Communication Networks of On-Farm Rubber in Riau Province, Indonesia

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Abstract. The rubber on-farm subsystem is an important part of rubber commodity development. Communication is an important part of the on-farm subsystem carried out by farmers because the communication network formed describes the farmer's communication pattern. The research aims to analyze the communication networks on-farm rubber in Riau and was conducted in two potential districts for rubber commodities in Riau Province, which are Kuantan Singingi Regency and Kampar Regency. To obtain research data, respondents were determined by purposive and snowball sampling. The number of respondents in this research was 168 rubber farmers. The results of the research showed that the on-farm communication network of rubber farmers in Kampar Regency, in a centralized pattern for \(m\) (interlocking personal network), indicated that there are individuals dominant in the communication network of rubber farmers. Meanwhile, the communication network for rubber farmers in Kuantan Singingi Regency, with a radial personal network, confirmed that the farmer information centers have begun to spread to several individuals. It is necessary to introduce institutional and communication technology, so that farmer information centers are not limited on only certain individuals, and farmers have choice of information sources that can increase knowledge and help to solve problems for rubber farmers in Riau Province.

1. Introduction

One of the plantation sectors developed in Indonesia is rubber plantations. Rubber is the second largest plantation commodity after palm oil which has a large share as a source of foreign exchange. Natural conditions that support and the world's high demand for natural rubber commodities make rubber a potential commodity to be developed in the context of agricultural development and the Indonesian economy.

Rubber plantation is one of the strategic commodities developed in Riau Province. Data obtained from the Indonesian Central Bureau of Statistics (CBS) in 2017 shows that the area of rubber plantations in Indonesia is 3,639,129 hectares with a production of 3,157,808 tons, while the area of rubber plantations in Riau Province is 349,714 hectares with a production of 324,123 tons. Based on existing data, it shows that Riau Province has great potential in the development of rubber plantations.

One of the obstacles in rubber development is the availability of information on the agribusiness subsystem. In the upstream subsystem, information on low seed quality is the main problem for plantations in the Sumatra corridor. This is indicated by the productive age of rubber plants which does not reach 30. In the farming subsystem, the availability of information on rubber plant
maintenance is one of the factors for the low quality of rubber. Meanwhile, in the downstream subsystem, information on the rubber market price is still controlled by collectors.

Knowledge, skills, and good cooperation will encourage the development of rubber, and vice versa, poor working relations between farmers, farmers, and extension workers are allegedly able to inhibit rubber development. The cooperative relationship that exists between these farmers can be seen from the quality and quantity of communication which can be seen through the analysis of communication networks. The relationships formed between individuals or groups will form a communication network[1][2][3]. One of the most effective sources of information for farmers is the communication network[4].

Communication analysis networks at the farmer level play a role in identifying the flow of information and knowing the role of each individual (actor) in the network, including identifying the central actor, namely opinion leaders who play an important role in rubber farmer communication.

2. Research methods
This research was conducted in Kampar and Kuantan Singingi Regency, Riau Province from September 2018 to June 2019. The location was chosen purposively with the consideration that these two districts are the regencies with the largest number of farmers in Riau Province.

This research used a quantitative approach that was supported by qualitative data. The communication analysis network in this research aimed to identify the overall network of members in the farmer group by considering two variables of data; internal characteristics, including age, level of education, family dependents, experience in farming, land ownership area and cosmopolitan level, and external characteristics that include the intensity of extension, accuracy of the extension channels and the number of information sources of the rubber farmers. This research was conducted using a census method for all farmers who are members of active farmer groups, with a total sample of 168 farmers.

The sociometric analysis is used to see the sociogram of communication networks and individual level communication networks. The method used is, among others, by making a matrix that contains the first relationship data obtained from the sociometric questions posed in the questionnaire. If there is communication between farmers, it is represented by number 1, whereas if there is no communication relationship it is represented by number 0. Furthermore, the matrix is inputted into the UCINET VI table for further processing and display in the sociogram form. This sociogram is then used to see the relationship patterns and roles of individual farmers in the communication network. From the results obtained, a sociogram can be made that illustrates the flow of information in the form of ties among rubber farmers. The function of sociometric analysis, among other things, helps researchers in visualizing the channels that are formed such as the flow of information that is intertwined from one person to another and through which an individual can influence other individuals.

