones can facilitate income generation, streamline daily activities, and provide timely access to critical information, such as fresh fruit bunch (FFB) prices. However, the study also reveals a concerning lack of ICT facilities in rural areas, with respondents expressing dissatisfaction with the available resources. Despite these limitations, there is a strong desire among smallholders to access online information about FFB prices and other agricultural insights. This highlights an opportunity for policymakers and stakeholders in the telecommunications industry - including government agencies, NGOs, and mobile network operators - to develop evidence-based ICT policies that cater to the needs of smallholders. By improving access to ICT resources and expanding network coverage, particularly in rural areas like Sabah and Sarawak, smallholders can benefit from enhanced market connections and increased productivity. Moreover, addressing the limitations in network coverage is essential for timely communication, especially in emergency situations where smallholders need to report disease outbreaks or production irregularities. Collaborating to improve mobile network infrastructure will not only enhance the effectiveness of extension services but also promote rural diversification and expand the market for mobile operators. Ultimately, this study emphasizes the crucial role of ICT in empowering oil palm smallholders to adapt to climate change and improve their livelihoods. By enhancing their ICT knowledge and expanding access to mobile-based services, we can support the growth of the oil palm sector while fostering sustainable agricultural practices that benefit independent smallholders in Malaysia.

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