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Do online communities of practice complement or substitute conventional agricultural extension services? Evidence from Indonesian shrimp farmers' participation in a Facebook group

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Abstract

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Abstract

Using a unique dataset of 1,574 shrimp farmers, this study investigates whether online communities of practice can replace or compensate for traditional agricultural extension services. This study reveals that the correlation between the use of the community and conventional extension services, such as neighboring farmers, family members, and extension workers, is not statistically significant in the full sample. However, on excluding the non-community members, the results indicate that those who obtain information from their neighbors or extension workers are more likely to use the community. Regarding the reliability of the community, those who obtain information from their neighboring farmers or family members are less likely to choose the community as their most reliable source of information. This is consistent with the results obtained after excluding non-community members. Furthermore, we found a negative and statistically significant correlation between the frequency of information sharing and inquiries and information sources such as neighboring farmers and family members, and no association between increased time spent at home due to the COVID-19 pandemic and increased use of the community. The results suggest that online

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communities of practice may not yet have penetrated farmers in Indonesia and act as a complement to, rather than a substitute for, conventional extension services.

Keywords: Online communities of practice; agricultural extension service; farmer-to-farmer extension; shrimp farming

JEL Codes: D80; O33; Q1

1. Introduction

Providing farmers with relevant agricultural information not only improves the technology adoption and marketing activities but also encourages them to use resources more efficiently and conserve the environment (World-Bank, 2007). Conventionally, in both developed and developing countries, agricultural extension agents have been responsible for dissemination of technologies and practices to farmers (Anderson & Feder, 2004; Feder et al., 1985; Garforth, 1982; Jarrett, 1985; Roberts, 1989). However, because of the shortage of extension agents, most smallholder farmers in developing countries lack access to their services (Cole & Sharma, 2017; Fabregas et al., 2019).

As an alternative to these physical constraints, the farmer-to-farmer extension (F2FE) approach, which is defined as the provision of information on farming technologies by farmers to farmers, has been in the spotlight since the late 1990s (Takahashi et al., 2020). Studies have found that most small-scale farmers in developing countries rely on information from their neighboring farmers and that there is a peer effect on farmers' adoption of technology (Bandiera & Rasul, 2006; Conley & Udry, 2010; Foster & Rosenzweig, 1995; Lee et al., 2019; Liverpool-Tasie & Winter-Nelson, 2012; Magnan et al., 2015). While this information dissemination through F2FE is promising, this also means that farmers who do not have close ties with neighboring farmers may face difficulties in obtaining the desired information from other farmers, which may widen the gap between farmers in villages (Takahashi et al., 2020).

The advent of the Internet created opportunities for those less connected farmers to access more information through online communities of practice (OCoPs) which act as a means for information exchange among peers (Johnson, 2001). Information provided by most OCoPs that are developed and managed by farmers is free from rivalries because many users are able to access the group simultaneously (Lee & Suzuki, 2020). While some OCoPs on platforms like Facebook include closed groups, which require specific qualifications and can be accessed only by paying a membership fee; other public groups are accessible to any Facebook user. In both types of groups, once a user shares information with the community, an additional individual's marginal cost for obtaining the information becomes zero (Rayna, 2008). Thus, relative to the F2FE approach, the OCoPs may act as a more effective method to disseminate agricultural information.

Given these characteristics, OCoPs could provide a valuable forum for agricultural producers in developing countries to exchange knowledge when needed. However, there is still a dearth of knowledge on how the OCoPs act relative to conventional methods of information dissemination among farmers. In addition, existing studies on OCoPs do not consider the relationship between individuals' socioeconomic characteristics and their online community use or behavior in OCoPs because the data sets used in the studies were created by extracting posts from social media (Lee & Suzuki, 2020; Lin & Chang, 2018; Wasko & Faraj, 2005; Zhao et al., 2022). In contrast, this study employs data collected through household surveys and investigates whether OCoPs developed and managed by farmers can replace or compensate for traditional agricultural extension services. To this end, we empirically determine the association between the use of conventional extension services and: 1) the use of OCoPs; 2) the selection of OCoPs as the most reliable information source; and 3) information sharing and inquiry within OCoPs.

To identify these associations, we investigate one of the largest Indonesian OCoPs related to shrimp production on Facebook—the Indonesian Vannamei Shrimp Community, or the Komunitas Udang Vaname Indonesia (KUVI)—which currently has approximately 117 thousand members (as of January 2023). Through telephonic and face-to-face surveys, we constructed a unique dataset of 1,574 shrimp farmers, comprising of 243 KUVI members and 1,331 non-members. The survey solicited data on the respondents' socio-economic and farm characteristics, as well as information acquisition behavior.

The result shows that the correlation between the use of KUVI and conventional extension services, such as neighboring farmers, family members, and extension workers, is not statistically significant in the full sample. However, on excluding the non-KUVI members, the results indicate that those who obtain information from their neighbors or extension workers are more likely to use KUVI[1]. Regarding the reliability of information provided by KUVI, those who obtain information from their neighboring farmers or family members are less likely to choose KUVI as their most reliable source of information. This is consistent with the results obtained after excluding non-KUVI members. Furthermore, we found a negative and statistically significant correlation between the frequency of information sharing and inquiries and F2FE information sources such as neighboring farmers and family members, and no association between increased time spent at home due to the COVID-19 pandemic and increased use of OCoPs. The results suggest that OCoPs may not yet have penetrated farmers in Indonesia and act as a complement to, rather than a substitute for, conventional extension services.

The remainder of this paper is organized as follows. In Section 2, we explain the concepts for identifying whether OCoPs complement or substitute conventional agricultural extension services. Section 3 describes the data used in the study and presents the summary statistics, Section 4 explains the estimation methods used, and Section 5 presents the results. Finally, we provide the conclusions in Section 6.

2. Conceptual framework

To investigate whether farmers use OCoPs as a substitute or in conjunction with the conventional extension services, we focus on the following relation. Assuming that a farm

1 Note that we differentiate KUVI members and KUVI users as explained later since not all KUVI members used the service in the target period.

household uses several types of agricultural information, the subscript *OC* represents the household's use of an OCoP and *CE* represents the household's use of conventional extension services such as agricultural extension services and offline F2FE.

$$\hat{\beta} = \frac{\partial USE_{OC}}{\partial USE_{CE}}, \tag{1}$$

where *USE* is a dummy variable that indicates whether a farmer uses each source of agricultural information. If the coefficient $\hat{\beta}$ in Equation (1) is positive, the relationship between the conventional extension services and OCoPs is likely to be complementary, indicating that farmers use both sources of information to increase productivity and/or profits, although the primary source of information is unclear. In contrast, if the coefficient $\hat{\beta}$ in Equation (1) is negative, OCoPs is likely to substitute conventional extension services and vice versa, or that people who do not use extension services tend to use OCoPs.

Further, we examine who tend to consider OCoPs as the most reliable source of agricultural information among those farmers who use conventional extension services. We focus on the following relation.

$$\hat{\beta} = \frac{\partial Most\_Reliable_{OC}}{\partial USE_{CE}}, \tag{2}$$

where *Most_reiable* is a dummy variable that indicates whether a farmer selects an OCoP as the primary source of agricultural information. If the coefficient $\hat{\beta}$ in Equation (2) is positive, farmers may use OCoPs as the primary source of information. In contrast, if the coefficient $\hat{\beta}$ in Equation (2) is negative, OCoPs are likely to supplement conventional extension services.

Furthermore, to determine whether an OCoPs is replacing conventional extension services, this study examines whether farmers approach other OCoP members when they need tailored information. We assume that the users of conventional extension services are more likely to approach other OCoP members to receive agricultural information if the OCoP compensates for the shortcomings of conventional extension services and provides the users with the desired information. We also examine whether farmers using conventional extension services are actively providing information to the OCoP to identify information spillover from these services to OCoPs. If those who use conventional extension services actively provide information to OCoPs, there may be an information spillover between OCoPs and conventional extension services.

3. Data

In this study, we created a unique dataset of 1,574 shrimp farmers, comprising of 1,331 non-members and 243 members of a public Facebook group called "Indonesian Vannamei Shrimp Community" (or "Komunitas Udang Vaname Indonesia," henceforth, KUVI), created on September 19, 2018 (see Appendix A1). We chose to focus on shrimp farmers because they are sensitive to information regarding ways to prevent shrimp diseases and are proactive in seeking out sources of information (Lee et al., 2019). Accordingly, shrimp farmers worldwide have voluntarily formed OCoPs and actively share information about shrimp cultivation (Lee & Suzuki, 2020). Among the OCoPs created by shrimp farmers, to the best of our knowledge, KUVI is currently the world's largest shrimp aquaculture OCoP with approximately 117 thousand members (as of January 2023).

The data from January to December 2020 were collected using the following steps. First, we scraped the KUVI members list with a self-made web crawler and sent invitations to 24,129 KUVI members who signed up in 2019 or earlier, using Facebook messenger. Nevertheless, only 230 shrimp farmers (0.95%) agreed for telephonic interview by us. Second, we conducted a face-to-face survey of 1,344 shrimp farmers (of which 13 were KUVI members and 1,331 are non-KUVI members) in the Gresik and Lamongan districts in East Java, Indonesia. Respondents were invited from 89 villages in Lamongan and 19 villages in Gresik, which had a shrimp farmer population of roughly 24,000 and 7,000 respectively. Because of the COVID-19-induced constraints on the selection of survey sites, the sites for the face-to-face survey were non-randomly selected based on the accessibility and convenience of conducting the survey. Thus, the low response rates for the telephonic and face-to-face surveys are likely to introduce a sample selection bias into the results of the analysis.

