# AGRIEKONOMIKA

http://journal.trunojoyo.ac.id/agriekonomika
Volume 12, Nomor 2, 2023
DOI: https://doi.org/10.21107/agriekonomika.v12i1.22127

*Agriekonomika has been accredited as a scientific journal by the Ministry of Research-Technology and Higher Education Republic of Indonesia:*
***No. 23/E/KPT/2019***
***SINTA 2***


## ICT and Signaling Effects on the Income of Rural Farmers in Indonesia


**Muhammad Maftuhin**

Central Bureau of Statistics Kota Cirebon, Indonesia



Received: Mei 2023; Accepted: August 2023; Published: October 2023



## ABSTRACT

This study investigates how the usage of ICT and signaling affects farmers' income in rural areas. Indonesian farmers employ a variety of ICT, including mobile phones, the internet, computers, and telephones. Indonesian farmers are frequently connected with a lack of ability to understand information technology. Furthermore, the village's poor facilities prevent farmers from adopting information technology, one of which is the presence of a signal. The 2018 national socioeconomic survey (susenas) is used in this study to examine the profile of people who work as farmers, and the 2018 village potential survey (podes) is used to determine the existence of current facilities in the village. The total sample size is 112,070 agricultural households from Indonesia. The ordinary least squares (OLS) approach was used to examine the impact of ICT elements on farmers' income, which included the ability to use ICT and the presence of 4G signals in the hamlet. According to the study's findings, farmers whose villages have a strong signal can improve their income. Farmers who use mobile phones in villages that receive 4G signals can also enhance their income.



Keyword: Agriculture, Socio-Economic, Communication, Network.


## INTRODUCTION

Agriculture plays a vital function as an economic support, particularly in developing nations such as Indonesia, where this sector supports the majority of the economy. This is seen by the Indonesian sector's GDP growth from 2018 to 2023 (Figure 1). The agriculture sector's greatest GDP value in 2023 was 1,454,586.9 trillion rupiah, with a 1.3 percent growth raterapid expansion without the assistance of human resources in this sector. This is evidenced by the fact that informal laborers have made up the vast majority of the agricultural workforce since 2018, representing more than 86.5 percent. This will influence agricultural output and productivity as land keeps decreasing (Mehrotra & Biggeri, 2007). Due to diminishing natural resources, agricultural productivity must be increased (Sørensen et al., 2019). Information technology is one technique for enhancing agricultural productivity (Omulo & Kumeh, 2020; Quandt et al., 2020).

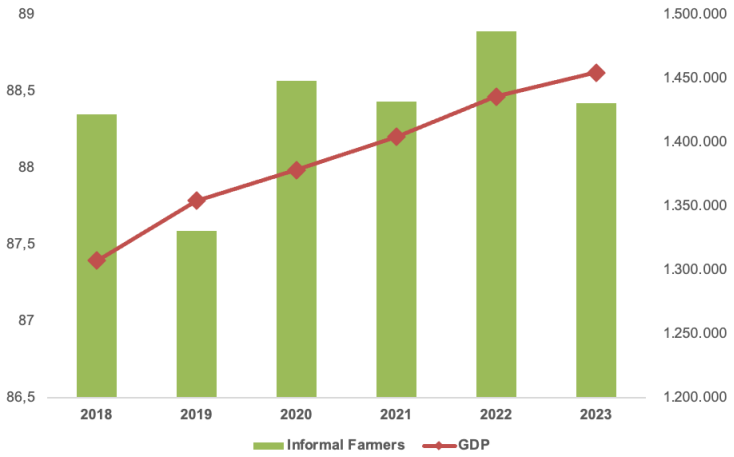
Farmer productivity is increased when ICT is used efficiently or in combination with other ICT components (Sørensen et al., 2019). The usage of mobile phones is an example of valuable ICT for farmers (Baumüller, 2018; Michailidis et al., 2011; Mittal & Mehar, 2012). Mobile phones can help improve revenue, increase market efficiency, minimize transaction costs, and give convenience in communicating information (Michailidis et al., 2011).The rapid rise of mobile phones and information services can assist extensive information transmission to the agriculture


*Corresponding author:
Email: maftuhin@bps.go.id




p-ISSN 2301-9948 | e-ISSN 2407-6260

sector and help overcome information asymmetry that occurs among farmer groups. This can help bridge the gap between stock availability, agricultural input delivery, and agricultural infrastructure (Mittal & Mehar, 2012). Mobile phones, for example, have the capacity to transmit relevant and timely information, allowing decision makers to use resources in the most productive and profitable way (Ekbia & Evans, 2009; Ommani & Chizari, 2008).




