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The Impact of Internet Access Contributing to Farmers' Welfare in Indonesia: A Case Study Based on National Socio-Economic Survey

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ABSTRACT

Research Originality: This study highlights the transformative role of digitalization, particularly the use of internet networks and mobile phones, in addressing these challenges and enhancing the welfare of farmers.

Research Objectives: This research aims to analyze the impact of internet usage on farmers' welfare in Indonesia. Specifically, it examines how access to digital tools can bridge the knowledge gap in the agricultural sector and improve economic outcomes, focusing on regional disparities between Western and Eastern Indonesia.

Research Methods: This study uses National Socio-Economic Survey (Susenas) data and the ordered probit model with marginal effects.

Empirical Results: Farmers in the upper-middle expenditure group can leverage the Internet and mobile phones to access production information, markets, and farm credit, supported by better finances and education. In contrast, low-income farmers, particularly in eastern Indonesia, face barriers such as costs, limited infrastructure, and low digital literacy, hindering technology adoption to improve welfare.

Implications: The government is expected to address this digital divide by accelerating the development of internet infrastructure in rural areas, improving digital literacy, subsidizing technological devices, and developing accessible agricultural applications.

Keywords:
farmer; internet services; welfare; education gap

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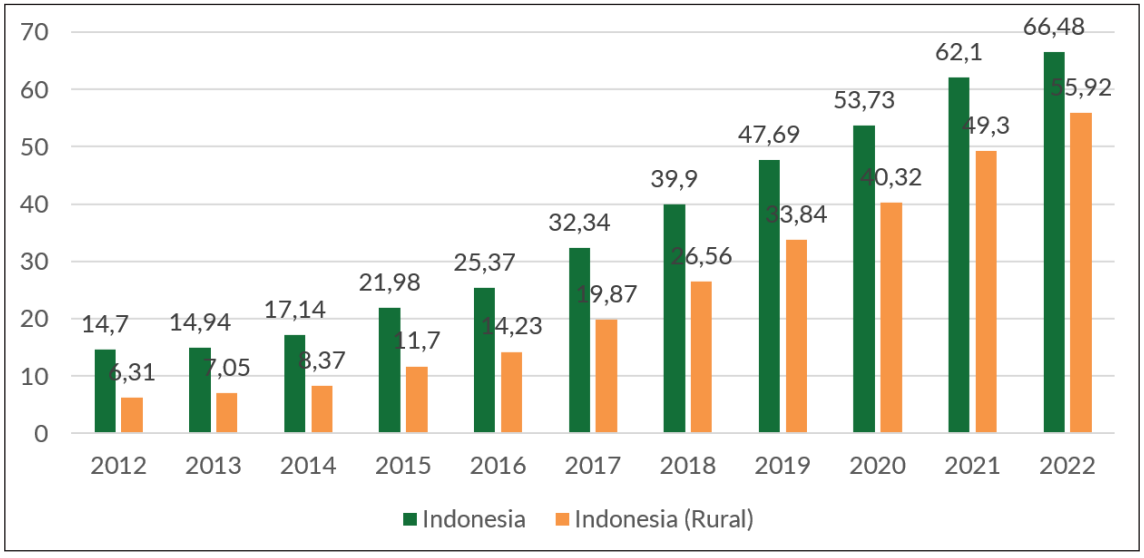
INTRODUCTION

Digital technology supports the economy by expanding access to information and business. In Indonesia, the Internet helps farmers access production information, inputs, credit, and government assistance, thereby reducing information asymmetry and increasing efficiency. Research shows that the Internet increases income (Chang & Just, 2009), production efficiency (Chen et al., 2022), and product marketing (Owusu et al., 2018). The Internet helps farmers find solutions to agricultural problems, including land management (Ma & Zheng, 2021). However, its impact varies depending on farmers' age, education, and income. Therefore, developing internet infrastructure in rural areas is key to supporting farmers' welfare.

