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RESEARCH PAPER

Social Network Analysis: Local and Global Centrality as the Communication Network Structure in the Beef Cattle Farmer Groups

Dyah Gandasari[1*], Diena Dwidienawati[2], David Tjahjana[3], Mochamad Sugiarto[4] & M Faisal[5]

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ABSTRACT

The dynamic among farmer institutions has essential problems to be addressed, especially regarding the pattern and process of communication interactions developing farmer institutions. Therefore, an assembly of agribusiness information within the communication network of the farmer group is of primary interest for our study. This study aims to analyze the agribusiness network structure of beef cattle farmer groups in Subang Regency, West Java, Indonesia. The Social Network Analysis (SNA) was used for discovering communication network structure. Data were collected through interviews using a questionnaire. The census method was used for the sampling technique, and UCINET 6 was used to analyze the data. The results of the study show that: 1) the average value of the local centrality of the Bina Insani farmer group shows a value of 2.28 – 3.33, and the Sarimulya Mandiri farmer group shows a value of 1.42 - 2.33. This means that beef cattle farmers can contact only one to three people to get agribusiness information on beef cattle, 2) the average value of the global centrality of the Bina Insani farmer group shows a value of 453.17 - 571.39, and the Sarimulya Mandiri farmer group shows a value of 90.67 to 240.00. This means that the value is still high and is close to the maximum. The limitation of this study is that it is only in quantitative approach. Therefore, it is recommended to conduct further research in a qualitative approach to further analyze the roles play in the networks that can be considered in an increasing group social capital.

KEYWORDS: *Communication; Connectivity; Network; Social capital.*

1. Introduction

Social network analysis (SNA) is a social science. According to [1], the actors could be individuals (specifically humans, but also other social species such as apes and dolphins) or organizations (such as corporations). [2] stated that some researchers (such as [3-5]) have applied SNA in studies of individual, group, and organization. Several other researchers using SNA are [6-14].

Several previous SNA studies exist in a variety of disciplines, such as in social sciences [15-19]; medicine [20-21]; computer sciences [22], [18]; mathematics [23-25]; business management [26-31]; agriculture [32-40]; and multidisciplinary [41-42].

The SNA approach offers significant potential in agriculture business or farmer business for gaining advanced understanding of interaction between the farmers through the networks. One of the problems that exists in livestock agribusiness is the dynamics of farmer groups. Therefore, it is important to study the process and pattern of communication in developing farmer groups.

Subang Regency is one of the important livestock cultivation bases in West Java. But its

* **Corresponding author:** ***Dyah Gandasari***
dyahgandasari@pertanian.go.id

1. *Animal Husbandry and Animal Welfare Extension Study Program, Department of Animal Husbandry, Bogor Agricultural Development Polytechnic (Polbangtan Bogor), Bogor, 16730, Indonesia.*
2. *Department of Management, BINUS Business School Undergraduate Program, Bina Nusantara University, Jakarta, Indonesia.*
3. *Universitas Multimedia Nusantara, Jakarta, Indonesia.*
4. *Department of Social and Economic, Faculty of Animal Science, Jenderal Soedirman University, Indonesia.*
5. *Sekolah Bisnis, Institut Pertanian Bogor, Bogor, Indonesia.*

performance is still not sufficient. Developing beef cattle business in this regency faced several problems, such as the business scale level which is still inadequate, and the business added value obtained is not optimal.

There is the Chinagarabogo People's Livestock Center (SPR) in Subang Regency. SPR is the center for integrated beef cattle agribusiness in Subang Regency. There are twenty farmer groups who are members of the SPR with an average ownership of 2-3 heads per farmer. The obstacle in SPR is the dynamics of farmer groups

According to [43] and [44], several problems in farmer institutions include lack of science and technology literacy, limited land, weak capital, and market access. Institutional growth and development require adequate information to achieve these goals.

According to market demand, adequate and reliable information is important in improving the quality, quantity, and continuity of products. In seeking knowledge, farmers must build a network structure with neighbours and other sources of information [45]. According to Freeman 1979 in [46], the network structure used in this study refers to measurements that consist of local centrality (degree centrality) and global centrality (closeness centrality).