Sources: BPS Data (Processed)

**Figure 1**
**GDP and Informal Labor Force in the Agricultural Sector in Indonesia, 2018–2023.**

According to BPS statistics, Indonesia's ICT development has improved significantly over the previous six years. In 2018, the ICT Development Index value was reported at 5.07, and it continued to rise until 2023, when it reached 5.90. Telephone customers will be 3.29 per 100 residents in 2023, compared to cellular telephone users who will be 126.36 per 100. Regarding other ICT components, in 2023, 18.06 percent of homes had a computer, while 87.08 percent had internet connectivity. This indicates that the internet has an enormous opportunity to improve the performance of the majority of people, including those who work in agriculture.

The computer is another component of ICT. The function of computers in assisting farmer production is highly helpful in report preparation (Nuthall, 2004). PCs enable farmers to easily and accurately keep financial records, oversee agricultural processes, summarize data, and make general decision-making easier (Gloy, 2000). The use of computers not only provides a platform for calculating soil fertility, but it can also reduce labor input (Hou et al., 2019).

In contrast to computers, the Internet enables farmers to acquire and analyze external data and information (Gloy, 2000). Internet access can impact farm household resource allocation as well as facilitate business administration and marketing activities, resulting in increased household economic welfare (W. Ma et al., 2020). The Internet significantly reduces transaction costs caused by distance and restricted connectivity in rural areas. In general, the availability of the internet has the potential to alleviate rural poverty (Chang & Just, 2009). Access to timely information is critical for enhancing market interactions and, as a result, changing farmer wellbeing (Goyal, 2010).

Despite the fact that mobile phone ownership has surged in recent years, mobile data costs have been reduced, leaving a significant gap in internet access (Mehrabi et al., 2020). Superfast networks are critical in the agricultural business for improving yield quality and crop quality while reducing labor utilization (Tang et al., 2021). It enables the automation of various

farms, such as for crop plowing, planting, and agricultural management phases, without the need for human intervention. When compared to earlier generations of internet, 4G technology will be able to provide more bandwidth, higher data rates, lower latency, and increased energy efficiency (Damsgaard et al., 2022).

There is a lot of literature that examines individual behavior related to internet use, but less attention is paid to agricultural household internet use, especially in rural areas. The composition of business fields in the agricultural purchasing sector has a good impact from ICT results which are considered low (Ali & Abdulai, 2010). This study examines the effects of using ICT on farmer income in Indonesia using two units of analysis, specifically households. In addition, another unit of study is the village, which is used to examine the impact of signal presence on farmer income in rural areas. Several prior research employed ICT variables such as computer use, internet access, mobile phone use, and the availability of internet cafes. This study investigates the use of ICT in rural areas more particularly by using signal strength and the presence of 4G signals as a gap investigation.

## RESEARCH METHODS

This study focuses on the usage of ICT by rural farmers in Indonesia. In this study, agricultural households in rural Indonesia were employed as the unit of analysis. This study included 112,070 farming households and 82,014 rural as samples. The data set used in this study was collected by BPS, including the 2018 national socioeconomic survey (Susenas) and the 2018 village potential survey (podes).

The Ordinary Least Squares (OLS) approach was used to estimate farmers' income. Several factors in the usage of information technology employed include mobile phones, telephones, computers, internet, internet cafés, BTS, signal strength, operators, and 4G signals. Age, gender, number of dependents, migration, reading ability, and education belong to the demographic characteristic

$$lny_i = \alpha_i + \beta_i \eta_i + \gamma_i \lambda_i + \varepsilon_i \text{.....(1)}$$

and

$$lny_d = \alpha_d + \beta_d \phi_d + \varepsilon_d \text{ .....(2)}$$

Equations (1) and (2) above show the equation model. Parameter η shows the socio-demographic factors of rural farmers. While the parameter λ shows the literacy factor in the use of information technology. The unit of analysis for agricultural households is i, while the unit of analysis for the village is d. The first model in this study examines the effects of ICT on farmer income. While the second model investigates the impact of signals on farmer income

## RESULTS AND DISCUSSION

The majority of the farmers in this survey in Indonesia were of productive age, with as many as 87.95 percent being between the ages of 15 and 64. Farmers of the male sex dominate at the national level, as well as in Java and outside Java. The majority of farmers in Indonesia do not migrate, but outside of Java, 21.79 percent of farmers migrate. Most farmers in Indonesia can read. However, when it comes to education, the majority of farmers in Indonesia have not completed primary school.

Mobile phones and telephones are two of the most common telecommunication technologies used by farmers in Indonesia. In Indonesia, cell phones are used as a means of communication by 66.24 percent of farmers. Farmers in Java have various challenges; the percentage of farmers who do not use telephones is higher, at 57.02 percent. A computer and the internet are examples of telecommunications equipment that farmers rarely utilize.