The public is increasingly using the Internet to get the information needed; the internet development in Indonesia can be seen in the figure below. The amount of Internet used is increasing, so the utilization of the Internet by the people of Indonesia is increasing. Rural communities can utilize greater internet access for their work interests. The figure below shows the development of the Internet due to greater public demand for the Internet. The increase in Internet access in rural areas has exceeded 50% in 2022, which means that the Internet's role is getting more prominent in the activities of rural communities.

Figure 1. Development of Internet Usage in Indonesia 2012-2022 (in percent)



Source: Central Bureau of Statistics of Indonesia

The Internet can contribute to farmers' performance by improving welfare and technical efficiency. Several studies have utilized the Internet to increase farmers' income, such as the results of research by Siaw et al. (2020), which showed a positive relationship between internet access and farmer welfare. Research shows that internet access helps farmers and their household income. The role of information and communication technology can increase the efficiency of agricultural products. In general, research in

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various countries shows that the role of the Internet has had a significant influence on the welfare of farmers. Research by Zhang et al. (2021) and Ma et al. (2020) shows that the Internet has provided technical efficiency for farmers. Internet access in rural areas has a significant impact on increasing farmers' knowledge and welfare, which can improve production quality. Research by Yuan et al. (2021) shows a positive relationship between internet use and farmer welfare, primarily through increased income. However, limited digital infrastructure, low farmer education, and difficult access in remote areas hinder optimizing internet benefits. Research by Moeis et al. (2020) confirms that information networks in rural areas are still inadequate. Government support through technology training, information systems, and the provision of devices such as cellular phones is needed to increase farmer productivity and welfare. The figure below shows the suboptimal role of the Internet in improving farmers' welfare at the provincial scale in Indonesia. Farmers' limited knowledge of internet usage hinders their welfare due to their low level of education.

Figure 2. Scatter Plot between Internet Use and Farmer Welfare by Province in Indonesia

Source: National Socio-Economic Survey (Susenas).

Some research has a negative relationship between the role of the Internet and the agricultural sector; Harahap et al. (2024) show the negative impact of digital transformation on Indonesia's agricultural sector; digital technology introduced for the agricultural sector is not by agricultural conditions such as weather, planting patterns, and land availability. Information technology for agriculture becomes less effective, which adds to the problems farmers face in managing agriculture. According to research by Ilyas (2022), agricultural information technology is still minimal, which impacts the low

number of young people working in the agricultural sector. A low understanding of the Internet is due to farmers' limited education in utilizing the Internet's role in supporting agricultural production. Research by Whitacre (2014) shows that broadband development does not affect the increase in the number of farmers using the Internet in agricultural activities, causing low farmer welfare. Farmers' understanding of digital technology must accompany broadband development through training.

Previous research shows the importance of internet use in improving farmers' welfare, but the research has some limitations. The study by Rahman et al. (2023) only focused on well-being, such as happiness and life satisfaction, without exploring the use of the Internet on material well-being through farmer household expenditure. Then, the research of Ardianti et al. (2023) only examines the effect of the Internet on food insecurity without exploring the relationship with household expenditure as a proxy for farmer welfare. Research by Moeis et al. (2020) explored farmer welfare through labor mobility and land ownership without examining the role of the Internet based on aspects between Eastern and Western Indonesia. Therefore, this study aims to fill the gap by analyzing the role of the Internet in improving farmers' welfare and identifying barriers to internet use in rural areas to provide strategic recommendations. The novelty of this study is that it will analyze the influence of the Internet on farmers' welfare according to the classification of farmers' household expenditures, which are seen as the highest to the lowest expenditures. The study will discuss the impact of the Internet on farmers' welfare in eastern and western Indonesia.

METHODS

This study uses the National Socio-Economic Survey (Susenas) was conducted in 2021, which the Central Statistics Agency (BPS) collected. Susenas is a cross-section of data consisting of a Kor section and a module section that we used to obtain demographic information, farmers who use the Internet, and household expenditures, which are processed by Stata 17.0 and ArcGIS. The survey is representative of national and provincial society. It was initiated in 1963 and continues in 2024. Furthermore, the study focuses on the effect of the Internet on farmers for every quartile of household expenditures in Western and Eastern Indonesia. Therefore, we employ ordinal probit and estimate with marginal effects to evaluate the impact of change in covariates on the probabilities (Chen & Tsai, 2012; Greene, 2003).