3. Results and Discussion
Communication networks are relationships between individuals with certain patterns based on the flow of information and communication and form certain structures [5]. The fulfillment of farmers’ needs for information can be seen from the communication network. [6].

3.1 Internal Characteristics of Farmers
Nearly all of the respondent rubber farmers in Riau Province are in the productive age group, as shown in Table1, comprising 159 farmers and 9 farmers of unproductive age. This illustrates that rubber farmers are easy to find and absorb rubber farming information provided by communicators. Junior High School-Senior High School was the majority of the educational level of the respondents, amounting to 112 individuals (66.67%). Meanwhile, 42 people did not finish elementary school – elementary school (low), and 14 graduates from Diploma – Bachelor Degree (8.33%). This condition explains that the majority of respondent rubber farmers are farmers who have the latest level of
education in the medium and low categories, this is because of the low awareness of the importance of education, which causes dependence on knowledge and information on highly educated farmers.

Table 1. Distribution of farmers based on internal characteristics

| Internal characteristics of farmers | Category                              | Total (Farmers) | Percentage(%) |
|------------------------------------|---------------------------------------|-----------------|---------------|
| Age                                | <15 years old (not yet productive)    | 0               | 0             |
|                                    | 15-64 years old (productive)          | 159             | 94.64         |
|                                    | >64 years old (unproductive)          | 9               | 5.36          |
|                                    | Did not finish elementary school--elementary school(low) | 42             | 25.00         |
| Level of education                 | Junior High School – Senior High School (medium) | 112            | 66.67         |
|                                    | Diploma – Bachelor Degree (high)      | 14              | 8.33          |
|                                    | 1 - 2 people (low)                    | 66              | 39.29         |
| Family dependents                  | 3 - 4 people (medium)                 | 88              | 52.38         |
|                                    | 5 - 6 people (high)                   | 14              | 8.33          |
|                                    | ≤7 years (new)                        | 6               | 3.57          |
| Experience in farming              | 8 - 14 years (medium)                 | 42              | 25.00         |
|                                    | ≥15 years (old)                       | 120             | 71.43         |
|                                    | 0.5 hectare (narrow land)            | 17              | 10.12         |
| Land ownership area                | 0.6 - 2 hectares (mediumland)         | 131             | 77.98         |
|                                    | > 2 hectares (wide land)              | 20              | 11.90         |

Based on the number of family dependents, it is known that the dominant respondent in the group of 3-4 people was 88 people with a percentage of 52.38%. Meanwhile, the distribution of the number of family dependents of 1-2 people was 66 with a percentage of 39.29% and the distribution of family dependents of 5-6 people were 14 people with a percentage of 8.33%. This condition states that the number of dependents of farmers is medium (3-4 people). The more the number of family dependents, the more the farmers spend. The experience of the farmers surveyed in rubber farming shows that most of the farmers' experience in rubber farming is classified as long (≥15 years). Usually, farmers who have been farming for a long time will have the experience of becoming a source of information for other farmers.

Land ownership was in the medium category of land, namely farmers who own 0.6-2 hectares of land as many as 131 or 77.98%. In the meantime, farmers with a narrow land category of 0.5 hectares were 17 or 10.12%, and farmers with a large land area in the land category > 2 hectares were 20 or 11.90%. These results show that the land owned by rubber farmers is still relatively moderate, so it does not allow them to do business more effectively.

The cosmopolitan level was the ability of a farmer to relate to a very wide environment. On the basis of Table 2, the cosmopolitan rubber farmer in the province of Riau was in the medium category with an average of 1.76. It shows that rubber farmers in the Riau Province have been quite active in reading information about rubber plants through mass media. Farmers have also been quite active in mingling with extension workers, and farmers can contact extension workers at farmer group meetings. However, most farmers did not travel to a place to seek knowledge or training in rubber farming. Farmers who have high education, such as a Bachelor's degree, were usually active in reading information about rubber farming, socializing with extension workers, and traveling outside the region to find information.