Using data from 243 KUVI members, we depict the residential locations of the KUVI members through Figure 1. As shown in the figure, most of the KUVI members resided in Java, Sumatra, Sulawesi, and Kalimantan, in that order, and relatively few members resided in the Maluku Islands and Western New Guinea. Although the distribution of the KUVI members in Figure 1 may be biased because the face-to-face survey was conducted in East Java, the results are consistent with FAO statistics on the distribution of shrimp farmers in Indonesia (FAO, 2022).

[Insert Figure 1]

Figure 2 illustrates the frequency of access, information sharing, and inquires by the KUVI members and shows two groups: extensive and intensive shrimp-farming groups. Extensive shrimp farmers[2] cultivate shrimp in a low-density and in rather a natural way, which requires less investment and inputs. Due to the farming environment required by the low density of shrimp, risk of disease outbreak is lower in extensive farming methods than in

2 Shrimp stocking densities per m^2 in extensive farms ranges from 1 to 3 PL (Rubel et al., 2019).

intensive shrimp farming methods such as semi-[3], super-[4], and intensive shrimp farming[5] (Rubel et al., 2019). Note that in this study, we use the term “intensive shrimp farming” to include semi-intensive and super-intensive farming methods for the ease of comparison with “extensive shrimp farming.” Considering the characteristics of shrimp-farming methods, the extensive and intensive shrimp-farming groups have different demands for timely information. Therefore, we have divided the study sample into these two groups. However, Figure 2 shows that contrary to our expectations, in 2020, extensive shrimp farmers accessed KUVI and exchanged information with other KUVI members as often as farmers in the intensive shrimp-farming group did. This may be because the extensive shrimp farmers who participated in KUVI also planned to convert to intensive shrimp farming. Overall, approximately 75% of the KUVI members in the extensive group accessed the group at least once a week, but only 33% shared information, and 40% made inquiries.

[Insert Figure 2]

Figure. 3 shows the types of information shared and inquired by the KUVI members. Although the eight administrators of KUVI allow anyone to view posts in the group and become a member without their approval, the administrators pre-censor all posts and only allow posts that follow the rules of the group: 1. Be kind and courteous (Bersikap Baik dan Sopan); 2. Do not engage in hate speech or bullying (Tidak Ada Ujaran Kebencian atau Perundungan); and 3. Do not advertise or spam (Tidak Ada Promosi atau Spam). Because of their efforts, advertisements and political posts are rarely seen in the group. As depicted in Figure. 3, extensive shrimp farmers mostly share information about topics such as shrimp price, input

3 Shrimp stocking densities per m^2 in semi-intensive farm ranges from 10 to 30 PL (Rubel et al., 2019).
4 Shrimp stocking densities per m^2 in super-intensive farm ranges from 60 to 300 PL (Rubel et al., 2019).
5 Shrimp stocking densities per m^2 in intensive farm ranges from 300 to 750 PL (Rubel et al., 2019).

use, shrimp cultivation technology, and shrimp disease in that order. Contrastingly, information on input use is most frequently shared by intensive farmers at 40.48%. This is because intensive shrimp farmers tend to use large amounts and varieties of inputs, whereas extensive shrimp farmers tend to use fewer inputs (Rubel et al., 2019). Both groups had the lowest number of posts about shrimp disease. One possible reason for this is that posts on shrimp farming techniques and input use also include information related to shrimp treatments or disease prevention methods.

[Insert Figure 3]

Table 1 outlines the respondents' socioeconomic characteristics. In total, the average age of the household head was 47.28 years; 96% of the respondents were male, 94% Javanese, and 100% Muslim; and the average years of education was 10.21 years. As shown in Columns (2) and (3), the KUVI members were 16.53 years younger than the non-members, had 0.39 fewer family members, and were less likely to be Javanese, Muslim, and married. Conversely, the KUVI members had 2.71 more years of education than non-members did, and a higher percentage of the KUVI members were literate and owned smartphones than the non-members. Although all these differences are statistically significant, when we exclude the extensive shrimp farmers from the dataset for the reasons mentioned above, only the age difference is statistically significant, with the KUVI members being 8.69 years younger than the non-members. In other words, farmers who conduct intensive farming methods are not very different depending on the status of KUVI membership.

[Insert Table 1]

Table 2 highlights the respondents' shrimp farm characteristics. Column (3) shows that 99% of the non-KUVI members conduct extensive farming. Farming methods vary more for KUVI members, with 53% engaged in extensive farming, 24% in semi-intensive, 23% in intensive, and 4% in super-intensive methods. Columns (2) and (3) show that the percentage of extensive shrimp farmers among the KUVI members is 46% lower than that among non-members, and KUVI members' experience of shrimp farming is seven years less than that of the non-members, indicating that relatively newer shrimp farmers join KUVI. It is also very clear that the production costs, sales volume, and sales revenues are far greater for the KUVI members than non-KUVI members. We can see that they conduct very different types of shrimp farming. However, when we exclude farmers engaged in extensive farming (Columns (4), (5), and (4)-(5)), the difference between KUVI members and non-KUVI members become smaller with the share of semi-intensive farming, years of shrimp farming, and other costs being the only variables that remain statistically significant.

[Insert Table 2]

Tables 3 and 4 show the types of information sources on shrimp cultivation and the correlation between the information sources, respectively. As shown in Table 3, 80% of the respondents answered that they obtain information from farmers living in the same village, 20% from family members, 9% from extensive officers, and 5% from KUVI. Again, on excluding extensive farms, differences on the sources of agricultural information between KUVI members and non-members become small. The correlation matrix in Table 4 denotes that the correlation between the use of KUVI and the acquisition of information from other sources is less than 0.45, which indicates that they are weakly correlated. It is also noteworthy that the correlation between the use of KUVI and obtaining information from farmers living in the same village is negative in the total sample, whereas positive in the subsamples excluding extensive farms or non-KUVI members. On contrary, the correlation between the use of KUVI and obtaining information from family is positive in the total sample, but negative in the subsample excluding non-KUVI members.

[Insert Table 3]

[Insert Table 4]

Table 5 depicts the responses of the farmers regarding their most trusted information sources and reflects the same order as shown in Table 3. This implies that most shrimp farms in Indonesia tend to rely more on informal information from family members or neighboring farmers as compared to the formal information (like, that from extension officers). Even among KUVI members, the share of farmers who chose KUVI as the most reliable source is 9.88% for the full sample and 11.3% for the sub-sample excluding extensive farms. In both samples, this ranks the 4th among all the agricultural information sources. It also indicates that KUVI is less popular and trusted by Indonesian shrimp farmers compared to other sources, even though KUVI was the largest OCoP on shrimp farming in Indonesia in 2020.

[Insert Table 5]

The low percentage of the KUVI members choosing KUVI as the most reliable information source among other sources may be related to the quality of the information shared through KUVI. Therefore, we asked the KUVI members about their satisfaction and dissatisfaction with their KUVI use, as shown in Table 6. The percentages of KUVI members who were satisfied with the input, price, and disease-related information in KUVI are 71%, 59%, and 77%, respectively. Among them, the percentage of extensive shrimp farmers who answered that they were satisfied with the price-related information in KUVI is 13% higher than that of farmers in the intensive shrimp-farming group, which is statistically significant at the 5% level. In terms of the respondents' dissatisfaction with KUVI, 72% chose none, 13% opted for inaccurate information, and 15% believed that the information obtained from KUVI was not suitable for their region. The high percentage of members choosing "none" could be attributed to the fact that most KUVI members belong to the community with low expectations. In addition, the percentage of farmers in the intensive shrimp-farming group who answered "information obtained from KUVI is inaccurate for my region" is 13% higher than that of extensive shrimp farmers, which is statistically significant at the 5% level. This difference reflects the fact that farmers in the intensive shrimp-farming group are more sensitive to information than extensive shrimp farmers are. It is also notable that the farmers who answered "information obtained from KUVI is not suitable for my region" is also high.

[Insert Table 6]

4. Empirical Strategies

Using the dataset mentioned in Section 3, this study empirically examines the following research questions (RQ) such as the association between the use of conventional extension services and: 1) the use of OCoPs; 2) the selection of OCoPs as the most reliable information source; and 3) information sharing and inquiry in OCoPs. Because the study participants included KUVI members who did not use KUVI in 2020, we distinguished between KUVI members and KUVI users and created variables for each. To create the dummy variable for KUVI users, we asked all respondents if they used KUVI in 2020 and identified that 65 of KUVI members and eight of non-KUVI members used it. We employed the linear probability model, logistic regression, and ordered logistic regression to answer the research questions mentioned above. The regression was performed using the following equation:

$$Y_{ijk} = \alpha + \beta X'_{ijk} + \gamma Info'_{ijk} + Mobil_{jk} + \eta_k + u_{ijk}, \quad (3)$$

where the subscript i denotes an individual, j denotes a province, and k denotes a geographical unit. Y is a binary variable equal to 1 if the respondent is using KUVI or answers that it trusts KUVI the most among the sources of information, and 0 otherwise, in the analyses of RQ 1 and 2. In the analysis of RQ3, Y represents a categorical variable indicating how often the respondent shares information or inquiries and is equal to 0 for never, 1 for more than once a year but less than once a month, 2 for more than once a month but less than once a week, and 3 for more than once a week. X' accounts for the main farmer[6], household, and farm characteristics. $Info'$ refers to the sources of information a farmer uses for shrimp farming, such as extension workers, neighboring farmers, and family members. Due to COVID-19, in 2020, Indonesians spent more time at home and avoided going out (Pramana et al., 2021). Consequently, they had less face-to-face contact with people outside their family members, which could have made it more difficult for the farmers to obtain information from extension officers or neighboring farmers (see Appendix A2). To capture the effect of COVID-19 restrictions, we added $Mobil$ as a variable indicating the change in the number of hours the farmers in each province j spent at home in 2020 from the pre-pandemic times.[7] This variable was constructed using Google's COVID-19 Community Mobility Reports. η captures the unobserved heterogeneity across regions, and u is an error term.