Ordinal Probit is most frequently and suitable for the analysis of cross-section data on ordinal or ordered dependent variables rather than OLS (Daykin & Moffatt, 2002; Hausman et al., 1992; Noreen, 1988; Peel et al., 1998; Williams, 2016). Because the use of OLS on ordinal dependent variable may tend to break assumptions of OLS regression and bring the model to inaccurate interpretation (Peel et al., 1998), the problem might arise if the OLS assumption is violated, including the following (Peel et al., 1998): (i). Pointless prediction, which is outside the range or between values, may occur on the scale of the nominal or categorial predicted variable; (ii) Erroneous hypothesis testing

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may occur because of invalid sampling variances and irregular to estimated standard errors on the coefficient of independent variables (t-values) and regression line (F-values); (iii) consequently for (i) and (iii) can bring for misleading of measure of goodness of fit.

Consider the mathematical model that we used as follows (Abdel-Aty, 2003; Chen & Tsai, 2012; Daykin & Moffatt, 2002; Greene, 2003; Hausman et al., 1992; Johnston et al., 2020; Peel et al., 1998):

$$K_n^* = x_n^{'}\beta + u_n \text{ , where } n = 1, \dots, n;$$

K_n^* is a latent and continuous variable measure of the quartile of household expenditure, $x_n^{'}$ is a vector of explanatory variables, and β is an estimated vector of parameters and Un error terms.

$$K_n = \begin{cases} 1. & if\ K_n^* < \alpha_1 \\ 2. & if\ \alpha_1 < K_n^* < \alpha_2 \\ j. & if\ K_n^* > \alpha_{j-1} \end{cases}$$

The parameters $\alpha j.j = 1. \dots \dots n$ is known as *threshold parameters* or *cut points*. In addition, we estimated the probability as follows:

$$Prob(1) = \Phi(\alpha_1 - x_n^{'}\beta)$$
$$Prob(2) = \Phi(\alpha_2 - x_n^{'}\beta) - \Phi(\alpha_1 - x_n^{'}\beta)$$
$$Prob(j) = \Phi(\alpha_j - x_n^{'}\beta) - \Phi(\alpha_{j-1} - x_n^{'}\beta)$$
$$Prob(J) = 1 - \Phi(\alpha_j - x_n^{'}\beta)$$

For Φ is a standard normal cumulative distribution function. Based on the theoretical mathematical model we explained before, the following is our model:

$$Probit(Exp) = ln\ [\frac{Exp}{1 - Exp}]$$
$$= \alpha + \beta_1 Int + \beta_2 HP + \beta_3 Land\ + \beta_4 Age + \beta_5 Educ + \beta_2 Male + \epsilon$$

Where $ln\ [Exp/(1 - Exp)]$ is household expenditure as the dependent variable by having five categories of expenditure of households working in the agricultural sector by classifying them into five categories of expenditure, namely "Quantile 1: 20% lowest household expenditure", "Quantile 2: 20% low household expenditure", "Quantile 3: 20% medium household expenditure", "Quantile 4: 20% high household expenditure", and "Quantile 5: 20% highest household expenditure". With Int s an independent variable that explains the use of Internet used by farmers with binary form 0: No; 1: Yes. Then binary control variables such as HP is the farmer's cell phone ownership, Land is the farmer's land ownership, Male is the gender of the farmer's head of household. Other control variables such as Age is the age of the head of the farmer's family, Educ is the years of schooling of the head of the farmer's family, IB is the Indonesian Section consisting of 1: Western Indonesia and 2: Eastern Indonesia.

In estimating binary models and presenting results meaningfully, epidemiologists and clinical researchers often use logit models with odds ratios. In contrast, economists may use logit, probit, or linear probability models with a tendency to use marginal

effects (Norton & Dowd, 2018). Marginal effects (ME) are useful in explaining the probability of a binary model predicting changes in risk factors (Norton et al., 2019). The authors chose to use MEs because they are most intuitive and in nonlinear models such as logistic regression, MEs of risk factors are an informative way of answering the researcher's question - How do changes in risk factors impact the probability of an outcome occurring? (Norton, et al., 2019).