Globally, the availability of BTS (Base Transceiver Station) at the village/kelurahan level is still limited. Only 38.15 percent of villages/kelurahans have BTS installed. Meanwhile,

villages/kelurahans in Java Island have a BTS of 52.27 percent. The intensity of the telephone signal in Indonesia is generally strong; only 8.05 percent of Indonesian villages have no service. In Indonesia, 4G signal coverage is uneven. The majority of 4G signals are found on the island of Java, where 49.54 percent of villages have a 4G signal

**Table 1**
**Description of Research Object**

| Variable | Indonesia | Java | Outside Java |
|---|---|---|---|
| **Age** | | | |
| 15– 64 | 87,95 | 79,70 | 89,89 |
| > 64 | 12,05 | 20,30 | 10,11 |
| **Sex** | | | |
| Male | 89,13 | 87,44 | 89,53 |
| Female | 10,87 | 12,56 | 10,47 |
| **Number of Children** | | | |
| 1 | 5,27 | 6,90 | 4,89 |
| ≥2 | 94,73 | 93,10 | 95,11 |
| **Migration** | | | |
| Yes | 18,40 | 3,91 | 21,79 |
| No | 81,60 | 86,09 | 78,21 |
| **Reading ability** | | | |
| Yes | 88,73 | 84,50 | 89,72 |
| No | 11,27 | 15,50 | 10,28 |
| **Education** | | | |
| Not Completed Primary School | 36,07 | 40,49 | 35,03 |
| Primary school | 36,68 | 43,75 | 35,03 |
| Junior High School | 14,05 | 9,50 | 15,12 |
| Senior High School | 12,00 | 5,50 | 13,53 |
| D1/D2/D3 | 0,39 | 0,30 | 0,40 |
| S1/D4 | 0,79 | 0,45 | 0,87 |
| S2/S3 | 0,02 | 0,02 | 0,02 |
| **Handphone** | | | |
| Yes | 66,24 | 54,75 | 68,93 |
| No | 33,76 | 45,25 | 31,07 |
| **Telephone** | | | |
| Yes | 54,34 | 42,98 | 57,00 |
| No | 45,66 | 57,02 | 43,00 |
| **Komputer** | | | |
| Yes | 2,11 | 1,43 | 2,27 |
| No | 97,89 | 98,57 | 97,73 |
| **Internet** | | | |
| Yes | 6,89 | 6,21 | 7,05 |
| No | 93,11 | 93,79 | 92,95 |
| **Internet caffe** | | | |
| Yes | 22,42 | 40,25 | 14,73 |
| No | 77,58 | 59,75 | 18,27 |
| **BTS** | | | |
| Yes | 38,15 | 52,27 | 31,94 |
| No | 61,85 | 47,43 | 68,06 |
| **Signal Strength** | | | |
| Very strong | 14,91 | 19,07 | 13,12 |
| Strong | 51,30 | 65,05 | 45,38 |
| Weak | 25,73 | 15,72 | 30,05 |
| No signal | 8,05 | 0,16 | 11,45 |
| **Operator** | | | |
| Yes | 86,10 | 96,99 | 81,40 |

| Variable | Indonesia | Java | Outside Java |
|---|---|---|---|
| No | 13,90 | 3,01 | 18,60 |
| **4G Network** | | | |
| Yes | 31,81 | 49,54 | 24,18 |
| No | 68,19 | 50,46 | 75,82 |

Sources: Susenas and Podes 2018 (processed)

## ICT analysis of farmers' income

Table 2 shows the influence of social demographic factors on farmers' income. Age has a significant effect on the income of farmers in Indonesia. The farmer's income rises by 0.0049 rupiahs (sig 1%) as he gets older. Male farmers make more money than female farmers. Farmers who have migrated have better incomes than farmers who have not migrated. According to Model 1, the income of farmers who relocate improves by 0.1280 rupiah (sig 1%). Farmers that can read enhance their farms tremendously. Farmers with an elementary school diploma earn 0.0171 rupiahs (sig 1%) more than farmers who do not complete elementary school.

Farmers who use cell phones, telephones, computers, the internet, and internet cafes as telecommunication tools significantly increase farmers income. Farmers' revenue can be increased by 0.092 rupiahs (significance 1%) by using mobile phones. Farmers who use telephones can enhance their revenue by 0.1050 rupiah (sig 1%) when compared to farmers who do not use telephones (Model 1). Computers can enhance farmers' income by 0.2038 rupiahs (significance 1%). Similarly, the internet can boost farmers' income by 0.2017 rupiahs (sig 1%). Farmers who live in areas with 4G signal increase their income significantly by 0.0875 (sig 1%).

The number of base stations in a rural has a substantial impact on farmer revenue. The more BTS in rural areas, the higher the farmers' income (sig 5%). The percentage of rural with a strong signal can enhance farmers' revenue by 0.5212 (sig 1%). However, the influence of the number of operators in the rural produced different results, which had a considerable negative effect on farmers' income. Farmers' income can be increased by 0.0875 (sig 1%) if there is a high percentage of 4G signals in their area.