6 In this study, a household member who makes decisions on shrimp farming and sales is defined as the main farmer.
7 The baseline day is the median value from the five-week period Jan 3–Feb 6, 2020.

To address the binary endogenous regressor $Info'_{ik}$, we employed the two-stage least squares (2SLS) method. The first-stage regression can be expressed as follows:

$$Info'_{ijk} = \alpha + \beta X'_{ijk} + \theta IV'_{ijk} + Mobil_{jk} + \eta_k + u_{ijk}, \quad (4)$$

where IV' is a set of valid instruments for $Info'$ and contains dummy variables that take the value of 1 if: 1) the respondent initially learned about shrimp farming from its family; 2) the respondent initially learned about shrimp farming from its neighboring farmers; 3) shrimp farmers engaged in a collective activity using the same canal as used by the respondent in 2020. The results of the first-stage are shown in Appendix A3.

5. Results

This study uses the data mentioned in Section 3 and empirically investigates whether OCoPs can complement or substitute conventional agricultural extension services. To improve the estimation precision, we cluster standard errors at the village level and include dummy variables for region and shrimp-farming methods. As mentioned in Section 4, we employed 2SLS in Tables 6–8; however, the result of the Hausman test for endogeneity indicates that all models using the instrumental variables in this table fail to reject the null hypothesis that the regressors are exogenous. Accordingly, the variables for information sources are unlikely to be endogenous and the ordinary least squares, ordered logit, or marginal effects from the logit model may have more explanatory power.

Columns (2) and (3) of Table 7 show that the squared age of the main farmers is positively correlated with the use of KUVI, although the use of KUVI decreases as the age of these farmers increases. These results are all statistically significant at the 1% or 5% levels. These results show concave curves with the rate of KUVI use gradually declining from age of 20 and rising again approximately from age 56.87. Contrary to general expectations, however, the correlations between the use of KUVI and gender, education level, ethnic minority, and shrimp farm size are not statistically significant in most columns except in Columns (4) and (5). Further, the variables representing whether the farmers obtain information from family, neighboring farmers, or extension officers are not statistically significantly correlated with the dependent variable. Regarding the reliability of the KUVI or other OCoPs presented in Columns (7), (8), and (10)−(12), our finding indicates that those who obtain information from neighboring farmers or family members are less likely to choose KUVI or other OCoPs as their most reliable source of information. Overall, the results for these two dependent variables are almost identical.

[Insert Table 7]

In addition to examining the determinants of KUVI and OCoPs used for the full sample, this study attempts to identify the determinants by excluding non-KUVI members, as shown in Table 8. This is because the full sample is likely to include farmers who have difficulty using KUVI and other OCoPs owing to a lack of internet access. In most columns of Table 8, the disease variable indicates that as the number of shrimp disease outbreaks in the farm increases, the farmers' probability of using KUVI or other OCoPs decreases by 4–5%, which is statistically significant at the 5% or 10% levels. It is in line with the results presented in Table 7, suggesting that information in KUVI and other OCoPs may not be considered useful for preventing or treating disease outbreaks. Columns (1) and (2) show that farmers who get information from other farmers residing in the same village are 14–16% more likely to use KUVI than those who do not, and Column (3) shows that farmers who get information from extension officers are 15% more likely to use KUVI than those who do not. Moreover, Columns

(7)−(12) indicate that those who get information from neighboring farmers or family members are less likely to choose KUVI or other OCoPs as the most reliable information source than those who do not. These results suggest that KUVI and other OCoPs are used by Indonesian shrimp farmers as a complement to conventional sources of information, rather than as a primary source of information.

[Insert Table 8]

Furthermore, to explore the determinants of the use of OCoPs and F2FEs, this study reclassified those who used KUVI or other OCoPs in 2020 as "OCoP users" (Columns (1), (2), (7), and (8)); those who obtained information from family members or neighboring farmers as "F2FE users" (Columns (3), (4), (9), and (10)); and those who use both OCoPs and F2FEs as "OCoPs and F2FEs users" (Columns (5), (6), (11), and (12))in Table 9.For full-sample model, the smaller the shrimp farm size, the higher the probability of using OCoPs or OCoPs and F2FEs together; while the larger the shrimp farm size, the higher the probability of using F2FEs, which is statistically significant at the 1%, 5%, and 10% levels except for Column (5). This trend is similar in the models using the subsample (wherein the non-KUVI members have been excluded), but only the result in Column (9) is statistically significant at the 10 % level. This relationship between pond size and the use of OCoPs and F2FEs is likely to be related to the fact that intensive farmers, who tend to require more sophisticated information on shrimp farming, tend to use smaller pond sizes. In both the models using the full sample and the model using the subsample, the disease variable indicates that as the number of shrimp disease outbreaks in the farm increases, the farmers' probability of using OCoPs decreases by 1–4%, which is statistically significant at the 5% or 10 % level. In contrast, the shrimp disease and F2FEs variables are positively correlated, but only statistically significant at the 5% level in

Column (3). Models with the F2FE variable as the dependent variable show that the probability of extension service users using F2FEs decreases by 18–46% depending on the full sample and subsample, and Columns (6) and (12) refer that the probability of extension service users using OCoP and F2FEs together increase by 7–14%.

[Insert Table 9]

To examine the characteristics of those who frequently share information and post inquiries in KUVI or other OCoPs, we exclude the non-KUVI members from the models in Table 10 as we did in Table 8. Since the dependent variables are the categorical variables mentioned in Section 4, hence we employ ordered logit models as shown in Columns (1) and (6). The results of the brant test in Table 10 guarantee that the parallel regression assumption has not been violated. In addition, although IV-2SLS is employed, the results of the Hausman test for endogeneity show that all models with instrumental variables in Table 10 fail to reject the null hypothesis that the regressors are exogenous.

In contrast to the results presented in Table 7, Table 10 shows that the relationship between the frequency of information sharing and inquiries among KUVI members and the age of the main farmers is a convex curve. That is, the frequency of information sharing gradually rises approximately from the age of 20 and decreases from age 42.59, as depicted in Column (2). Additionally, the frequency of inquiries gradually rises approximately from the age of 20 and decreases from age 43.26, as shown in Column (7). Furthermore, the dependent variables and sources of information, such as neighboring farmers, family members, and extension officers, show statistically significant and negative correlations. These results suggest that KUVI members who obtain information from family members, farmers in the same village, or extension officers are less likely to share or inquire about shrimp farming with other KUVI members than those who do not. However, they are more likely to merely view the information posted on KUVI.

[Insert Table 10]

6. Conclusions

Most studies on OCoPs have used data collected from social media; however, this study conducted a telephonic and a face-to-face survey in Indonesia in 2020 and created a unique dataset of 1,574 shrimp farmers, comprising of 243 KUVI members and 1,331 non-members. Using this dataset, we empirically tested whether OCoPs can complement conventional extension services such as government extension services and F2FE services.

We found that those who obtained information from their neighboring farmers or family members were less likely to choose KUVI as their most reliable source of information. Furthermore, KUVI members who obtained information from family members or farmers living in the same village were less likely to share information or inquiries about shrimp farming with other KUVI members than those who do not. These farmers are more likely to merely view the information posted on KUVI rather than relying on it. In addition, the correlation between the use of KUVI and the age of the main farmers is shaped like a concave curve, and the correlation between the frequency of information sharing and inquiries with the KUVI members and the age of the main farmers is shaped like a convex curve. However, contrary to general expectations, the main farmers' education level, gender, ethnicity, and farm size are not significantly correlated with their use of KUVI. The correlation between the severity of COVID-19 and the use of KUVI and other OCoPs is also not statistically significant.

These findings reveal that OCoPs are used by a wide range of farmers in Indonesia, rather than by those with specific characteristics. Moreover, Indonesian shrimp farmers use OCoPs not as a primary source of agricultural information, but as a means to supplement conventional information sources. This finding may be attributed to the fact that the information disseminated in KUVI by the members is mostly fragmented; therefore, farmers often do not find accurate information that would benefit their farming practices. Moreover, they appear to seek information not only from OCoPs, but also from their peers, who belong to the same community. This is primarily because the ecological prerequisites for shrimp farming differ by locality and depend on climate. To compensate for these shortcomings of OCoPs, information from conventional extension services needs to flow into OCoPs. However, this study reveals that users of conventional extension services tend to avoid providing information to OCoPs.