RESULTS AND DISCUSSION

Table 1 shows the estimation results of the effect of the Internet on farmers' welfare based on household expenditure groups. The variable internet use (Int) negatively and significantly affects the welfare of farmers in the Q1-Q2 household expenditure classification. In contrast, farmers' use of the Internet in the Q3-Q5 household expenditure classification positively and significantly affects the welfare of farmers. Likewise, the variable cellular phone (HP) negatively and significantly influences farmers' welfare in the Q1-Q2 household expenditure group. Then, the variable cellular phone (HP) has a positive and significant effect on the welfare of farmers in the Q3-Q5 household expenditure group.

Table 1. Probit Regression of the Effect of the Internet on Improving Farmer Welfare in Indonesia

VARIABLES	Q1	Q2	Q3	Q4	Q5
int	-0.0624***	-0.0133***	0.00608***	0.0226***	0.0470***
	-0.00348	-0.000746	-0.000374	-0.00127	-0.00261
HP	-0.0804***	-0.0171***	0.00783***	0.0292***	0.0605***
	-0.00269	-0.000607	-0.000316	-0.000992	-0.00206
Land	-0.0359***	-0.00766***	0.00350***	0.0130***	0.0271***
	-0.00319	-0.000685	-0.000321	-0.00116	-0.0024
educ	-0.00550***	-0.00117***	0.000536***	0.00200***	0.00414***
	-0.000376	-8.10E-05	-3.88E-05	-0.000137	-0.000283
Male	-0.202***	-0.0430***	0.0197***	0.0732***	0.152***
	-0.00372	-0.001	-0.000548	-0.00145	-0.00302
age	0.00195***	0.000416***	-0.000190***	-0.000709***	-0.00147***
	-0.0001	-2.18E-05	-1.08E-05	-3.65E-05	-7.58E-05
Observations	78,402	78,402	78,402	78,402	78,402

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Furthermore, farmer land ownership (Land) in the Q1-Q2 household expenditure classification negatively and significantly affects the welfare of farmers. Meanwhile, farmers' land ownership has a positive and significant effect on the welfare of farmers in the middle, high, and highest household expenditure groups. Then, the variable years of schooling of the head of the farmer family (Educ) and the gender of the head of the farmer family

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(Male) negatively and significantly affect the welfare of farmers in the Q1-Q2 household expenditure group, the variables (Educ) and (Male) positively and significantly affect the welfare of farmers in the Q3-Q5 household expenditure group. The age variable of the head of the farming family (age) has a positive and significant effect on the welfare of farmers in the Q1-Q4 household expenditure group. In contrast, the variable age of the head of the farming family (age) in the Q5 household expenditure classification negatively and significantly affects the welfare of farmers.

Farmers in household expenditure groups Q3 to Q5 have utilized the Internet and mobile phones to improve welfare. Meanwhile, farmers in the Q1 to Q2 household expenditure groups can still not optimize the use of the Internet and mobile phones to support welfare improvement. Better digital infrastructure can improve information on agricultural production. Farmers who obtain information from the Internet and mobile phones will help make agricultural production more efficient. In addition to agricultural production information, farmers can obtain information on market prices and digital marketing opportunities. The Internet will make it easier for farmers to access education platforms on agricultural production techniques and crop quality. Mobile phones make it easier for farmers to communicate with distribution networks and access farm business credit. Farmers can sell business information directly to the final seller through this digital role without intermediaries. This finding is consistent with Chang and Just's (2009) research, where using the Internet can significantly improve farmers' welfare. The Internet can give farmers broader access to market information, commodity prices, and modern agricultural practices. Farmers can more easily make the right decisions for their farming business after getting information from the Internet. In addition, farmers can expand the market to reduce intermediaries who can reach buyers directly.