In further detail, the authors use interaction effects to examine the impact of ICT on farmer income. Model 2 The interaction between cell phones and 4G signals can have a positive and significant effect on increasing farmers' income by 0.1239 rupiahs (sig 1%). Model 3 of the interaction between HP and a strong signal can increase farmers' income by 0.3307 rupiahs (sig 1%). Model 4 shows that the interaction between HP and a strong signal can increase farmers' income by 0.4711 (sig 1%). Meanwhile, model 4 shows that the interaction between the telephone and a strong signal can increase farmers' income by 0.3480 (sig 1%).

**Table 2**
**OLS Regression Results: Socio-Demographic Factors and ICT Literacy on Farmers' Income in Indonesia.**

| Variabel | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| ***Social & Demoghraphic*** | | | | | |
| Age | 0.0049*** | 0.0049*** | 0.0049*** | 0.0049*** | 0.0049*** |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Sex (Male =1) | 0.0459*** | 0.0462*** | 0.0461*** | 0.0463*** | 0.0464*** |
| | (0.0076) | (0.0076) | (0.0076) | (0.0076) | (0.0076) |
| Number of children | -0.1054*** | -0.1054*** | -0.1054*** | -0.1055*** | -0.1055*** |
| | (0.0013) | (0.0013) | (0.0013) | (0.0013) | (0.0013) |
| Migration (yes = 1) | 0.1280*** | 0.1288*** | 0.1283*** | 0.1276*** | 0.1277*** |
| | (0.0053) | (0.0053) | (0.0053) | (0.0053) | (0.0053) |
| Reading ability (yes = 1) | 0.0971*** | 0.0983*** | 0.0980*** | 0.0969*** | 0.0976*** |

| Variabel | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| | (0.0081) | (0.0081) | (0.0081) | (0.0081) | (0.0081) |
| Education | | | | | |
| Primary school | 0.0171*** | 0.0173*** | 0.0175*** | 0.0176*** | 0.0176*** |
| | (0.0055) | (0.0055) | (0.0055) | (0.0055) | (0.0055) |
| Junior High School | 0.0733*** | 0.0736*** | 0.0736*** | 0.0737*** | 0.0737*** |
| | (0.0074) | (0.0074) | (0.0074) | (0.0074) | (0.0074) |
| Senior high School | 0.1610*** | 0.1611*** | 0.1609*** | 0.1615*** | 0.1608*** |
| | (0.0078) | (0.0078) | (0.0078) | (0.0078) | (0.0078) |
| D1/D2/D3 | 0.4159*** | 0.4146*** | 0.4149*** | 0.4130*** | 0.4131*** |
| | (0.0298) | (0.0297) | (0.0298) | (0.0297) | (0.0297) |
| S1/D4 | 0.3754*** | 0.3738*** | 0.3717*** | 0.3638*** | 0.3702*** |
| | (0.0259) | (0.0258) | (0.0258) | (0.0256) | (0.0258) |
| S2/S3 | 1.0003*** | 0.9931*** | 0.9855*** | 0.9827*** | 0.9806*** |
| | (0.1354) | (0.1366) | (0.1366) | (0.1212) | (0.1370) |
| ***ICT Literacy*** | | | | | |
| Handphone (yes =1) | 0.0922*** | 0.0471*** | 0.0423*** | 0.0927*** | 0.0932*** |
| | (0.0066) | (0.0096) | (0.0098) | (0.0066) | (0.0066) |
| Telephone (yes = 1) | 0.1050*** | 0.1057*** | 0.1055*** | 0.1050*** | 0.0519*** |
| | (0.0063) | (0.0063) | (0.0063) | (0.0063) | (0.0095) |
| Computer (yes = 1) | 0.2038*** | 0.2032*** | 0.2023*** | 0.1980*** | 0.2018*** |
| | (0.0158) | (0.0157) | (0.0157) | (0.0157) | (0.0157) |
| Internet (yes = 1) | 0.2017*** | 0.2003*** | 0.1999*** | 0.1216*** | 0.1993*** |
| | (0.0089) | (0.0089) | (0.0089) | (0.0144) | (0.0089) |
| Internet cafee | 0.0002*** | 0.0002*** | 0.0002*** | 0.0002*** | 0.0002*** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| BTS | 0.0001** | 0.0001** | 0.0001** | 0.0001** | 0.0001** |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| Signal Strength | 0.5212*** | 0.5136*** | 0.2806*** | 0.4358*** | 0.2999*** |
| | (0.0356) | (0.0355) | (0.0532) | (0.0367) | (0.0489) |
| operator | -0.0703*** | -0.0694*** | -0.0691*** | -0.0699*** | -0.0693*** |
| | (0.0033) | (0.0033) | (0.0033) | (0.0033) | (0.0033) |
| percent_4G | 0.0875*** | 0.0055 | 0.0884*** | 0.0886*** | 0.0879*** |
| | (0.0216) | (0.0276) | (0.0216) | (0.0216) | (0.0216) |
| Hp x percent 4G | | 0.1239*** | | | |
| | | (0.0239) | | | |
| HP x Strong signal | | | 0.3307*** | | |
| | | | (0.0539) | | |
| Internet x Strong signal | | | | 0.4711*** | |
| | | | | (0.0742) | |
| Telephone x Strong signal | | | | | 0.3480*** |
| | | | | | (0.0510) |
| Constant | 13.3657*** | 13.3892*** | 13.3945*** | 13.3757*** | 13.3934*** |
| | (0.0153) | (0.0156) | (0.0157) | (0.0153) | (0.0157) |
| **Observations** | 112,070 | 112,070 | 112,070 | 112,070 | 112,070 |
| **R-squared** | 0.2074 | 0.2078 | 0.2079 | 0.2081 | 0.2081 |

*Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*
*Source: Susenas and Podes 2018 (Processed)*

**Signal Analysis of Farmers' Income**

Table 3 shows that 4G signals can significantly increase the income of farmers in villages. Farmers in areas with 4G signals earn 0.0332 rupiahs (sign 1%) more than farmers in villages without 4G signals. The findings are consistent: the 4G signal has a positive and significant effect both inside and outside of Java. Only outside Java does the 3G signal have a beneficial and meaningful effect. Villages in Indonesia that are not reached by signals have the potential to severely diminish farmer incomes both within and

outside of Java.

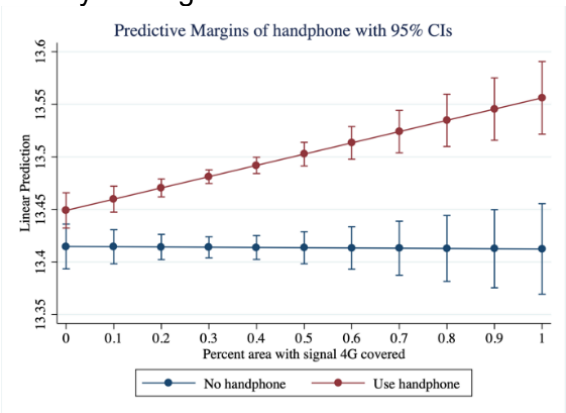
**Table 3**
**OLS Regression Results: The Impact of Signals on Farmers' Per capita Income in Rural**

| Variable | Indonesia | Java | Outside Java |
|---|---|---|---|
| Signal 4G | 0.0332*** | 0.0579** | 0.0740*** |
| | (0.0041) | (0.0252) | (0.0043) |
| Signal 3G | -0.0059 | -0.0001 | 0.0276*** |
| | (0.0040) | (0.0251) | (0.0041) |
| Signal 2G | 0.0015 | -0.0448* | 0.0191*** |
| | (0.0045) | (0.0254) | (0.0047) |
| No Signals | -0.0286*** | 0.0055 | -0.0276*** |
| | (0.0050) | (0.0272) | (0.0050) |
| Constant | 13.4831*** | 13.4083*** | 13.4835*** |
| | (0.0038) | (0.0251) | (0.0038) |
| **Observations** | **82,014** | **23,916** | **58,098** |
| **R-squared** | **0.0069** | **0.0247** | **0.0159** |

*Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*
Sources: Susenas and Podes 2018

The use of mobile phones by farmers in Indonesia has significantly increased the income of rural farmers. Mobile phones can help farmers raise their income, improve marketing efficiency, and minimize transaction costs (Michailidis et al., 2011). Farmers are more productive when using telephone technology that is supported by internet signals. Cellular technology can help fellow farmers, particularly small farmers, share information (Baumüller, 2018). The findings of this study support previous research by Mittal & Mehar (2012) that the expansion of mobile phones is one technique for improving information distribution to the agricultural sector, as well as a type of endeavor to eliminate knowledge asymmetry amongst farmer groups.