Table 2. Distribution of rubber farmers based on cosmopolitan in Riau Province

| Number | Description                                                                 | Score | Category |
|--------|------------------------------------------------------------------------------|-------|----------|
| 1.     | Farmers read information about rubber farming knowledge through the mass media | 1.73  | Medium   |
| 2.     | Farmers get along with other farmers to find information about rubber farming | 1.99  | Medium   |
| 3.     | Farmers travel to a place (outside the area) to seek information about rubber farming knowledge | 1.55  | Low      |

Total Score 5.27
Average Score 1.76 Medium

3.2 External characteristics
The need for information sources is increasing for farmers in developing countries, as farmers have to make increasingly complex decisions.[7]

Table 3. The intensity of extension to rubber farmers in Riau Province

| Number | Description                               | Score | Category |
|--------|-------------------------------------------|-------|----------|
| 1.     | Extension workers provide extension       | 2.01  | Medium   |
| 2.     | Adequacy of extension intensity           | 2.36  | Medium   |

Total Score 4.38
Average Score 2.19 Medium

Extension intensity was the number of meetings of extension officers attended by farmers. Based on Table 3, the intensity of the extension of farmers in Riau province has still existed. It can be seen from the score of 2.19 in the medium category, where extension workers rarely made direct extensions. Extension officers conducted only remote evaluations of farmers and rarely went directly to the field. However, these extension activities still exist especially when assistance is provided to groups of farmers. In order to update farmers, actors can be used in the communication network as information channels and communication intermediaries [8].

Table 4. The accuracy of the extension channels for rubber farmers in Riau Province

| Number | Description                                                       | Score | Category |
|--------|-------------------------------------------------------------------|-------|----------|
| 1.     | Communication channels with a direct way (lectures and discussions) | 2.30  | Medium   |
| 2.     | The accuracy of targeting the extension communication channels    | 2.43  | High     |

Total Score 4.73
Average Score 2.36 High

Based on Table 4, the accuracy of the extension channels for rubber farmers in Riau Province was in the high category with an average score of 2.36. This condition shows that the communication channel in a direct way (lectures and discussions) was in the medium category with a score of 2.30 or considered good enough by some farmers. And seen from the accuracy of targeting the extension channels were also in the high category with a score of 2.43. Overall the accuracy of the rubber farmer extension channels in Riau Province is good, where farmers can absorb the rubber information provided by extension workers during extension activities.
Table 5. The number of information sources on farmers’ rubber farming in Riau Province

| Number | Description                                                                 | Score | Category |
|--------|-----------------------------------------------------------------------------|-------|----------|
| 1.     | Amount of information about rubber farming                                  | 2.44  | High     |
| 2.     | Amount of information sources on rubber farming                            | 2.00  | Medium   |
| Total Score |                                                   |       |          |
| Average Score |                                               | 2.22  | Medium   |

From the table above, the amount of information available to rubber farmers in Riau Province on rubber farming is in the high category with an average score of 2.44. The information obtained by farmers is in the form of materials related to cultivation, inputting, marketing, and support institutions (farmer groups and cooperatives). Information obtained from rubber farmers came from extension workers, farmer group leaders, fellow farmers, and the boss. In the meantime, other sources of information come from the Internet, farmers from other areas, newspapers, magazines, and others.

3.3. Communication Network Analysis

An analysis of the communication network was carried out on rubber farmers in Riau Province. An analysis of the communication network can identify the communication structure that has been formed, how many individuals can connect with other individuals, and describe the patterns of interaction that are formed between individuals in the system. Besides, the role of individuals in the network can also be identified. The different understandings and interpretations of farmers towards advancement will differentiate the patterns of relations between farmers[9]. The advantages of the messages received will be determined by the form of a communication network[10].

Analysis of the communication network of rubber farmers in Riau Province was studied in two regencies, namely Kampar Regency and Kuantan Singingi Regency. Each regency took two villages as samples, wherein Kampar Regency, namely Tanjung Alai Village and Batu Bersurat Village, while in Kuantan Singingi Regency, Lubuk Terentang Village and Gunung Village. Information dissemination in the network is divided into four groups, which are the upstream agribusiness subsystem, the on-farm agribusiness subsystem, the downstream agribusiness subsystem, and the supporting institution subsystem.

3.3.1. Upstream subsystem communication network.

The communication network on the upstream subsystem in rubber farmers was set up as a result of the production and distribution of the production facilities needed by farmers for rubber plant farming. The production facilities used by rubber farmers are seeds, fertilizers, pesticides, vinegar, latex stimulants, and agricultural equipment.