Despite the limitations of this study, such as the use of recall data and bias in the selection of respondents, this study reveals that OCoPs currently complement, not substitute conventional extension services. This study does not shed light on the relationship between OCoPs and farmer productivity. Therefore, a future study should be conducted to verify the relationship using panel data. We hope that the findings of this study and the future studies will contribute to a better understanding of OCoPs to provide better extension services, especially to farmers who have been marginalized by the traditional extension services.

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Tables and Figures

Table 1. Socioeconomic characteristics of the respondents

		Total	Full sample			Subsample excluding extensive farms		
			KUVI member	Non-KUVI mem.		KUVI member	Non-KUVI mem.	
		(1)	(2)	(3)	(2)-(3)	(4)	(5)	I-(d)
MF's age	Years	47.28	33.3	49.83	-16.53***	33.02	41.71	-8.69***
		(12.61)	(9.33)	(11.40)	[0.77]	(9.88)	(11.73)	[2.63]
MF's gender	1=Male	0.96	0.97	0.96	0.01	0.97	1.00	-0.03
		(0.19)	(0.71)	(0.19)	[0.01]	(0.18)	(0.00)	[0.04]
MF's ethnicity	1=Javanese	0.94	0.63	0.99	-0.36***	0.63	0.82	-0.19
		(0.24)	(0.48)	(0.08)	[0.01]	(0.48)	(0.39)	[0.12]
MF's religion	1=Muslim	1.00	0.98	1.00	-0.02***	0.96	1.00	-0.04
		(0.07)	(0.16)	(0.03)	[0.00]	(0.20)	(0.00)	[0.05]
MF's schooling	Years	10.21	12.5	9.79	2.71***	12.42	12.76	-0.35
		(3.59)	(2.63)	(3.58)	[0.24]	(2.88)	(2.49)	[0.74]
MF's literacy	1=Proficient	0.96	0.99	0.95	0.03**	0.99	1.00	-0.01
		(0.20)	(0.11)	(0.21)	[0.01]	(0.09)	(0.00)	[0.02]
Marriage	1=Married	0.85	0.62	0.89	-0.28***	0.57	0.76	-0.20
		(0.36)	(0.49)	(0.31)	[0.02]	(0.50)	(0.44)	[0.13]
Household size	Number	3.55	3.22	3.61	-0.39***	3.12	2.65	0.47
		(1.55)	(1.71)	(1.51)	[0.11]	(1.65)	(1.06)	[0.41]
Mobile phone	1=I have	0.82	0.98	0.79	0.18***	0.97	0.94	0.02
		(0.38)	(0.16)	(0.10)	[0.03]	(0.18)	(0.24)	[0.05]
Smart phone	1=I have	0.73	0.95	0.69	0.26***	0.95	0.94	0.01
		(0.44)	(0.22)	(0.46)	[0.03]	(0.22)	(0.24)	[0.06]
Household spending	Million IDR	32.04	49.15	28.92	20.23***	39.03	39.03	7.52
		(21.45)	(34.65)	(16.20)	[1.41]	(18.52)	(18.52)	[7.34]
N		1,574	243	1,331	1,574	115	17	132

Notes: MF is an abbreviation for the main farmer. Standard deviations are reported in brackets. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2. Characteristics of the respondents' shrimp farms

		Total	Full sample			Subsample excluding extensive farms		
			KUVI member	Non-KUVI mem.		KUVI member	Non-KUVI mem.	
		(1)	(2)	(3)	(2)-(3)	(4)	(5)	(4)-(5)
Extensive	1=Yes	0.92	0.53	0.99	-0.46***	-	-	-
		(0.28)	(0.50)	(0.11)	[0.02]	-	-	-
Semi-intensive	1=Yes	0.05	0.24	0.01	0.23***	0.46	0.71	-0.25*
		(0.21)	(0.43)	(0.10)	[0.01]	(0.50)	(0.47)	[0.13]
Intensive	1=Yes	0.04	0.23	0.00	0.23***	0.46	0.29	0.17
		(0.19)	(0.42)	(0.06)	[0.01]	(0.50)	(0.47)	[0.13]
Super-intensive	1=Yes	0.01	0.04	0.00	0.04***	0.08	0.00	0.08
		(0.08)	(0.19)	(0.00)	[0.01]	(0.27)	(0.00)	[0.07]
Years of shrimp farming	Years	14.54	8	15.73	-7.73***	6.80	13	-6.20***
		(8.23)	(7.32)	(7.82)	[0.54]	(6.65)	(11.91)	[1.95]
Total shrimp pond size	ha	1.28	2.16	1.11	1.05***	2.02	1.05	0.97
		(2.61)	(5.60)	(1.48)	[0.18]	(7.44)	(0.79)	[1.81]
Seed cost	Million IDR	10.66	42.26	4.89	37.37***	53.43	40.86	12.57
		(40.51)	(92.14)	(13.42)	[2.66]	(93.17)	(77.37)	[23.74]
Feed cost	Million IDR	32.46	177.57	5.97	171.60***	320.5	268.03	52.47
		(236.02)	(547.6)	(82.82)	[15.90]	(762.54)	(698.67)	[196.17]
Permanent worker cost	Million IDR	4.25	22.98	0.83	22.15***	41.85	20.66	21.19
		(41.35)	(101.2)	(9.13)	[2.83]	(143.17)	(45.65)	[35.09]
Temporary worker cost	Million IDR	1.78	2.99	1.56	1.43***	4.22	4.65	-0.42
		(5.90)	(7.16)	(5.62)	[0.41]	(9.09)	(8.65)	[2.35]
Other costs	Million IDR	4.16	10.56	2.99	7.58***	17.06	48.75	-31.69*
		(27.64)	(37.74)	(25.21)	[1.92]	(49.92)	(144.55)	[17.92]
Shrimp sales volume	kg	1,860.97	9,319.46	499.27	8,820.19***	15,412.66	10,675.18	4,737.49
		(9,733.22)	(22,403.73)	(2,949.05)	[641.75]	(29,826.83)	(23,755.68)	[7,573.93]
Shrimp sales revenue	Million IDR	112.24	584.54	26.01	558.53***	990.28	612.29	377.99
		(629.13)	(1,460.77)	(177.93)	[41.58]	(1,963.37)	(1,460.97)	[495.96]
N		1,574	243	1,331	1,574	115	17	132

Notes: Standard deviations are reported in brackets. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Types of agricultural information sources used by the respondents

	Total	Full sample			Subsample excluding extensive farms		
		KUVI member	Non-KUVI mem.		KUVI Member	Non-KUVI mem.	
	(1)	(2)	(3)	(2)-(3)	(4)	(5)	(4)-(5)
Extension officer	0.09	0.19	0.07	0.12***	0.28	0.41	-0.13
	(0.28)	(0.40)	(0.26)	[0.02]	(0.45)	(0.51)	[0.12]
KUVI	0.05	0.28	0.01	0.27***	0.23	0.00	0.23**
	(0.21)	(0.45)	(0.08)	[0.01]	(0.43)	(0.00)	[0.10]
Other OCoPs	0.02	0.03	0.01	0.02**	0.02	0.06	-0.04
	(0.12)	(0.18)	(0.11)	[0.01]	(0.13)	(0.24)	[0.04]
Farmers living in the same village	0.80	0.59	0.83	-0.24***	0.61	0.53	0.08
	(0.40)	(0.49)	(0.37)	[0.03]	(0.49)	(0.51)	[0.13]
Farmers living in other villages	0.09	0.14	0.08	0.06***	0.15	0.18	-0.03
	(0.29)	(0.35)	(0.28)	[0.02]	(0.36)	(0.39)	[0.09]
Family (parents, siblings, etc.)	0.20	0.35	0.17	0.17***	0.26	0.12	0.14
	(0.40)	(0.48)	(0.38)	[0.03]	(0.44)	(0.33)	[0.11]
Local feed/input seller	0.02	0.04	0.01	0.03***	0.08	0.00	0.08
	(0.12)	(0.20)	(0.10)	[0.01]	(0.27)	(0.00)	[0.07]
Collector/middleman	0.03	0.05	0.02	0.03**	0.05	0.18	-0.12*
	(0.16)	(0.22)	(0.15)	[0.01]	(0.22)	(0.39)	[0.07]
Cooperative	0.01	0.01	0.00	0.01*	0.01	0.00	0.01
	(0.07)	(0.11)	(0.06	[0.00]	(0.09)	(0.00)	[0.02]
Others	0.04	0.11	0.02	0.08***	0.14	0.00	0.14
	(0.19)	(0.31)	(0.16)	[0.01]	(0.35)	(0.00)	[0.08]
N	1,574	243	1,331	1,574	115	17	132

Notes: Standard deviations are reported in brackets. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Correlation between agricultural information sources

a) Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) KUVI	1.000									
(2) Extension officer	0.108***	1.000								
(3) Other OCoPs	0.045*	-0.021	1.000							
(4) Farmers living in the same village	-0.079***	-0.241***	-0.079***	1.000						
(5) Farmers living in other villages	0.154***	0.007	0.103***	0.032	1.000					
(6) Family (parents, siblings, etc.)	0.059**	-0.023	0.067***	-0.514***	0.226***	1.000				
(7) Local feed/input seller	0.070***	0.016	-0.015	-0.040	0.031	-0.011	1.000			
(8) Collector/middleman	0.169***	-0.023	0.045*	0.043*	0.167***	0.038	0.142***	1.000		
(9) Cooperative	0.026	0.009	-0.009	0.036	-0.023	-0.036	-0.009	-0.012	1.000	
(10) Others	0.081***	0.079***	0.303***	-0.050**	0.029	-0.032	0.030	-0.032	0.362***	1.000