Research by Chang and Just (2009) showed that cell phones can contribute significantly to farmers' welfare. Cell phones make it easier for farmers to communicate with buyers, who can speed up transactions. Research by Chen et al. (2022), the Internet will make it easier for farmers to produce agriculture more efficiently. Farmers will be more optimal in using resources so that there is no waste and increased crop products. Ma and Zheng research (2021) explains that the Internet can help farmers manage agricultural production, such as crop rotation, fertilizer use, and irrigation. The more effective agricultural management, the more likely it is to improve the welfare of farmers. Research by Wu et al. (2023) explained that farmers who utilize the Internet will increase the efficiency of agricultural production. Wu et al. (2023) also emphasized the development of adequate digital infrastructure in rural areas to maximize agricultural production.

Based on the probit regression results, the farmers with household expenditure in Q3-Q5 are financially superior, so Internet and mobile phone access can be utilized efficiently. This finding is consistent with the studies of Khan et al. (2019), Moeis et al. (2020) and Javaid et al. (2022), showing farmers with higher expenditures will more easily access the Internet and cell phones because they can meet the costs of internet and cellphone access for agricultural activities. In contrast, farmers in the lowest and low

household expenditure groups (Q1-Q2) find it challenging to utilize Internet and mobile phone access in improving farmers' welfare. Limited access to digital technology makes it more difficult for farmers to obtain the latest information on agricultural techniques. Farmers in the Q1-Q2 household expenditure classification find it challenging to obtain digital technology devices because the cost is higher than the income received by farmers. This finding is consistent with the research of Javaid et al. (2022) and Ilyas (2022); farmers will find it difficult to access the Internet due to higher costs and limited Internet access in rural areas. Moeis et al. (2020) state that low farmer income is insufficient to meet the need for internet access.

Farmers' land ownership (Land) in the Q3-Q5 household expenditure group significantly affects farmers' welfare. Farmers with higher household expenditures can access the latest technology, better fertilization, and efficient farming techniques. Farmers can diversify their agricultural products with the help of the newest technology to increase their source of income. Farmers with higher expenditures have more significant capital to access the newest technology and invest their income in improving agricultural products. Meanwhile, land holdings of farmers in the Q1-Q2 household expenditure classification will find it challenging to obtain the latest technology. Farmers with the lowest household expenditure do not have sufficient capital to increase agricultural production. According to research by Pasaribu and Istriningsih (2020), farmers who own agricultural land will have higher incomes than those who work with a profit-sharing system. Research from Mihailova (2022) shows that farmers who own land can reduce operational costs compared to farmers who rent land. According to research by Sanchez et al. (2022), farmers who own agricultural land tend to be able to increase product diversification. This diversification contributes to increased income, especially for farmers with adequate resources to support the process.

The length of schooling of the farmer household head (education) significantly affects farmer welfare, especially for farmers in the middle to highest household expenditure groups. Farmers in the middle to high household expenditure group tend to have a higher level of education. Farmers with higher education can access better agricultural information and technology. Higher education allows farmers to utilize knowledge of the latest agricultural techniques, financial management, and market access. Meanwhile, farmer household heads who do not have higher education often do not have large enough household expenditures. Farmers in the lowest and lowest expenditure household groups face difficulties accessing education, resulting in a lack of efficiency in agricultural production. Low-knowledge farmers are unable to adopt the latest technology to improve agricultural yields. This finding is consistent with Siregar, R. (2016) and Moeis, M. et al. (2020), showing that farmer knowledge determines better agricultural production outcomes.

Farmers with higher knowledge can obtain more efficient farming techniques to increase their income. Highly educated farmers will better manage their finances regarding production costs, increasing welfare. Conversely, farmers with low levels of education tend to be more dominant in the lowest to low-expenditure household groups. This results in difficulties accessing the latest agricultural technology supporting welfare improvements.

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Farmers' knowledge affects the quality of resources used, such as water and fertilizer, which can reduce agricultural yields and ultimately reduce farmers' income. Farmers from the middle to upper household expenditure group can better utilize knowledge to achieve higher welfare than farmers from the low household expenditure group. The results of this analysis follow the research of Istriningsih et al. (2022) farmers' low knowledge of agricultural techniques will hinder productivity and lead to a decrease in farmers' income.