3.3.1.1. Upstream subsystem communication network in Kampar Regency.

Research on communication networks in Kampar Regency has been conducted in two villages, Batu Bersurat and Tanjung Alai Village. In Batu Bersurat Village, there are 45 individuals involved in the upstream communication network in the area consisting of 42 farmers and 3 non-farmers (Image 1). Meanwhile, there are 58 individuals in Tanjung Alai Village, of whom 55 are farmers, and three are people from outside the farmers (Image 2).
Figure 1. Upstream subsystem communication network in Batu Bersurat Village, Kampar Regency

Figure 2. Upstream subsystem communication network in Tanjung Alai Village, Kampar Regency

- Rubber farmer
- Traders
- Extension worker

The upstream subsystem communication network in the two villages illustrates the same pattern, namely the communication structure formed by a wheel structure (interlocking personal network) with a wheel center at nodes 6, 24, and 43 in Batu Bersurat village and nodes 56 and 57 in Tanjung Alai Village. The leader of the opinion in the two villages was the leader of the farmer group. The individual who acted as a bridge between the group and other groups was the secretary of the farmer group, who was also the head of the Community Empowerment Institutions in Batu Besurat and the extension workers' villages. In addition, individuals acting as stars, i.e. people who had a strong relationship with others were traders or shop owners.

The majority of farmers in the upstream subsystem had a direct relationship with the upstream subsystem actors in Tanjung Alai Village, in this case traders responsible for the distribution of production facilities such as fertilizers, pesticides and equipment used by rubber farmers.

3.3.1.2. Upstream subsystem communication network in Kuantan Singingi Regency.
The upstream communication network was formed by interactions between farmers and individuals within and outside the group. This was done to meet the need for information on agricultural production facilities such as seeds, pesticides and farm equipment.

Research in Kuantan Singingi District was also carried out in two villages, which are Lubuk Terentang Village and Gunung Village. There are 48 individuals in the Lubuk Terentang Village communication network, 40 are farmers, while 8 are not farmers, including traders, villagers, extension workers and staff from the Agriculture Office (Image 3). And 18 individuals studied in Gunung Village, 12 individuals were farmers and 6 individuals were not farmers, including traders, extension workers, and assistants from the agricultural office (Image 4).
The pattern of communication that occurs in rubber farmers in Kuantan Singingi Regency has started in a pattern that spreads to all directions (radial personal network). Farmers as well as community leaders in Lubung Terentang Village and the head of the farmer group association in Gunung Village acted as opinion leaders. Individuals acting as bridges were rubber farmers, while those acting as stars were the extension workers. The integration of rubber farmers into the Kuantan Singingi rubber farmer association opens opportunities for communication between rubber farmers with more sources and providing information to each other. So that the communication network of rubber farmers in Kuantan Singingi Regency is more widespread, and is not focused on just one person.

3.3.2. Farming subsystem communication network.
Farmers need information on farming subsystems to get the maximum production and the quality standards the market wants.

3.3.2.1. Farming subsystem communication network in Kampar Regency.
Information on the farming subsystem manages inputs to rubber farmers including land clearing, seedling care, spacing, planting, maintenance of yielding crops, how to tapping, use of fertilizers, and use sorax (stimulant sap)
Based on Image 5 and 6, it can be seen that most of the patterns formed were the wheel pattern (interlocking personal network) with the center of the wheel at the instructor. The form of the wheel communication network was quite good because it could move in one command. The individual who acted as the leader of the opinion was also the leader of the farmer group. The individual who acts as a bridge is the farmer who becomes a liaison for other farmers in obtaining farming information from extension workers (Image 6). Individuals who act as stars are extension workers who serve in the area.

3.3.2.2. Communication network for the farming subsystem in Kuantan Singingi Regency.

The communication network of the farming subsystem in Kuantan Singingi Regency was formed as a result of the interaction between farmers and individual farmers or non-farmers. It is done to meet the information needs of agricultural business information, such as land clearing, planting, maintenance, and harvesting.