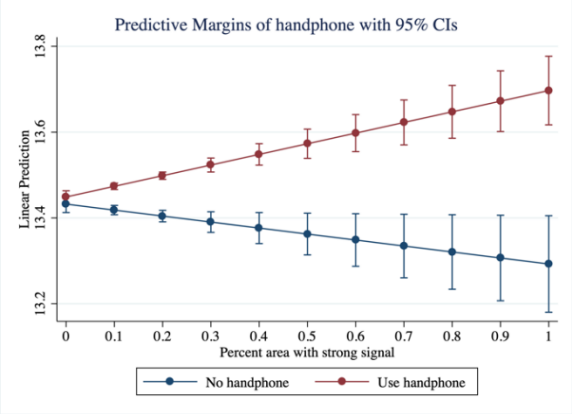
The interaction model between farmers who use mobile phones and are in areas that have a 4G signal significantly increases farmers' income (Model 2). Figure 2 indicates that when farmers use mobile phones and are in an area completely covered by a 4G signal, their production increases when compared with farmers who are not connected to mobile phones. This is because the 4G signal will provide improved capabilities for accessing data and information, as well as the ability to run apps swiftly ((Khan et al., 2009). When in a region that has strong 4G coverage, agricultural workers can easily and quickly access important data such as rainfall, seed costs, and seeds.




Sources: Susenas (2018)

**Figure 2**
**Farmer's Income: Interaction model between cellphones and 4G signals**

The role of signals has a significant influence on increasing farmer productivity. Model 3 shows that the interaction between cell phones and a strong signal in an area can increase the income of rural farmers. The signal role is very beneficial, especially for farmers who have adopted smart technology in their operations. Smart irrigation technology is significantly reliant on the strength of the GSM signal received by smartphones to function (Sushanth & Sujatha, 2018). Furthermore, the usage of mobile phones in locations with strong signal strength might improve engagement amongst farmers through fluid communication flows

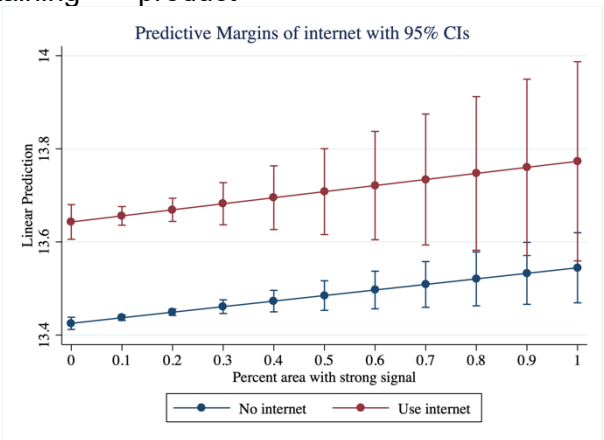



Sources: Susenas and Podes (2018)

**Figure 3**

**Farmer's Income: Interaction model between mobile and strong signal**

Internet connectivity can help to improve the economic well-being of farm households by making the selling of agricultural goods easier (W. Ma et al., 2020). Figure 4 shows the relationship between farmers who have used the internet and are in a high signal location getting a higher income. Internet access is beneficial for obtaining product information, pricing, supplies, and contacting with consumers and suppliers (Gloy, 2000). Furthermore, internet access may significantly cut transaction costs imposed by far rural locations, decreasing poverty and unemployment rates in rural areas (Chang & Just, 2009; Michailidis et al., 2011).



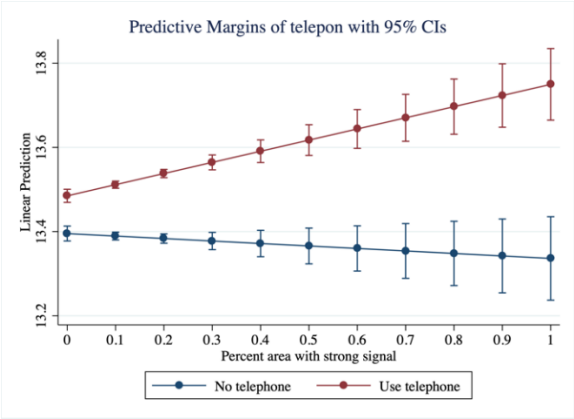

Sources: Susenas and Podes (2018)

**Figure 4**

**Farmer's Income: Interaction model between internet access and strong signals**

Computers are another type of ICT component that farmers might utilize. Table 2 shows that the usage of computers has a considerable beneficial influence on the income of Indonesian rural farmers. These results are consistent across all models. Farmers that utilize computers are more creative and have higher levels of technical proficiency (Khanna, 2001). The smart agricultural system uses computers to improve the quantity of fertile land, so it decreases labor input (Hou et al., 2019). Furthermore, computers improve farmers' access to public information (Aker & Ksoll, 2016).The common use of computers and the internet is beneficial in terms of increasing agricultural output.

Figure 5 shows the interaction between telephone usage by agricultural households in villages with a strong signal. Telephones will be more beneficial to farming households. Optimal telephone use may improve the agricultural industry by ensuring a seamless flow of information, improving income, and regulating food security (van Dijk et al., 2022). Telephones help farmers avoid relatively expensive information costs and assure more efficient market functions (Owusu et al., 2018).The significance of telephone dialing for farmers derives from the fact that not all rural locations in Indonesia have adequate internet connectivity, owing to signal restrictions (Ge et al., 2010).