The simplest measure of centrality is degree, which is simply the number of ties of a given type that a node has. A node's degree can be calculated without having information about the full network in which they are embedded [47]. Freeman defined closeness centrality as the sum of geodesic distances from a node to all others. Recall that the geodesic distance from a node to another node is the length of the shortest path connecting them [47]. It is suspected that the higher the level of farmer's ties and the shortest path connecting them, the better the agribusiness activities carried out by the farmer. Network structure can describe how farmers' communication behaviour in receiving, giving, and disseminating information occurs in agribusiness activities. Therefore, research on farmer SNA is essential to enact. This study aims to analyze the agribusiness communication network structure of beef cattle farmer groups in Subang Regency, West Java, Indonesia.

2. Literature Review

2.1. The principles of social network

The first principle is the relations between actors. [48] stated that network analysis is the importance of understanding the interactions between actors, rather than a focus exclusively on the attributes of actors. The social network represented a movement "away from individualist, essentialist, and atomistic explanations toward more relational, contextual, and systemic understandings" [47].

The second principle is the emphasis on embeddedness. Embeddedness at the system level can refer to a preference for interacting with those within the community rather than those outside the community. Human behavior is seen as embedded in a network of interpersonal relationships [49]. People in organizations or groups tend to have exchange relationships with family, friends, or acquaintances, not with strangers [3].

The third driving principle of social network research is the belief that network connections constitute social capital that provides value (Burt, 2000). According to Brass & Krackhardt (1999) in [3], social capital is at the heart of social network analysis. Depending upon the arrangement of social connections surrounding an actor, more or less value can be extracted (Burt, 1992 in [3]; [50]). At the system level, a generalized spirit emerges from and contributes to the many interactions of trust and interdependence between individual actors within the system (Coleman, 1990 in [3]; [51]).

The fourth principle is the emphasis on structural patterning. Network researchers look for the patterns of "connectivity and cleavage" in social systems (Wellman, 1988 in [3]). Structural factors through which actors generate and re-create network ties. At the local level surrounding a particular actor, the structure of ties can be described, for example, as relatively closed (actors tend to be connected to each other) or open (actors tend to be disconnected from each other) (Burt, 1992 in [3]). At the system level, organizational networks can be assessed for the degree of clustering they exhibit and the extent to which any two actors can reach each other through a short number of network connections.

2.2. Social network analysis

Social Network Analysis (SNA) was conducted on the actor networks based on the relation and interaction of actors to characterize the information transmission of messages throughout the network [6]. The theoretical perspective of social networks focuses on actor relationships [2] where there are links between and among actors that form pathways, or connections, and there are mechanisms of influencing or being influenced [52].

Social network analysis (SNA) is the systematic

inquiry into the pattern of relations among social actors at different levels of analysis [52]. In networks, actors or nodes are the participants, and ties or lines depict the strength and direction of their relationships [2]. Actors can be persons, teams, organizations, or even entities such as neurons. Network visualization (Net draw) enables the identification of key network actors and collaborative links (Pierce et al., 2021). The network analysis software that can be used to analyze such as UCINET and Pajek [52].

SNA using communication network structure or social network structure related article was first found in early 1961, as shown in Table 1.

Tab. 1. The first SNA study publications

Author	Title	Year of Publication
Kōzō, N.	Economic base concept and functional region	1961
Nishimura, M.	Relationship between centrality-index and distance, and the construction of equilibrium circle	1965
Hattori, K.	Concerning the civic center and the sub-centers of the metropolis	1966
French, J.R.P., Sherwood, J.J., Bradford, D.L.	Change in Self-identity in a Management Training Conference	1966
Bechtell, H.	Frattini subgroups and Ø-central groups	1966

SNA using communication network structure or social network structure related article in the recent years, as shown in Table 2.