*** p<0.01, ** p<0.05, * p<0.1

b) Subsample excluding extensive farms

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) KUVI	1.000									
(2) Extension officer	0.042	1.000								
(3) Other OCoPs	-0.077	0.013	1.000							
(4) Farmers living in the same village	0.032	-0.316***	-0.082	1.000						
(5) Farmers living in other villages	0.257***	0.051	-0.064	0.303***	1.000					
(6) Family (parents, siblings, etc.)	0.108	-0.134	-0.086	-0.114	0.303***	1.000				
(7) Local feed/input seller	0.086	-0.043	-0.041	-0.085	0.137	-0.013	1.000			
(8) Collector/middleman	0.161*	-0.043	-0.041	0.099	0.556***	0.268***	0.285***	1.000		
(9) Cooperative	-0.044	-0.057	-0.013	0.072	-0.037	-0.049	-0.024	-0.024	1.000	
(10) Others	-0.016	0.217**	0.099	-0.122	-0.027	-0.102	0.084	-0.100	0.235***	1.000

*** p<0.01, ** p<0.05, * p<0.1

c) Subsample excluding non-KUVI members

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) KUVI	1.000									
(2) Extension officer	0.094	1.000								
(3) Other OCoPs	0.041	-0.032	1.000							
(4) Farmers living in the same village	0.118*	-0.103*	-0.082	1.000						
(5) Farmers living in other villages	0.309***	0.073	0.059	0.286***	1.000					
(6) Family (parents, siblings, etc.)	-0.022	-0.093	-0.037	-0.295***	0.106*	1.000				
(7) Local feed/input seller	0.011	0.003	-0.038	-0.081	0.096	-0.063	1.000			
(8) Collector/middleman	0.284***	-0.015	0.064	0.112*	0.510***	0.154**	0.240***	1.000		
(9) Cooperative	0.014	0.040	-0.021	0.093	-0.045	-0.081	-0.023	-0.025	1.000	
(10) Others	0.025	0.235***	0.309***	-0.147**	-0.024	-0.140**	0.062	-0.079	0.323***	1.000

*** p<0.01, ** p<0.05, * p<0.1

Table 5. Types of agricultural information respondents rely on most

	Total	Full sample		Subsample excluding extensive farms	
		KUVI member	Non-KUVI mem.	KUVI member	Non-KUVI mem.
Extension officer	108	35	73	20	6
	6.86%	14.4%	5.48%	17.39%	35.29%
KUVI	33	24	9	13	0
	2.10%	9.88%	0.68%	11.30%	0.00%
Farmers living in the same village	1,174	111	1,063	55	10
	74.59%	45.68%	79.86%	47.83%	58.82%
Farmers living in other villages	41	4	37	1	0
	2.60%	1.65%	2.78%	0.87%	0.00%
Family (parents, siblings, etc.)	193	52	141	18	1
	12.26%	21.40%	10.59%	15.65%	5.88%
Others	25	17	8	8	0
	1.59%	7.00%	0.60%	6.96%	0.00%
N	1,574	243	1,331	115	17

Table 6. Satisfaction and dissatisfaction points with KUVI

	Total	Extensive	Intensive	
	(1)	(2)	(3)	(2)-(3)
Satisfaction				
Input info.	0.71	0.75	0.66	0.09
	(0.46)	(0.43)	(0.48)	[0.06]
Shrimp pricing info.	0.59	0.66	0.52	0.13**
	(0.49)	(0.48)	(0.50)	[0.06]
Shrimp disease info.	0.77	0.78	0.75	0.03
	(0.42)	(0.42)	(0.44)	[0.05]
Dissatisfaction				
None	0.72	0.77	0.65	0.07
	(0.41)	(0.4)	(0.41)	[0.05]
Inaccurate info.	0.13	0.07	0.20	-0.13***
	(0.34)	(0.26)	(0.40)	[0.04]
Info. obtained from KUVI is not suitable for my region	0.15	0.16	0.15	0.01
	(0.36)	(0.36)	(0.36)	[0.05]
N	243	128	115	243

*** p<0.01, ** p<0.05, * p<0.1

Table 7. Usage and trust on KUVI (including the non-KUVI members)

	1= Using KUVI			1= Using other OCoPs			The most reliable info. (1=KUVI)			The most reliable info. (1=Other OCoPs)		
	MFX	OLS	IV2SLS	MFX	OLS	IV2SLS	MFX	OLS	IV2SLS	MFX	OLS	IV2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
MF's age	-0.001	-0.01*	-0.01**	-0.001	-0.01**	-0.01**	0.003	-0.002	-0.002	0.002	-0.003	-0.003
	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
MF's age ^2	-0.00001	0.0001*	0.0001*	-0.00001	0.0001**	0.0001**	-0.0001*	0.00001	0.0001	-0.00005	0.00002	0.00002
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00002)	(0.0002)	(0.00003)	(0.00003)	(0.00003)
MF's schooling	0.02*	0.0002	-0.001	0.004	-0.003	-0.004	-0.004	-0.004	-0.004	-0.004	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
MF's schooling ^2	-0.001	0.0001	0.0001	0.00001	0.0003	0.0003	0.0001	0.0002	0.0002	0.0002	0.0003	0.0003
	(0.000)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0002)
ln_total shrimp pond size	-0.004	-0.01	-0.01	-0.01*	-0.02**	-0.02	-0.002	-0.002	-0.003	-0.002	-0.003	-0.004
	(0.005)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.004)	(0.005)	(0.01)	(0.004)	(0.005)	(0.01)
Shrimp disease (0-4)	-0.01**	-0.01	-0.01	-0.01*	-0.01	-0.004	-0.004	-0.004	-0.01	-0.003	-0.003	-0.004
	(0.004)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.003)	(0.005)	(0.005)	(0.004)	(0.005)	(0.01)
1= info. from family	0.004	0.02	-0.07	0.01	0.02	-0.03	-0.02**	-0.04**	-0.02	-0.02**	-0.05**	-0.02
	(0.01)	(0.03)	(0.11)	(0.02)	(0.03)	(0.13)	(0.01)	(0.02)	(0.07)	(0.01)	(0.02)	(0.07)
1= info. from farmers living in the same village	0.004	0.02	-0.12	-0.01	-0.01	-0.17	-0.04**	-0.05**	0.002	-0.06**	-0.06***	-0.02
	(0.01)	(0.03)	(0.12)	(0.02)	(0.03)	(0.12)	(0.02)	(0.02)	(0.08)	(0.03)	(0.02)	(0.08)
1= info. from extension officers	0.02	0.04	-0.02	0.01	0.02	-0.04	-0.002	0.002	0.02	-0.01	-0.01	0.01
	(0.02)	(0.03)	(0.06)	(0.02)	(0.03)	(0.06)	(0.01)	(0.02)	(0.04)	(0.01)	(0.02)	(0.04)
Log duration of time spent at home	-0.03	-0.09	-0.07	-0.01	-0.01	0.01	-0.01	-0.01	-0.01	-0.004	-0.01	-0.01
	(0.03)	(0.12)	(0.12)	(0.04)	(0.13)	(0.13)	(0.02)	(0.07)	(0.07)	(0.02)	(0.07)	(0.07)
Constant		0.26	0.40		0.20	0.32		0.14	0.10		0.19	0.15
		(0.25)	(0.28)		(0.25)	(0.30)		(0.16)	(0.18)		(0.17)	(0.18)
N	1541	1,543	1543	1,541	1543	1,543	1541	1543	1543	1541	1543	1543
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Shrimp farming Type FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
F Statistic			8.76			8.76			8.76			8.76
Over (p-value)			0.40			0.87			0.12			0.10
Endo (p-value)			0.55			0.26			0.41			0.63
Adjusted R-squared	.	0.17	0.12	.	0.16	0.10	.	0.09	0.07	.	0.07	0.06

Notes: In addition to the variables in the table above, the models are controlled by variables of household spending, number of household members, a dummy for a member of a cooperative, and shrimp farm income. Standard errors in parentheses are clustered for 175 villages. *** p<0.01, ** p<0.05, * p<0.1.