The communication network for the farming subsystem in Taluk Kuantan Regency consists of rubber farmers, traders, extension workers, village heads, and related agencies. Based on images 7 and 8, it can be seen that the communication network in Kuantan Singingi Regency has led to a multi-way communication network (radial personal network), where rubber farmers have communicated with many farmers or other parties. This communication network is quite good, considering the multi-directional communication network, which illustrates that farmers are able to obtain and provide information from many parties. And it also means that farmers will get a lot of information about rubber cultivation. Individuals who acted as opinion leaders were community leaders and chairman of the association of farmer groups. The bridge in the communication network was the chairman of the association of farmer groups to other farmers in contacting agricultural department employees. The star in the communication network was the extension worker who was assigned to the area.

The results confirm that group leaders act as main actors in the communication and marketing networks of production [15]. This may cause some problems in the field that farmers who play a role in farmer groups can also be an obstacle to the transfer of knowledge to others [19]. Further, extension workers are needed to communicate the needs and problems of farmers [17] and are very instrumental in disseminating agricultural technology to farmers [16].
3.4. Individual Level Communication Network Analysis

The proximity of the personality between the farmer and his group can be formed from the interaction and communication network of the farmer [11]. The relationship of the communication network in the group structure may differ from the individual level [18] and depend on the benefits of communication [10].

3.4.1. Upstream subsystem. In the communication network, there was the role of actors in the network; as a star (as centrality), broker (as a liaison, but did not have a network position), bridge (as a liaison and occupy a position in the network), gatekeeper (as a controller of information flow) and isolate (had no role in the communication network)[12].

**Table 6.** Individual level communication network analysis in the upstream subsystem

| Information                      | Local centrality | Global centrality | Betweenness |
|----------------------------------|------------------|-------------------|-------------|
| Kampar Regency                   |                  |                   |             |
| Batu Bersurat Village            |                  |                   |             |
| Maximum                          | 36.000           | 109.000           | 53.109      |
| Minimum                          | 2.000            | 52.000            | 0.000       |
| Tanjung Alai Village             |                  |                   |             |
| Maximum                          | 33.000           | 200.000           | 72.650      |
| Minimum                          | 1.000            | 122.000           | 0.000       |
| Kuantan Singingi Regency        |                  |                   |             |
| Lubuk Terentang Village         |                  |                   |             |
| Maximum                          | 41.000           | 373.000           | 59.915      |
| Minimum                          | 1.000            | 219.000           | 0.000       |
| Gunung Village                   |                  |                   |             |
| Maximum                          | 12.000           | 306.000           | 33.333      |
| Minimum                          | 1.000            | 82.000            | 0.000       |

The values of each farmer were obtained by using the UCINET device 6.0 to calculate the communication network at the individual levels of the upstream subsystems. In Batu Bersurat Village,
traders and formal leaders in their groups were individuals with high local authority in this respect. Agricultural shop owners demonstrated high centrality in Tanjung Alai Village. The extension worker was the high value of the local centrality of the Lubuk Terentang village. Whereas there was a high centrality value in the Gunung Village, which was chaired by the Berkah Illahi Farmer Group.

The second indicator for measuring communication networks at the individual level is global centrality, indicating the number of steps that an individual must take when contacting other individuals in the system. In other words, the smaller the global centrality and the greater the individual’s ability to contact all members of the network. The higher the score for centrality, the stronger the communication that occurs [13].

The maximum global centrality value in Batu Bersurat Village was 109 in the communication network for the upstream subsystem and a the minimum of 52. The lowest global centrality value for traders had maximum access to all network members. It is in keeping with the local centrality and its role in the network where traders were central to the network as traders of manufacturing plants. Meanwhile, in Tanjung Alai Village the lowest global centrality is owned by agricultural shop owners. In Lubuk Terentang Village, the lowest global centrality is owned by traders of production facilities. Whereas in Gunung Village the lowest global centrality was the traders of production facilities and administrators of the Berkah Illahi group.

Furthermore, the indicator in measuring the communication network at the individual level is the level of betweenness. The betweenness level in this research is defined as the frequency at which a node/individual is located among other nodes in a close distance that connects between these nodes. In other words, a high level of betweenness indicates a high level of individual dependence on a system.