Tab. 2. The recent year of SNA study publications

Author	Title	Year of Publication
Joyez, C., Laffineur, C.	The occupation space: network structure, centrality and the potential of labor mobility in the French labor market	2022
Flemming, R., Schüttig, W., Ng, F., Leve, V., Sundmacher, L.	Using social network analysis methods to identify networks of physicians responsible for the care of specific patient populations	2022
Blanken, M., Mathijssen, J., van Nieuwenhuizen, C., Raab, J., van Oers, H.	Intersectoral collaboration at a decentralized level: information flows in child welfare and healthcare networks	2022
Toraman, C., Şahinuç, F., Yilmaz, E.H., Akkaya, I.B.	Understanding social engagements: A comparative analysis of user and text features in Twitter *Open Access*	2022
Arnold, C., Hennrich, P., Wensing, M.	Information exchange networks for chronic diseases in primary care practices in Germany: a cross-sectional study	2022

Analyzed search results from Scopus database show that SNA using communication network structure or social network structure related article was first found in early 1961 and still increasing in recent years (Figure 1).

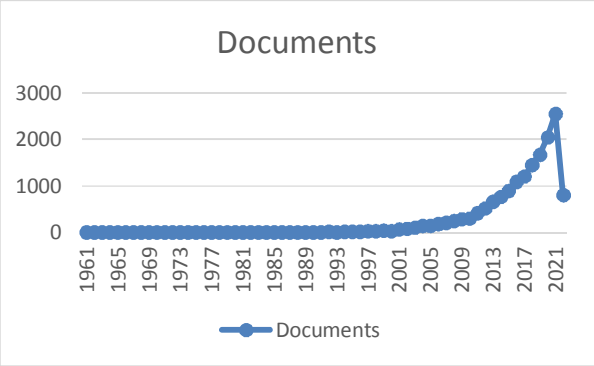

Fig. 1 Document by year in SNA study

SNA is frequently used by several disciplines such as social sciences, medicine, computer sciences, mathematics, business management, agriculture, and multidisciplinary (Figure 2). The social sciences become the most subject area, published around 15% (4168 documents), but other disciplines such as multidisciplinary or agriculture or business management subject areas is still rarely, only 4% (average 1150 documents). Therefore, SNA in agriculture sciences, especially in human value or behavior, are still limited. Related works from authors in agriculture human behavior are such as farmer innovation learning [37], diffusion of agriculture network [53], local food marketing [36], poultry farm [54], exchange information [32], and sustainable rural development [38]. Because of that, study on social networks in the agribusiness sector, especially farmer groups in beef cattle commodities, is still rarely carried out.

Figure 3 shows the visualization of authors' countries in SNA study. The top five countries of the authors that contribute most publications are the United States (5116 documents), United Kingdom (2659 documents), China (2574 documents), Germany (1512 documents), and Italy (1115 documents). Thailand leads SNA publication in the Southeast Asia as the 41th country with 194 documents, followed by Indonesia (148 documents), Malaysia (134 documents), Singapore (112 documents), and the Philippines (29 documents).

From the analyzed search results from Scopus database showed that SNA is still a promising method to identify novel collaborative and team science opportunities for scientists, and provides an empirical evidence base for similar organizations/groups/society seeking to improve collaborations and productive outcomes of interest to their organizations/groups/society. This is in line with [2].