Male household head gender is often associated with improved farmer welfare, especially in the middle and upper household expenditure groups. Male household heads in higher household expenditure groups tend to have better education, training and technology resources. In addition, the majority of male farmers have the opportunity to participate in agricultural activities that can increase income. Male household heads have social networks and relationships with various parties that can support agricultural businesses. Therefore, male heads of households in the upper-middle expenditure household group significantly improve farmers' welfare. This is reflected in their ability to utilize more adequate resources, knowledge and economic opportunities. The results of this study by Gurning et al. (2024) showed that the influence of gender can determine the welfare of farmers. Male farmer family heads have more opportunities to make more strategic decisions regarding investment in agriculture. Male farmers are likely to have better access to education, agricultural training, and new technologies that can increase the productivity and efficiency of agricultural businesses. The results of this analysis are based on the research of Fauziyah (2018), which shows that access to education, training, agricultural extension, capital, and credit is dominated by men. This means that male farmers have a greater chance of owning agricultural resources than women.

The variable age of farmers (age), according to the lowest and lowest household expenditure groups, affects the improvement of farmers' welfare. Conversely, farmer age by middle and upper household expenditure group decreases farmer welfare. The age of farmers with medium to high household expenditure may change the priority of economic activities from agriculture to non-agriculture. Meanwhile, farmers with the lowest and lowest household expenditure have extensive farming experience, so they are able to manage their land well despite having limited resources. This analysis is based on the research of Sujaya et al. (2018), who state that farmer experience plays an important role in improving farmers' technical expertise, which has an impact on increasing farm productivity. The increasing productivity of farmers has the opportunity to improve welfare. Some studies explain that farmer age has no significant effect on farmer welfare, as research by Hildayanti et al. (2017) showed that the age of farmers did not significantly affect farmers' household expenditure. The agricultural sector requires the regeneration of young farmers to replace unproductive age regardless of household expenses. This finding was made by research by Suriani et al. (2023), which shows that young farmers will be more productive in managing the agricultural sector than those of an unproductive age. Meanwhile, farmers of unproductive age face physical limitations in accessing new technological information. According to research by Gusti et al. (2021), the productive age variable significantly affects agricultural knowledge and can improve farmers' welfare.

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Table 2. Probit Regression of the Effect of the Internet on Improving the Welfare of Farmers in Western and Eastern Indonesia

Variables	Western Indonesia					Eastern Indonesia				
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
int	-0.0617***	-0.0110***	0.00687***	0.0226***	0.0433***	-0.0715***	-0.0195***	0.00533***	0.0258***	0.0598***
	-0.00446	-0.0008	-0.000536	-0.00164	-0.00312	-0.00557	-0.00154	-0.000504	-0.00203	-0.00466
HP	-0.108***	-0.0193***	0.0120***	0.0396***	0.0759***	-0.0530***	-0.0145***	0.00395***	0.0192***	0.0444***
	-0.00364	-0.000731	-0.000499	-0.00137	-0.00264	-0.00397	-0.00111	-0.000356	-0.00145	-0.00334
land	-0.0635***	-0.0113***	0.00706***	0.0232***	0.0445***	-0.00964**	-0.00264**	0.000718**	0.00348**	0.00807**
	-0.00436	-0.000798	-0.000517	-0.00161	-0.00307	-0.0046	-0.00126	-0.000345	-0.00166	-0.00385
educ	-0.0103***	-0.00183***	0.00115***	0.00377***	0.00722***	-0.00144***	-0.000395***	0.000108***	0.000522***	0.00121***
	-0.000536	-9.98E-05	-6.72E-05	-0.000199	-0.000378	-0.000519	-0.000142	-3.91E-05	-0.000188	-0.000435
age	0.00176***	0.000313***	-0.000196***	-0.000643***	-0.00123***	0.00105***	0.000286***	-7.81e-05***	-0.000379***	-0.000877***
	-0.000143	-2.59E-05	-1.67E-05	-5.23E-05	-0.0001	-0.000145	-3.99E-05	-1.16E-05	-5.25E-05	-0.000122
Male	-0.222***	-0.0394***	0.0246***	0.0810***	0.155***	-0.174***	-0.0477***	0.0130***	0.0631***	0.146***
	-0.00495	-0.00122	-0.000781	-0.002	-0.00383	-0.00556	-0.00174	-0.000741	-0.00212	-0.00488
Observations	45,960	45,960	45,960	45,960	45,960	32,442	32,442	32,442	32,442	32,442