In the upstream communication network in Batu Bersurat village, the maximum level of betweenness is 53,109 and the minimum is 0. The data have shown that the farmers’ betweenness level was classified as low. The low level of membership is linked with the farmers’ activity in the upstream communication network being limited to dealing with the traders. The production trader facilities were the highest level of betweenness. Meanwhile, in Tanjung Alai Village, the highest betweenness level was owned by agricultural shop owners. In Lubuk Terentang Village, the highest betweenness level was the extension workers who had a task area in Lubuk Terentang Village. While in Gunung Village the maximum betweenness was the chairman of Berkah Illahi group.

3.4.2. Farming subsystem.

There were two types of roles of nodes, namely as a core role that occupied a central position and a bridge role as a liaison between the nodes[14].

| Information                | Local centrality | Global centrality | Betweenness |
|----------------------------|------------------|-------------------|-------------|
| Kampar Regency             |                  |                   |             |
| Batu Bersurat Village      |                  |                   |             |
| Maximum                    | 42.000           | 89.000            | 93.666      |
| Minimum                    | 1.000            | 46.000            | 0.000       |
| Tanjung Alai Village       |                  |                   |             |
| Maximum                    | 45.000           | 119.000           | 80.421      |
| Minimum                    | 1.000            | 65.000            | 0.000       |
| Kuantan Singingi Regency   |                  |                   |             |
| Lubuk Terentang Village    |                  |                   |             |
| Maximum                    | 43.000           | 174.000           | 78.697      |
| Minimum                    | 1.000            | 33.000            | 0.000       |
| Gunung Village             |                  |                   |             |
| Maximum                    | 15.000           | 49.000            | 40.117      |
| Minimum                    | 1.000            | 380.000           | 0.000       |
Batu Bersurat Village, the individual communication network with a high local centrality, was demonstrated by agricultural extension workers. In Tanjung Alai Village, an agricultural extension worker from Koto Kampar Agricultural Extension Center XIII who had a job in Tanjung Alai Village showed a high local centrality of farming. The high value of local centrality in Lubuk Terentang Village was shown by the extension worker assigned to Lubuk Terentang Village. Whereas in Gunung Village the high centrality value was shown by farmers who were considered successful in terms of planting and caring for rubber plants as well as community leaders. The role of a person as a bridge for others in communication will determine the importance of that person's role in the communication network[15].

The second indicator in measuring communication networks at the individual level is global centrality. In the communication network on the agricultural subsystem, Batu Bersurat Village, which acted as an agricultural extension worker, had the lowest global centrality value. Meanwhile, the lowest global centrality in Tanjung Alai Village was also the extension worker from the XIII Koto Kampar District Agricultural Extension Centre. The lowest global centrality in Lubuk Terentang Village is owned by agricultural shop owners. Whereas the lowest global centrality in Gunung Village was the farmers who were considered community leaders in Gunung Village.

In addition, the level of betweenness is the indicator in the communication network measurement at the individual level. The maximum level of betweenness that was demonstrated by individual extension workers from the XIII Koto Kampar District Agricultural Extension Center was obtained in the farming communication network in Batu Bersurat and Tanjung Alai villages. An extension from the Gunung Toar District Agricultural Extension Center is also the highest betweenness in Lubuk Terentang Village and Gunung Village. It illustrates that in agriculture, the role of extension workers is important for rubber farmers.

4. Conclusions and Recommendations

In Riau, there were two forms of communication networks, the centralized pattern that took place in Kampar Regency, and in Kuantan Singingi Regency, the pattern began to spread in all directions. A centralized communication network has shown that certain actors in the communication network have become command points. The communication network demonstrated that there was a limited flow of information to farmers. As the communication network spread, it illustrated that the interaction that takes place started in all directions. With some parties, farmers can communicate. There has been a Rubber Farmers Association established in Kuantan Singingi Regency since 2017. Members of the association were rubber farmers who belonged to farmer groups in the Regency of Kuantan Singingi. The association, which was formed through the Kuantan Singingi Regency Plantation Office, was formed to help rubber farmers to get the best and equivalent price. Farmers who were members of the association were also the members of WhatsApp group. It helps farmers to communicate and obtain a lot of information from the many parties in the group. Institutions and communication technologies should be introduced so that the information center is not just focused on certain people; farmers must choose sources of information to enhance knowledge and help solve problems.

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