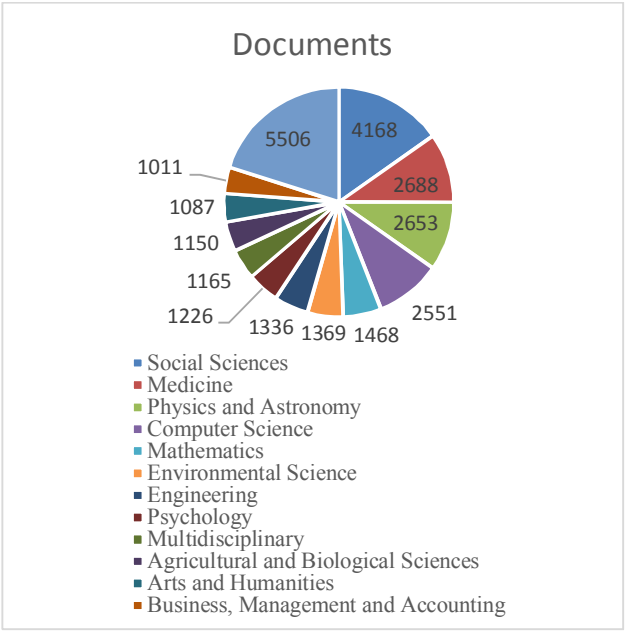

Fig. 2 several disciplines in SNA study

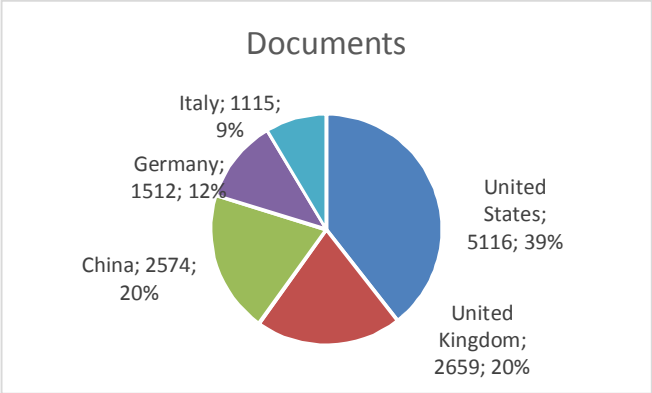

Fig. 3. Top five countries of the author that contribute most publication

SNA in this research was conducted on the actor networks based on the relation and interaction of actors to characterize the information transmission of messages throughout the network in the beef cattle breeder groups. The communication network is based on the topic of communication networks regarding cultivation, breeding, institutions, marketing, and animal health.

3. Methodology/Materials

This study uses the SNA approach for discovering communication network structure within beef cattle farmers in the group. There are two classes of the groups. Therefore, this study analyzed two groups: the Sarimulya Mandiri farmer group, the beginner farmer group with 12 respondents, and the Bina Insani farmer group, the advanced farmer group with 18 respondents. These two groups joined the Cinagarabogo People's Animal Husbandry Center (SPR) in the Cipunagara sub-district, Subang, West Java. The location selection was made with the consideration that Subang is one of the centers of the beef cattle industry in Indonesia. Data were collected through interviews using a questionnaire based on the topic of communication networks regarding cultivation, breeding, institutions, marketing and animal health. Moreover, this current research used census method as a sampling technique. Communication network structure (local and global centrality) and net draw were analysed using UCINET 6 software, in which the unit of analysis studied is the individual.

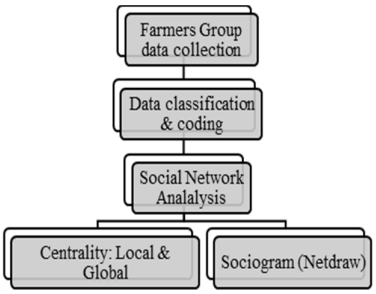

Fig. 4. Research flow chart

This research examined and evaluated the network structure. Network centralization is one of two main indicators used to assess the network structure. Centrality is one of the most widely used concepts in SNA. A centrality measure scores each node in the network in terms of its structural importance [47]. Centrality is used to describe the coherence of a network and the role of a certain node in the whole network [12]. The concept of centrality in the network reflects the importance of different actors for the structural features of the network. This parameter is perceived as descriptive statistics of specific structural features of the actors or networks. The measures of centrality are degree centrality, eigenvector centrality, beta centrality, closeness centrality, k-step reach centrality, and betweenness centrality [47]. This research only used degree and closeness centrality for measured parameters. This study is limited to using only two measurements of centrality, namely degree and closeness centrality.

The contribution of this research provides an empirical evidence base of the group performance based on the communication structure (the connectivity, coordination, sharing information) that can be used by stakeholders to improve collaborations and productive outcomes to farmer groups as a group dynamic.

4. Results and Findings

4.1. Local centrality

The results of the study show that the average value of the local centrality of the Bina Insani farmer group shows a value of 2.28 – 3.33 (Table 3). This means that beef cattle farmers in the Bina Insani farmer group on average can contact two to three people to get agribusiness information on beef cattle.

The local centrality maximum value for beef cattle cultivation information shows the number 17 (in-Degree) and the number 6 (out-Degree). Number 17 (in-Degree) is owned by node 16, namely the head of the Bina Insani farmer group. Meanwhile, number 6 (out-Degree) is owned by node 1, which is a member of the Bina Insani farmer group. The minimum value of local centrality to obtain information on beef cattle cultivation is 1. This figure is owned by only two individuals, namely nodes 2 and 3. Individuals who have this minimum local centrality figure show low individuality in obtaining cultivation information on beef cattle.