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

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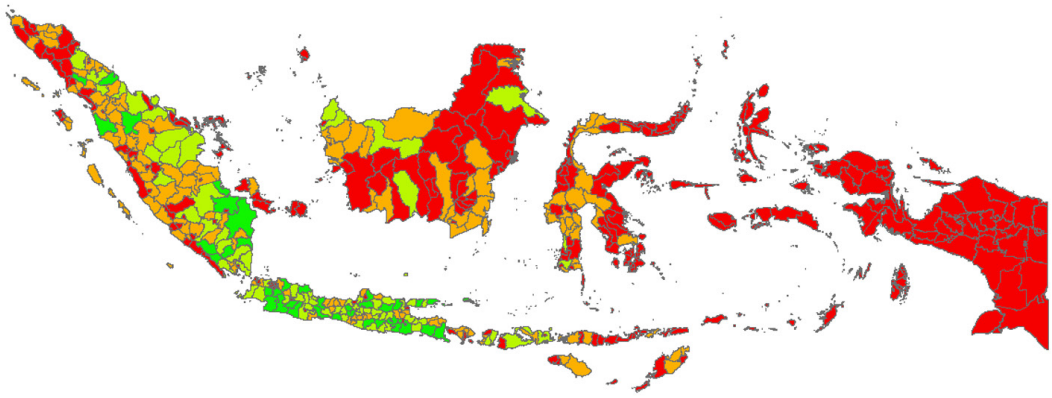
Table 2 shows the effect of the internet and control variables on farmer welfare based on Western and Eastern Indonesia. The role of the Internet and mobile phones in western and eastern Indonesia is in line with the regression results in Table 1. Using the Internet and mobile phones is likely to improve the welfare of farmers in the upper-middle household expenditure classification (Q3-Q5) in western and eastern Indonesia. Farmers in the upper-middle household group (Q3-Q5) in western and eastern Indonesia are most likely to access agricultural technology, market prices and weather forecasts. The use of the Internet and mobile phones by farmers in the upper household expenditure group has access to digital information for the needs of agricultural products, income and access to basic needs such as education and health. Furthermore, the control variables of farmers' land ownership, years of schooling, and age in the western and eastern parts of Indonesia have no difference in the effect on farmers' welfare compared to the general regression results (Table 1).

Figure 3. Map of Farmers' Internet Usage by City District in Indonesia in 2021

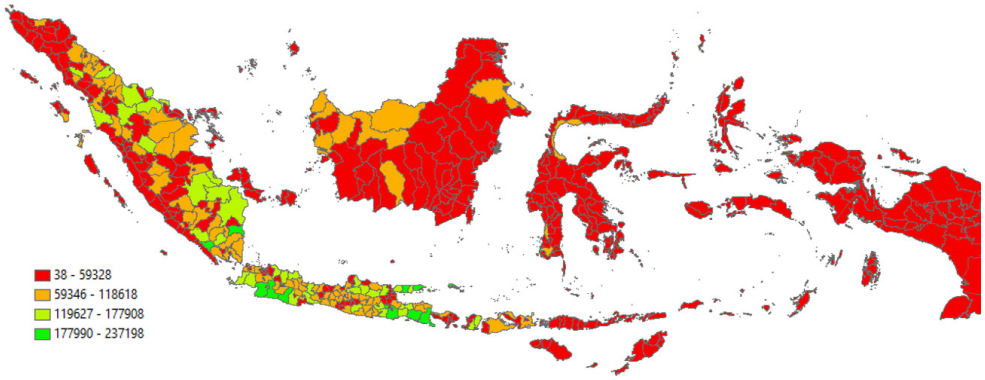


Source: National Socio-Economic Survey (Susenas).