Table 8. Usage and trust on KUVI (excluding the non-KUVI members)

	1= Using KUVI			1= Using other OCoPs			The most reliable info. (1=KUVI)			The most reliable info. (1=Other OCoPs)		
	MFX	OLS	IV2SLS	MFX	OLS	IV2SLS	MFX	OLS	IV2SLS	MFX	OLS	IV2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
MF's age	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	0.02	0.00	0.00	0.02	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
MF's age ^2	0.0002	0.0002	0.0003	0.0003	0.0003	0.0004	-0.0003	-0.0001	-0.0001	-0.0003	-0.0001	-0.0001
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0002)
MF's schooling	0.20	0.02	0.02	0.21	0.03	0.02	0.02	0.01	0.01	0.04	0.01	0.01
	(0.19)	(0.04)	(0.04)	(0.19)	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)	(0.07)	(0.02)	(0.02)
MF's schooling ^2	-0.01	0.0002	0.0005	-0.01	0.0004	0.001	-0.0001	-0.0002	-0.0004	-0.001	-0.00002	-0.0003
	(0.01)	(0.002)	(0.002)	(0.01)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
ln_total shrimp pond size	-0.01	-0.01	-0.03	-0.01	-0.01	-0.03	0.03	0.02	0.03	0.04*	0.03	0.03*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Shrimp disease (0-4)	-0.04**	-0.04**	-0.03	-0.04**	-0.04**	-0.03	-0.04***	-0.05***	-0.05***	-0.04***	-0.04**	-0.04**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)
1= info. from family	-0.04	-0.02	0.23	-0.10	-0.09	0.18	-0.08**	-0.12**	-0.12	-0.12***	-0.14***	-0.11
	(0.06)	(0.07)	(0.18)	(0.06)	(0.08)	(0.17)	(0.04)	(0.05)	(0.10)	(0.03)	(0.05)	(0.11)
1= info. from farmers living in the same village	0.14**	0.16**	0.38	0.09	0.10	0.26	-0.19***	-0.18***	-0.26	-0.21***	-0.19***	-0.28*
	(0.06)	(0.07)	(0.23)	(0.06)	(0.07)	(0.23)	(0.05)	(0.05)	(0.16)	(0.05)	(0.05)	(0.16)
1= info. from extension officers	0.07	0.09	0.15*	0.05	0.07	0.12	0.04	0.02	0.00	0.03	0.01	-0.01
	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.08)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)
Log duration of time spent at home	-0.12	-0.06	-0.08	-0.04	0.01	-0.001	-0.01	-0.00	0.01	0.02	0.002	0.01
	(0.12)	(0.12)	(0.13)	(0.12)	(0.12)	(0.13)	(0.08)	(0.07)	(0.08)	(0.08)	(0.07)	(0.08)
Constant		-0.19	-0.37		-0.25	-0.38		0.21	0.28		0.24	0.32
		(0.56)	(0.64)		(0.56)	(0.62)		(0.38)	(0.40)		(0.38)	(0.41)
N	225	227	227	225	227	227	225	227	227	225	227	227
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Shrimp farming Type FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
F Statistic			3.81			3.81			3.81			3.81
Over (p-value)			0.49			0.34			0.99			0.99
Endo (p-value)			0.19			0.18			0.87			0.74
Adjusted R-squared	.	0.09	0.02	.	0.12	0.05	.	0.13	0.11	.	0.13	0.10

Notes: In the addition to the variables in the table above, the models are controlled by variables of household spending, number of household members, a dummy for a member of a cooperative, and shrimp farm income. Standard errors in parentheses are clustered for 158 villages. *** p<0.01, ** p<0.05, * p<0.1.

Table 9. Who uses OCoPs, F2FEs, or OCoPs and F2FEs together?

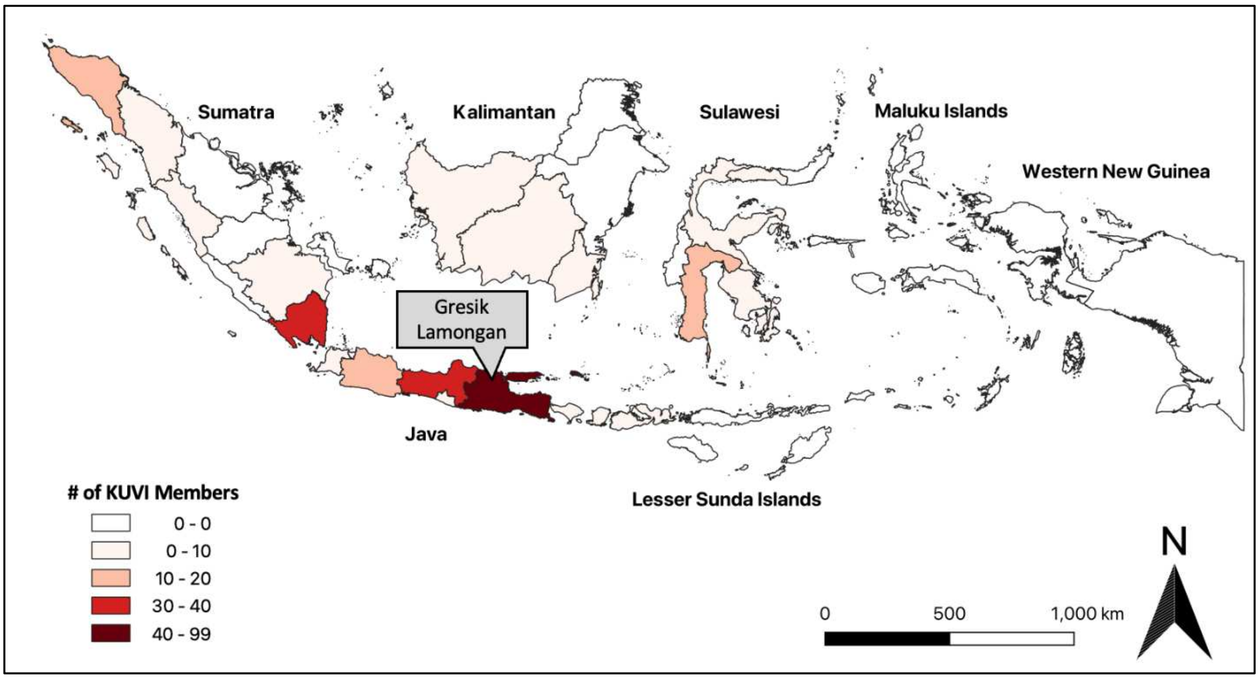
	Full sample						Subsample excluding non-KUVI members					
	1= Using OCoPs		1= Using F2FEs		1= Using OCoPs & F2FEs		1= Using OCoPs		1= Using F2FEs		1= Using OCoPs & F2FEs	
	MFX	OLS	MFX	OLS	MFX	OLS	MFX	OLS	MFX	OLS	MFX	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
MF's age	-0.002	-0.01**	-0.001	0.002	0.0001	-0.004	-0.03	-0.03	0.01	0.004	-0.02	-0.02
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
MF's age ^2	-0.000002	0.0001**	0.0000003	-0.00001	-0.00001	0.00003	0.0004	0.0003	-0.0001	-0.00004	0.0003	0.0003
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.0003)	(0.0003)	(0.0002)	(0.0001)	(0.0002)	(0.0003)
MF's schooling	0.004	-0.003	0.000	0.002	0.01	0.001	0.21	0.03	0.003	0.001	0.10	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.18)	(0.05)	(0.05)	(0.02)	(0.10)	(0.03)
MF's schooling ^2	0.00003	0.0003	-0.000003	-0.00003	-0.0001	0.00004	-0.01	0.0004	-0.0005	0.0001	-0.003	0.0002
	(0.0003)	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0002)	(0.01)	(0.002)	(0.002)	(0.001)	(0.004)	(0.001)
ln_total shrimp pond size	-0.01*	-0.02**	0.02***	0.01**	-0.01	-0.01**	-0.00	-0.01	0.04*	0.01	0.01	-0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)
Shrimp disease (0-4)	-0.01*	-0.01	0.01**	0.001	-0.01	-0.01	-0.04**	-0.04**	-0.01	0.02	-0.04***	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.004)	(0.005)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
1= info. from extension officers	0.01	0.02	-0.46***	-0.25***	0.01	0.07**	0.04	0.07	-0.32***	-0.18***	0.03	0.14**
	(0.02)	(0.03)	(0.09)	(0.05)	(0.02)	(0.03)	(0.06)	(0.07)	(0.07)	(0.04)	(0.06)	(0.06)
Log duration of time spent at home	-0.01	-0.01	0.08	0.08	0.02	0.08	-0.00	0.01	0.13	0.09	0.15	0.10
	(0.04)	(0.13)	(0.06)	(0.08)	(0.03)	(0.09)	(0.13)	(0.12)	(0.10)	(0.08)	(0.12)	(0.09)
Constant		0.20		0.35*		-0.21		-0.25		0.18		-0.80*
		(0.25)		(0.19)		(0.19)		(0.56)		(0.30)		(0.48)
N	1541	1,543	1541	1,543	1541	1,543	225	227	225	227	220	227
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Shrimp farming Type FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adjusted R-squared	.	0.16	.	0.69	.	0.18	.	0.12	.	0.70	.	0.30

Notes: In addition to the variables in the table above, the models are controlled by variables of household spending, number of household members, a dummy for a member of a cooperative, and shrimp farm income. Standard errors in parentheses are clustered for 175 villages (Columns (1)-(6)) and 158 villages (Columns (7)-(12)). *** p<0.01, ** p<0.05, * p<0.1.