Sources: Susenas dan Podes (2018)

**Figures 5**

**Farmer's Income: Interaction model between telephone and strong signals**

Signals can influence farmer production by influencing availability in a region. Firstly, the farmers use smart agriculture in the process. When compared to 3G or 2G transmissions, 4G signals are stronger (R. Ma et al., 2017; Tong et al., 2019). Table 3 shows that areas with good 4G signals in all analysis units could increase farmer income. The condition is different, such a village that does not have a signal can reduce the income of farmers in the region. The incidence of a poor signal in a village can affect farmer production, particularly among farmers who practice smart agriculture.

## CONCLUSION

Based on the data analysis, the research concludes that ICT is important for farmers in simplifying communication among farmers, acquiring information on fertilizers and weather forecasts, and simplifying financial transactions. Access to information and communication may be facilitated by mobile phone technology, regardless of distance obstacles. Mobile phones combined with a robust internet signal can help farmers increase output by providing precise access to diverse information.

Computers can help farmers by keeping track of many records. Farmers who use smart agriculture will earn a lot of money if they keep solid records. Computers have made it easier to record numerous reports and strategies in agriculture. Especially when a computer is combined with an accurate connection to the internet, such as farmers' access to important public information. Good information interchange, particularly in terms of increasing farmer production in rural regions.

The existence of internet access gives additional benefits to Indonesian farmers. The internet, when combined with other technologies such as mobile phones and PCs, will enable information flow systems for farmers. Internet access makes it easier for farmers to sell agricultural products and acquire market information. This can have a direct impact on farmers' revenue

The implementation of ICT will be strongly reliant on the signal strength available in that location. When compared to a 3G signal, areas with a strong 4G signal give faster internet access. Limitations of 4G signal in an area may delay internet performance and disrupt the flow of information. Limitations to an internet connection can diminish agricultural production, lowering money derived indirectly.

## REFERENCE

Aker, J. C., & Ksoll, C. (2016). Can mobile phones improve agricultural outcomes? Evidence from a randomized experiment in Niger. *Food Policy*, *60*, 44–51. https://doi.org/10.1016/j.foodpol.2015.03.006

Ali, A., & Abdulai, A. (2010). The Adoption of Genetically Modified Cotton and Poverty Reduction in Pakistan. *Journal of Agricultural Economics*, *61*(1), 175–192. https://doi.org/10.1111/j.1477-9552.2009.00227.x

Awuor, F., Kimeli, K., Rabah, K., & Rambim, D. (2013). ICT solution architecture for agriculture. *2013 IST-Africa Conference & Exhibition*, 1–7.

Baumüller, H. (2018). The Little We Know: An Exploratory Literature Review on the Utility of Mobile Phone-Enabled Services for Smallholder Farmers. *Journal of International Development*, *30*(1), 134–154. https://doi.org/10.1002/jid.3314

Chang, H.-H., & Just, D. R. (2009). Internet Access and Farm Household Income - Empirical Evidence using a Semi-parametric Assessment in Taiwan. *Journal of Agricultural Economics*, *60*(2), 348–366. https://doi.org/10.1111/j.1477-9552.2008.00189.x

Chhachhar, A. R., Qureshi, B., Khushk, G. M., & Ahmed, S. (2014). Impact of information and communication technologies in agriculture development. *J. Basic Appl. Sci. Res.*, *4*(1), 281–288. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85045914989&partnerID=40&md5=030b41b5582cb339d3e1205564623cfc

Ekbia, H. R., & Evans, T. P. (2009). Regimes of Information: Land Use, Management, and Policy. *The Information Society*, *25*(5), 328–343. https://doi.org/10.1080/01972240903212789

El Bilali, H., & Allahyari, M. S. (2018). Transition towards sustainability in agriculture and food systems: Role of information and communication technologies. *Information Processing in Agriculture*, *5*(4), 456–464. https://doi.org/10.1016/j.inpa.2018.06.006

Ge, N., Zang, Z., Gao, L., Shi, Q., Li, J., Xing, C., & Shen, Z. (2010). *Multipath for Agricultural and Rural Information Services in China* (pp. 345–351). https://doi.org/10.1007/978-3-642-12220-0_50

Gloy, B. (2000). Computer and internet adoption on large U.S. farms. *The International Food and Agribusiness Management Review*, *3*(3), 323–338. https://doi.org/10.1016/S1096-7508(01)00051-9

Hou, J., Huo, X., & Yin, R. (2019). Does computer usage change farmers' production and consumption? Evidence from China. *China Agricultural Economic Review*, *11*(2), 387–410. https://doi.org/10.1108/CAER-09-2016-0149