Tab. 3. The local centrality value of bina insani farmer group in SPR subang based on the topic of communication networks

No.	Node	Cultivation Information		Breeding Information		Institution Information		Marketing Information		Animal Health Information	
		Out degree	*In degree*	*Out degree*	*In degree*	*Out degree*	*In degree*	*Out degree*	*In degree*	*Out degree*	*In degree*
1.	1	6	0	2	0	3	0	3	0	3	0
2.	2	1	0	1	0	0	0	1	0	1	0
3.	3	1	0	1	0	1	0	1	0	1	0
4.	4	3	0	1	0	3	0	4	0	4	0
5.	5	3	0	1	0	2	0	2	0	2	0
6.	6	2	0	1	0	2	0	0	0	1	0
7.	7	3	0	1	0	1	0	1	0	1	0
8.	8	2	0	1	0	2	0	1	0	2	0
9.	9	4	0	4	0	3	0	2	0	3	0
10.	10	4	0	2	0	4	0	3	0	3	0
11.	11	4	0	4	0	4	0	3	0	4	0
12.	12	4	0	2	0	2	0	4	0	2	0
13.	13	3	0	3	0	3	0	5	0	4	0
14.	14	3	0	3	0	3	0	3	0	4	0
15.	15	4	0	3	2	4	0	3	3	5	0
16.	16	5	17	4	13	2	11	4	13	3	6
17.	17	4	1	4	0	3	0	3	0	2	0
18.	18	4	1	3	0	2	5	5	0	2	0
	Average Value	3.33	1.06	2.28	0.83	2.44	0.89	2.67	0.89	2.61	0.33

The local centrality maximum value for beef cattle breeding information shows the number 13 (in-Degree) and the number 4 (out-Degree). Number 13 (in-Degree) is owned by node 16, namely the head of the Bina Insani farmer group. Meanwhile number 4 (out-Degree) is owned by node 16, namely the head of the Bina Insani farmer group and the nodes 9, 11, and 17 members. The minimum value of local centrality to obtain information on beef cattle breeding is 1. This figure is owned by eight individuals, namely nodes 1, 2, 3, 4, 5, 6, 7, and 8. Individuals who have this minimum local centrality figure show low individuality obtaining breeding information.

The local centrality maximum value for institutional information on beef cattle shows the number 11 (in-Degree) and the number 4 (out-Degree). Number 11 (in-Degree) is owned by node 16, namely the head of the Bina Insani farmer group. While number 4 (out-Degree) is owned by nodes 10, 11 as a member and node 15, namely the farmer group secretary. The minimum value of local centrality for obtaining beef cattle institutional information is 0. This figure is owned by one individual, namely node 2. Individuals who have this minimum local centrality number show low individuality in obtaining beef cattle institutional information.

The local centrality maximum value for beef cattle marketing information shows the number 13 (in-Degree) and the number 5 (out-Degree). Number 13 (in-Degree) is owned by node 16, namely the head of the Bina Insani farmer group. While number 5 (out-Degree) is owned by node 13 members and 18, namely the farmer group accountants. The minimum value of local centrality to obtain beef cattle marketing information is 0. This figure is owned by one individual, namely node 6. The individual who has this minimum local centrality figure shows

low individuality in obtaining beef cattle marketing information.

The local centrality maximum value for beef cattle animal health information shows the number 6 (in-Degree) and the number 5 (out-Degree). Number 6 (in-Degree) is owned by node 16, namely the head of the Bina Insani farmer group. While number 5 (out-Degree) is owned by node 15, namely the secretary of the farmer group. The minimum value of local centrality to obtain animal health information is 1. This figure is owned by four individuals, namely nodes 2, 3, 6, and 7. Individuals who have this minimum local centrality number show low individuality in obtaining health information on beef cattle.

In these five communication networks, the average local centrality is in-Degree 1 and out-Degree 3. This means that, there is one central person in the group who can be a source of information for group members (node 16). The node 16 namely the group leader still plays a role as a source of information for its members, even though members can access 2-3 other sources of information, both inside and outside the group. The leader has high status actor whose advice, knowledge, and skill are sought by others.