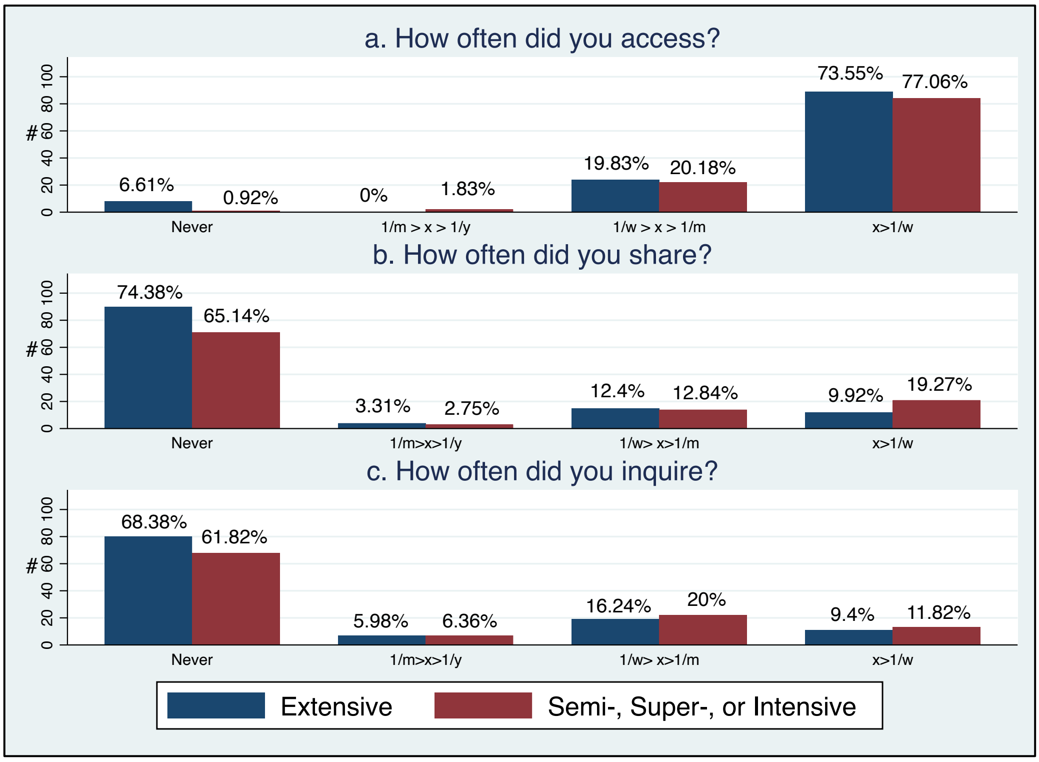
Table 10. Who frequently shares and inquires about shrimp farming information with other KUVI members?

	How often did you share info. in KUVI in 2022?					How often did you inquire info. in KUVI in 2022?				
	Ologit	OLS	OLS	IV2SLS	IV2SLS	Ologit	OLS	OLS	IV2SLS	IV2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MF's age	0.54***	0.19***	0.19***	0.19***	0.19***	0.27**	0.12**	0.12**	0.12***	0.13***
	(0.15)	(0.05)	(0.05)	(0.04)	(0.04)	(0.12)	(0.05)	(0.05)	(0.05)	(0.05)
MF's age ^2	-0.01***	-0.002***	-0.002***	-0.002***	-0.002***	-0.003*	-0.001**	-0.001**	-0.001**	-0.002**
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
MF's schooling	-0.22	-0.15	-0.17	-0.15	-0.17	0.16	0.05	0.05	0.05	0.04
	(0.39)	(0.20)	(0.21)	(0.19)	(0.20)	(0.22)	(0.10)	(0.09)	(0.09)	(0.09)
MF's schooling ^2	0.01	0.01	0.01	0.01	0.01	-0.01	-0.003	-0.003	-0.002	-0.002
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.004)	(0.004)	(0.004)	(0.004)
ln_total shrimp pond size	-0.16	-0.06	-0.09	-0.06	-0.08	0.08	0.04	0.02	0.05	0.04
	(0.17)	(0.07)	(0.07)	(0.07)	(0.08)	(0.15)	(0.06)	(0.06)	(0.06)	(0.07)
Shrimp disease (0-4)	-0.12	-0.07	-0.06	-0.06	-0.06	-0.16	-0.06	-0.06	-0.06	-0.06
	(0.11)	(0.05)	(0.05)	(0.06)	(0.06)	(0.12)	(0.05)	(0.05)	(0.06)	(0.06)
1= info. from family	-0.68	-0.23	-0.22	-0.34	-0.41	-1.01**	-0.40***	-0.39***	-0.91**	-0.96**
	(0.42)	(0.16)	(0.16)	(0.46)	(0.46)	(0.40)	(0.15)	(0.15)	(0.45)	(0.47)
1= info. from farmers living in	-0.81**	-0.36**	-0.34**	-0.29	-0.36	-0.70*	-0.37**	-0.34**	-0.35	-0.37
the same village	(0.37)	(0.15)	(0.15)	(0.57)	(0.55)	(0.38)	(0.15)	(0.15)	(0.61)	(0.59)
1= info. from extension officers	-0.22	-0.07	-0.07	-0.07	-0.09	-0.19	-0.13	-0.13	-0.17	-0.17
	(0.42)	(0.17)	(0.18)	(0.20)	(0.20)	(0.45)	(0.18)	(0.18)	(0.20)	(0.20)
Log duration of time spent at home	0.88	0.35*	0.21	0.35**	0.21	0.53	0.21	0.20	0.20	0.18
	(0.57)	(0.18)	(0.24)	(0.18)	(0.24)	(0.49)	(0.19)	(0.24)	(0.19)	(0.26)
Constant		-1.43	-1.18	-1.49	-1.17		-0.70	-0.76	-0.73	-0.76
		(1.74)	(1.81)	(1.79)	(1.82)		(1.24)	(1.30)	(1.37)	(1.37)
N	227	227	227	227	227	227	227	227	227	227
Regional FE	NO	NO	YES	NO	YES	NO	NO	YES	NO	YES
Shrimp farming Type FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Brant test (p-value)	0.07					0.58				
F Statistic				3.92	4.03				3.92	3.75
Over (p-value)				0.17	0.13				0.04	0.04
Endo (p-value)				0.95	0.92				0.63	0.62
Adjusted R-squared		0.11	0.09	0.10	0.09		0.13	0.11	0.08	0.05

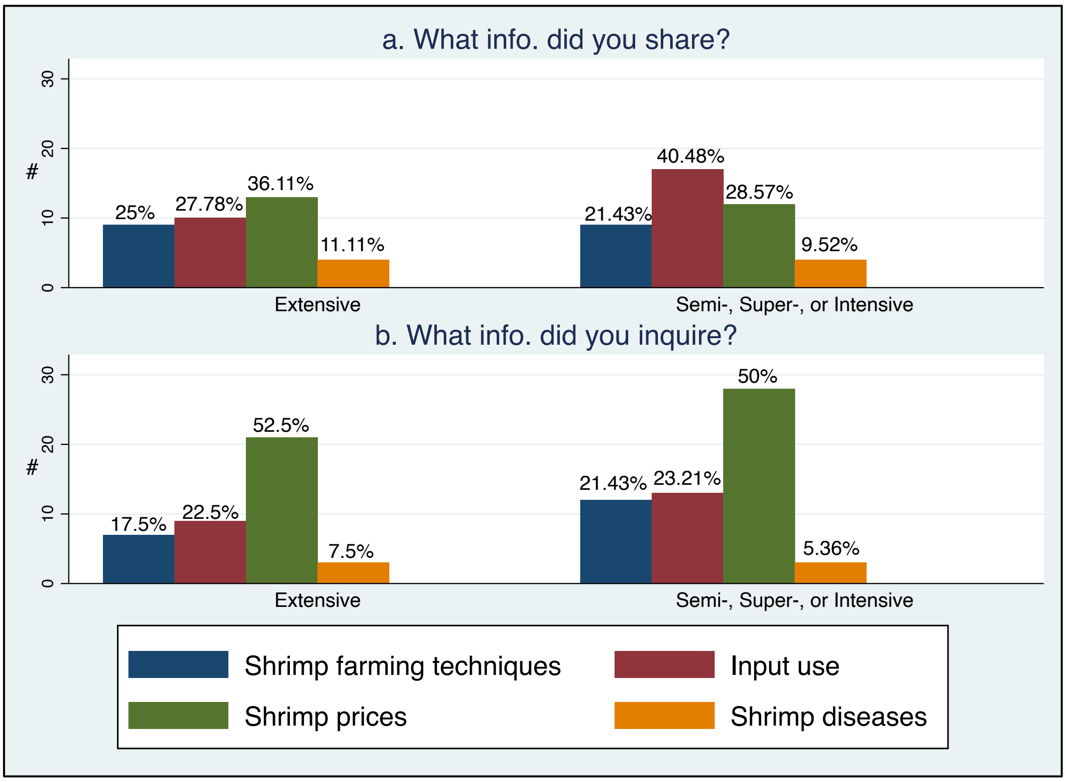
Notes: In addition to the variables in the table above, the models are controlled by variables of household spending, number of household members, a dummy for a member of a cooperative, and shrimp farm income. Standard errors in parentheses are clustered for 158 villages. *** p<0.01, ** p<0.05, * p<0.1.