Although the Internet and mobile phones positively influence farmers' welfare in the middle and upper household expenditure groups, there is still a digital divide between western and eastern Indonesia. Figure 3 shows internet utilization by farmers spread across Indonesia. As seen on the green map, farmers' Internet use in Indonesia is still concentrated in the western part of Indonesia (Sumatra and Java Islands). Farmers have not utilized the Internet evenly due to unreachable internet access in some areas. Some areas in eastern Indonesia tend to have limitations in accessing digital-based information. This finding is based on research (Ardianti et al., 2023); limited digital infrastructure causes farmers to have difficulty accessing the Internet more easily. The digital literacy of farmers in eastern Indonesia is still low, so the utilization of the Internet is still inefficient. This finding is consistent with the research study of Iskandar et al. (2020), which shows that some farmers in Indonesia may not understand how to use the Internet effectively and efficiently. Farmers generally have limited ability and knowledge to utilize the Internet to facilitate agricultural activities. Then, the limitations to accessing the Internet in eastern Indonesia are due to the cost of accessing the Internet being more expensive. Ultimately, internet access burdens

farmers' expenses in eastern Indonesia, which is difficult to fulfil. This finding is similar to the study of Javaid et al. (2022), which states that devices that support internet access are complicated for farmers to obtain because these devices tend to have high costs.

Figure 4. Map of Farmers' Cell Phone Ownership by City District in Indonesia in 2021



Source: National Socio-Economic Survey (Susenas).

Figure 4 shows farmers' distribution map of cell phone ownership in Indonesia. Based on the distribution map, cell phone ownership by farmers in eastern Indonesia is still low. This can be caused by several factors, including financial limitations, which are a condition that causes farmers to have limitations in cell phone ownership, especially in rural areas. Many farmers face limited financial resources, making buying a cell phone and paying for telecommunication services a significant economic burden. This finding is consistent with Tadesse and Bahiigwa (2015) research that farmers' low income makes cell phones a problematic item to afford, especially for farmers in remote areas. Cell phones are a heavy burden for farmers because they have to buy cellphone devices, plus operational costs. In addition, farmers in eastern Indonesia are generally not covered by adequate telecommunications networks, limiting their ability to use cell phones effectively. Eastern Indonesia still has many remote areas difficult to reach to build digital infrastructure. This finding aligns with the study of Moeis et al. (2020), which shows that rural areas often face limitations of cellphone networks, especially in remote areas with mountainous topography. This makes it difficult for remote farmers to access information via mobile phones.

CONCLUSION

Farmers in the upper-middle household expenditure group (Q3-Q5) can optimally utilize the Internet and mobile phones to improve welfare. The Internet makes it easier for farmers to obtain information on production techniques, market prices, digital marketing, and access to farm credit. Higher finances and education levels support this ability, so they understand how to apply technology effectively. In contrast, farmers from low household expenditure groups (Q1-Q2) face difficulties accessing and utilizing the Internet and mobile phones due to cost constraints and inadequate digital infrastructure in rural areas. Farmers in the lowest household expenditure group constitute a significant obstacle to improving farmer welfare.

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Although the Internet and mobile phones can potentially improve welfare among farmers in the middle to upper-middle household expenditure group (Q3-Q5), digital inequality still exists between the eastern and western Indonesian regions. Internet utilization by farmers is concentrated in the western regions, such as Sumatra and Java. Meanwhile, farmers in eastern Indonesia face limited internet access in terms of infrastructure, digital literacy and high internet access costs.

The government can make policies for farmers to make applying the Internet and cell phones easier. This digital divide still occurs in western and eastern Indonesia, where digital applications are used. The government is expected to make policies to build digital literacy in rural eastern Indonesia through socialization, counseling, and training. In addition, the government can provide policies to accelerate the development of internet networks in rural eastern Indonesia so that access becomes more effortless.

Digital infrastructure can be realized through collaboration between the government and the private sector so that internet access is evenly available and increases the digital literacy of rural communities. The government can develop applications that suit the needs of farmers to get information on how to develop agricultural products, market access, and weather conditions with applications that are easy to understand. The government subsidizes internet devices and cell phones for low-income farmers. Farmers will more easily access technical agricultural information and business management after the government subsidizes farmers.

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