A combined net draw of the 5 topics in Figure 5 identifies only node 16 (group leader) acting as a star. Everyone in the group contacted the chairman especially in the cultivation aspect.

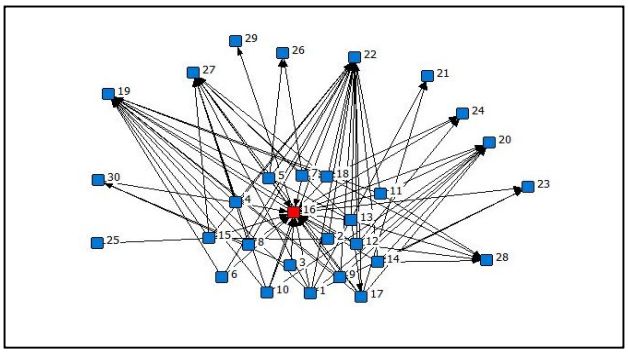

Fig. 5. Net draw in beef cattle of bina insani group

Tab. 4. The local centrality value of sarimulya mandiri farmer group in SPR subang based on the topic of communication networks regarding cultivation, breeding, institutions, marketing, and animal health

No.	Node	Cultivation Information		Breeding Information		Institution Information		Marketing Information		Health Information	
		Out degree	*In degree*	*Out degree*	*In degree*	*Out degree*	*In degree*	*Out degree*	*In degree*	*Out degree*	*In degree*
1.	1	12	8	15	4	13	6	1	0	4	0
2.	2	0	1	0	1	1	1	0	0	2	0
3.	3	1	1	0	1	0	1	1	0	2	0
4.	4	1	1	1	1	1	1	0	0	1	0
5.	5	2	1	1	1	1	1	0	0	1	0
6.	6	0	1	0	1	0	1	0	0	1	0
7.	7	4	1	2	1	1	1	0	0	2	0
8.	8	1	1	2	1	0	1	0	0	1	0
9.	9	1	1	1	1	1	1	1	0	2	0
10.	10	1	1	2	1	1	1	2	0	2	0
11.	11	4	1	2	1	0	1	1	0	2	0
12.	12	1	2	1	1	1	1	0	0	1	0
	Average Value	2.33	1.67	2.17	1.25	1.67	1.42	0.50	0.00	1.75	1.00

The results of the study in Table 4 show that the average value of the local centrality of the Sarimulya Mandiri farmer group shows a value of 1.42 to 2.33. This means that beef cattle farmers in the Sarimulya Mandiri farmer group on average can contact one to twoe people to get beef cattle agribusiness information.

The local centrality maximum value for beef cattle cultivation information shows a value 8 (in-Degree) and a value 12 (out-Degree). The values 8 (in-Degree) and 12 (out-Degree) are owned by node 1, namely the head of the Sarimulya Mandiri farmer group. The minimum value of local centrality to obtain information on beef cattle cultivation is 0. This figure is owned by 2 individuals, namely nodes 2 and 6. Individuals

who have this minimum local centrality number show low individuality in obtaining information on beef cattle cultivation.

The local centrality maximum value for beef cattle breeding information shows a value 4 (in-Degree) and a value 15 (out-Degree). The values 4 (in-Degree) and 15 (out-Degree) are owned by node 1, namely the head of the Sarimulya Mandiri farmer group. The minimum value of local centrality to obtain information on beef cattle breeding is 0. This figure is owned by three individuals, namely nodes 2, 3, and 6. Individuals who have this minimum local centrality number show low individuality in obtaining information on beef cattle breeding. The local centrality maximum value for beef cattle institutional information shows a value of 6 (in-Degree) and a value of 13 (out-Degree). Node 1 has a value of 6 (in-Degree) and 13 (out-Degree), namely the head of the Sarimulya Mandiri farmer group. The minimum value of local centrality for obtaining beef cattle institutional information is 0. This value is owned by four individuals, namely nodes 3, 6, 8, and 11. Individuals who have this minimum local centrality value show low individuality in obtaining beef cattle institutional information.

The local centrality maximum value for beef cattle marketing information shows a value of 0 (in-Degree) and a value of 2 (out-Degree). This value of 0 (in-Degree) is shared by all nodes. While the value of 2 (out-Degree) is owned by node 10, namely members of the farmer group. The minimum value of local centrality to obtain beef cattle marketing information is 0. This value is owned by all individuals, namely nodes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12; individuals who have numbers. This minimum local centrality indicates low individuality in obtaining beef cattle marketing information.