Source: Based on GADM (2022) and KUVI (2020)
Figure 1. Map of KUVI members' residences



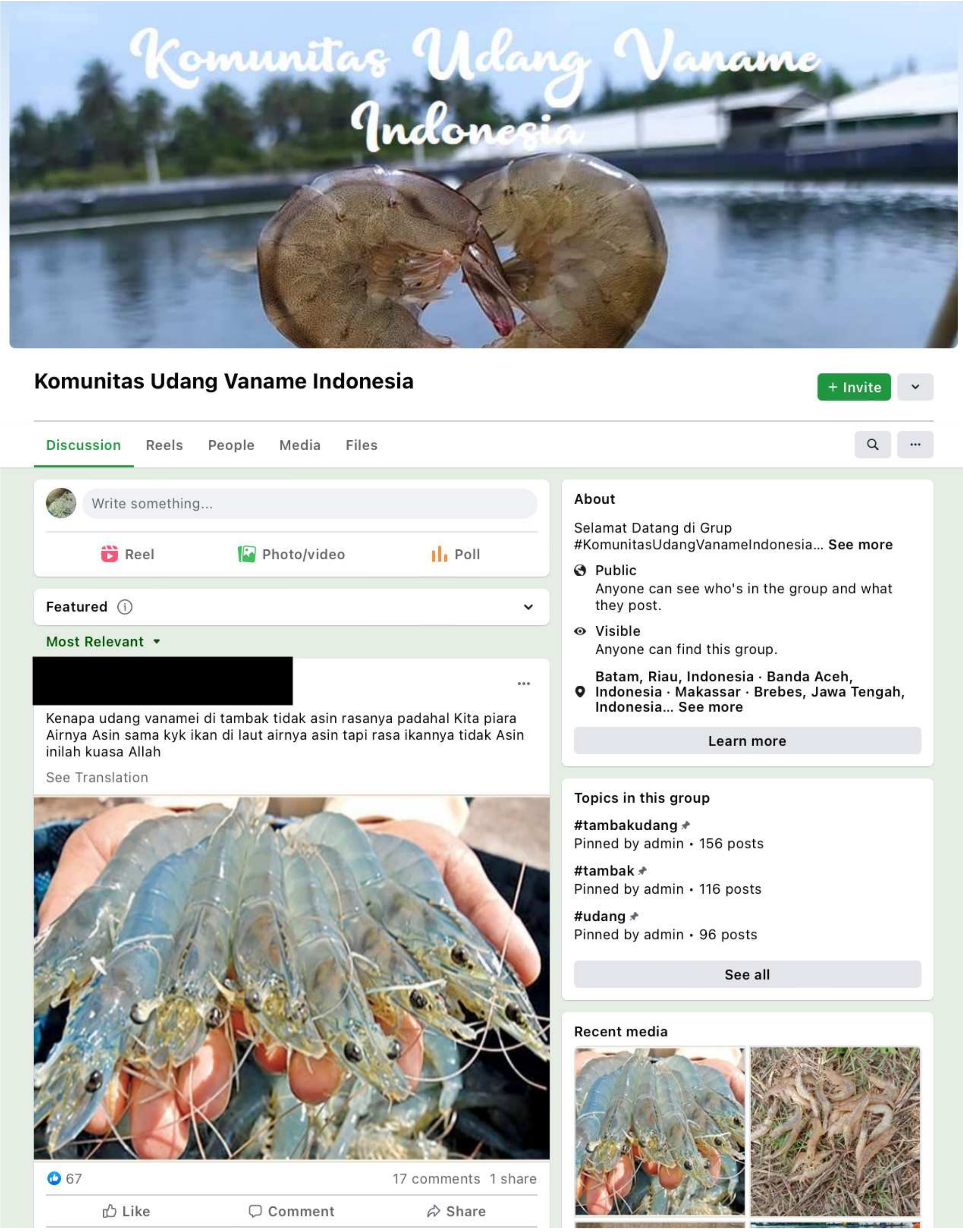
Source: Based on KUVI (2020)
Figure 2. Frequency of access, information sharing, and inquiries by KUVI members



Source: Based on KUVI (2020)

Figure 3. Types of information shared and inquired by KUVI members

Appendix A1. KUVI on Facebook



Source: KUVI (2020)

Appendix A2. Obtaining agricultural information during the COVID-19 pandemic

a) Has it become difficult to contact extension officers after the COVID-19?

		KUVI members		KUVI members w/o extensive	
		Yes	No	Yes	No
Yes, very difficult	#	82	518	31	7
	%	33.74	38.92	26.96	41.18
Yes, little difficult	#	61	348	26	6
	%	25.10	26.15	22.61	35.29
Same	#	78	394	49	3
	%	32.10	29.60	42.61	17.65
No, more frequently	#	22	71	9	1
	%	9.05	5.33	7.83	5.88
N		243	1331	115	17

b) Has it become difficult to contact the farmers in the same village after the COVID-19?

		KUVI user		KUVI user w/o extensive	
		Yes	No	Yes	No
Yes, very difficult	#	3	92	2	0
	%	1.34	7.89	1.89	0.00
Yes, little difficult	#	24	361	15	5
	%	10.71	30.96	14.15	31.25
Same	#	170	519	80	10
	%	75.89	44.51	75.47	62.50
No, more frequently	#	27	194	9	1
	%	12.05	16.64	8.49	6.25
N		224	1166	106	16

Appendix A3. The results of the first-stage regression

a) Full sample

	1= Using KUVI		1= Using other OCoPs		The most reliable info. (1=KUVI)		The most reliable info. (1=Other OCoPs)	
	1= info. from family (1)	1= info. from farmers living in the same village (2)	1= info. from family (3)	1= info. from farmers living in the same village (4)	1= info. from family (5)	1= info. from farmers living in the same village (6)	1= info. from family (7)	1= info. from farmers living in the same village (8)
1= *i* initially learned about shrimp	0.12***	0.003	0.12***	0.003	0.12***	0.003	0.12***	0.003
farming from their family	(0.04)	(0.08)	(0.04)	(0.08)	(0.04)	(0.08)	(0.04)	(0.08)
1= *i* initially learned about shrimp	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06
farming from their neighboring farmers	(0.04)	(0.10)	(0.04)	(0.10)	(0.04)	(0.10)	(0.04)	(0.10)
1= *i* engaged in a collective activity using	-0.17***	0.16***	-0.17***	0.16***	-0.17***	0.16***	-0.17***	0.16***
the same canal	(0.04)	(0.02)	(0.04)	(0.02)	(0.04)	(0.02)	(0.04)	(0.02)
N	1543	1543	1543	1543	1543	1543	1543	1543
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES
Shrimp farming Type FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The models are controlled by variables of the main farmer's age, squared age, schooling, squared schooling, shrimp pond size, shrimp disease, duration of time spent at home, household spending, number of household members, a dummy for a member of a cooperative, and shrimp farm income. Standard errors in parentheses are clustered for 175 villages. *** p<0.01, ** p<0.05, * p<0.1.

b) Subsample excluding non-KUVI members

	1= Using KUVI		1= Using other OCoPs		The most reliable info. (1=KUVI)		The most reliable info. (1=Other OCoPs)	
	1= info. from family (1)	1= info. from farmers living in the same village (2)	1= info. from family (3)	1= info. from farmers living in the same village (4)	1= info. from family (5)	1= info. from farmers living in the same village (6)	1= info. from family (7)	1= info. from farmers living in the same village (8)
1= *i* initially learned about shrimp	0.24***	0.11	0.24***	0.11	0.24***	0.11	0.24***	0.11
farming from their family	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
1= *i* initially learned about shrimp	-0.21**	0.34***	-0.21**	0.34***	-0.21**	0.34***	-0.21**	0.34***
farming from their neighboring farmers	(0.09)	(0.10)	(0.09)	(0.10)	(0.09)	(0.10)	(0.09)	(0.10)
1= *i* engaged in a collective activity using	-0.11	0.11	-0.11	0.11	-0.11	0.11	-0.11	0.11
the same canal	(0.10)	(0.11)	(0.10)	(0.11)	(0.10)	(0.11)	(0.10)	(0.11)
N	227	227	227	227	227	227	227	227
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES
Shrimp farming Type FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The models are controlled by variables of the main farmer's age, squared age, schooling, squared schooling, shrimp pond size, shrimp disease, duration of time spent at home, household spending, number of household members, a dummy for a member of a cooperative, and shrimp farm income. Standard errors in parentheses are clustered for 158 villages. *** p<0.01, ** p<0.05, * p<0.1.

c) Full and subsample excluding non-KUVI members

	How did you often share info. in KUVI in 2022?				How did you often inquire info. in KUVI in 2022?			
	1= info. from family	1= info. from farmers living in the same village	1= info. from family	1= info. from farmers living in the same village	1= info. from family	1= info. from farmers living in the same village	1= info. from family	1= info. from farmers living in the same village
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1= *i* initially learned about shrimp	0.25***	0.11	0.25***	0.11	0.25***	0.11	0.25***	0.11
farming from their family	(0.08)	(0.07)	(0.08)	(0.07)	(0.08)	(0.07)	(0.08)	(0.07)
1= *i* initially learned about shrimp	-0.20**	0.36***	-0.20**	0.36***	-0.20**	0.36***	-0.20**	0.36***
farming from their neighboring farmers	(0.08)	(0.01)	(0.08)	(0.01)	(0.08)	(0.01)	(0.08)	(0.01)
1= *i* engaged in a collective activity using	-0.10	0.06	-0.10	0.06	-0.10	0.06	-0.10	0.06
the same canal	(0.10)	(0.12)	(0.10)	(0.12)	(0.10)	(0.12)	(0.10)	(0.12)
N	227	227	227	227	227	227	227	227
Regional FE	NO	NO	YES	YES	NO	NO	YES	YES
Shrimp farming Type FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The models are controlled by variables of the main farmer's age, squared age, schooling, squared schooling, shrimp pond size, shrimp disease, duration of time spent at home, household spending, number of household members, a dummy for a member of a cooperative, and shrimp farm income. Standard errors in parentheses are clustered for 158 villages. *** p<0.01, ** p<0.05, * p<0.1.