Khan, A. H., Qadeer, M. A., Ansari, J. A., & Waheed, S. (2009). 4G as a Next Generation Wireless Network. *2009 International Conference on Future Computer and Communication*, 334–338. https://doi.org/10.1109/ICFCC.2009.108

Khanna, M. (2001). Sequential Adoption of Site-Specific Technologies and its Implications for Nitrogen Productivity: A Double Selectivity Model. *American Journal of Agricultural Economics*, *83*(1), 35–51. https://doi.org/10.1111/0002-9092.00135

Ma, R., Teo, K. H., Shinjo, S., Yamanaka, K., & Asbeck, P. M. (2017). A GaN PA for 4G LTE-Advanced and 5G: Meeting the Telecommunication Needs of Various Vertical Sectors Including Automobiles, Robotics, Health Care, Factory Automation, Agriculture, Education, and More. *IEEE Microwave Magazine*, *18*(7), 77–85. https://doi.org/10.1109/MMM.2017.2738498

Ma, W., Nie, P., Zhang, P., & Renwick, A. (2020). Impact of Internet use on economic well-being of rural households: Evidence from China. *Review of Development Economics*, *24*(2), 503–523. https://doi.org/10.1111/rode.12645

Mehrotra, S. K., & Biggeri, M. (2007). *Asian Informal Workers*. Routledge. https://doi.org/10.4324/9780203966532

Michailidis, A., Partalidou, M., Nastis, S. A., Papadaki-Klavdianou, A., & Charatsari, C. (2011). Who goes online? Evidence of internet use patterns from rural Greece. *Telecommunications Policy*, *35*(4), 333–343. https://doi.org/10.1016/j.telpol.2011.02.006

Mittal, S., & Mehar, M. (2012). How Mobile Phones Contribute to Growth of Small Farmers? Evidence from India. *Quarterly Journal of International Agriculture*, *892-2016–65169*, 18. https://doi.org/10.22004/ag.econ.155478

Nuthall, P. L. (2004). Case studies of the interactions between farm profitability and the use of a farm computer. *Computers and Electronics in Agriculture*, *42*(1), 19–30. https://doi.org/10.1016/S0168-1699(03)00084-X

Ommani, A., & Chizari, M. (2008). *Information Dissemination System (IDS) Based E-Learning in Agricultural of Iran (Perception of Iranian Extension agents)*.

Omulo, G., & Kumeh, E. M. (2020). Farmer-to-farmer digital network as a strategy to strengthen agricultural performance in Kenya: A research note on 'Wefarm' platform. *Technological Forecasting and Social Change*, *158*, 120120. https://doi.org/10.1016/j.techfore.2020.12012

Owusu, A. B., Yankson, P. W. K., & Frimpong, S. (2018). Smallholder farmers' knowledge of mobile telephone use: Gender perspectives and implications for agricultural market development. *Progress in Development Studies*, *18*(1), 36–51. https://doi.org/10.1177/1464993417735389

Quandt, A., Salerno, J. D., Neff, J. C., Baird, T. D., Herrick, J. E., McCabe, J. T., Xu, E., & Hartter, J. (2020). Mobile phone use is associated with higher smallholder agricultural productivity in Tanzania, East Africa. *PLOS ONE*, *15*(8), e0237337. https://doi.org/10.1371/journal.pone.0237337

Serbulova, N., Kanurny, S., Gorodnyanskaya, A., & Persiyanova, A. (2019). Sustainable food systems and agriculture: the role of information and communication technologies. *IOP Conference Series: Earth and Environmental Science*, *403*(1), 012127. https://doi.org/10.1088/1755-1315/403/1/012127

Sørensen, C. A. G., Kateris, D., & Bochtis, D. (2019). *ICT Innovations and Smart Farming* (pp. 1–19). https://doi.org/10.1007/978-3-030-12998-9_1

Sushanth, G., & Sujatha, S. (2018). IOT Based Smart Agriculture System. *2018 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)*, 1–4. https://doi.org/10.1109/WiSPNET.2018.8538702

Tong, W., Feng, X., & Chen, X. J. (2019). *Research on Remote Control and Management Based on "4G Network" in Modern and High Efficiency Agriculture* (pp. 233–241). https://doi.org/10.1007/978-3-030-02777-3_21

van Dijk, M. P., Limpens, G., Kariuki, J. G., & de Boer, D. (2022). Telephone farmers and an emerging ecosystem are unlocking the hidden middle of agricultural value chains in Kenya through innovation. *Journal of Agribusiness in Developing and Emerging Economies*. https://doi.org/10.1108/JADEE-03-2021-0059

Zhang, Y., Wang, L., & Duan, Y. (2016). Agricultural information dissemination using ICTs: A review and analysis of information dissemination models in China. *Information Processing in Agriculture*, *3*(1), 17–29. https://doi.org/10.1016/j.inpa.2015.11.002