The local centrality maximum value for beef cattle health information shows a value of 0 (in-Degree) and a value of 4 (out-Degree). This value of 0 (in-Degree) is shared by all nodes. While the value 4 (out-Degree) is owned by node 1, namely the head of the Sarimulya Mandiri farmer group. The minimum value of local centrality for obtaining beef cattle health information is 1. This value is owned by all individuals, namely nodes 4, 5, 6, 8, and 12. Individuals who have this minimum local centrality figure show low individuality in obtaining animal health information.

In these five communication networks, the average local centrality is in-Degree 1 and out-Degree 2. This means that, there is one person in the group who can be a source of information for group members (node 1). Node 1 namely the group leader still plays a role as a source of information for its members, and even members can access two other sources of information, both inside and outside the group. The leader has high status actor whose advice, knowledge, and skill are sought by others. A combined net draw of the 5 topics in Figure 6 identifies only node 1 (the group leader) acting as a star. Everyone in the group contacted the chairman, especially in the cultivation aspect. The group leader supports the communication process in order to improve collaboration and group agribusiness outcomes.

Figures 5 and 6 identify only group leaders acting as a star. The head of the farmer group as a group mover develops knowledge, learns together, and works together. This is in line with the findings of [37]. According to [53], farmers often have a combination of formal/political and informal/social positions in the community. In addition, they seem to have a long standing credibility among the community, mostly in trade. Businessmen who are well known in the community are also important sources of new information and knowledge, particularly if they travel to other places and come back with new knowledge about agricultural practices. According to [31], the positive impact of leader centrality in advice-giving networks is contingent on team needs for leadership to meet communication and coordination challenges.

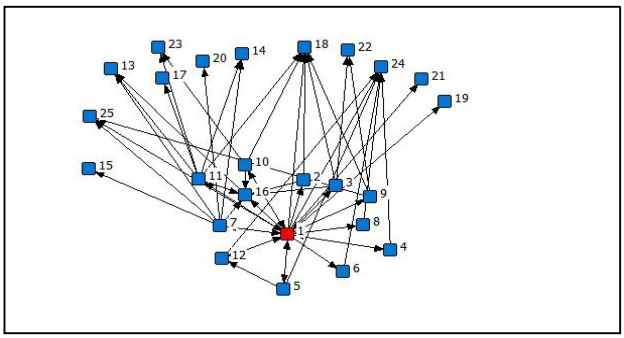

Fig. 6. Net draw in beef cattle of sarimulya mandiri group

4.2. Global centrality

Global centrality considers the advantages of actors with the entire network. The value of global centrality represents the number of ties required for a person to reach everyone in the system. Global centrality is needed as a consideration to choose the right people as the key to disseminating information. According to [46], the smaller the value of global centrality an individual has, the greater the individual's ability to contact everyone in the system.

Table 5 shows the global centrality maximum value for cultivation data on beef cattle reaching 525 (out-Close) and 650 (in-Close), while the minimum value is 455 (out-Close) and 225 (in-Close). Moreover, the average values for the global centralities are 593.33 (out-Close) and 623.61 (in-Close). The individual with the lowest value of global centrality in the communication network for collecting beef cattle cultivation information is node 16. This means that node 16 is the fastest individual in contacting everyone in the system.

The global centrality maximum value for breeding data reaches 552, and the minimum value is 416 (out-Close) and 231 (in-Close), while the average global centrality values are 543.17 (out-Close) and 516. 94 (in-Close). The individual with the greatest global centrality for the communication network for gathering information on beef cattle breeding is shown by nodes 4, 5, and 7. This means that the node with the maximum value is the individual with the most difficulty contacting all individuals who are members of the network system. The individual with the lowest global centrality value in the communication network for gathering information on beef cattle breeding is node 16. This means that node 16 is the fastest individual in contacting all members in the group.

Tab. 5. The global centrality value of bina insani farmer group in SPR subang based on the topic of communication networks regarding cultivation, breeding, institutions, marketing, and animal health

No.	Node	Cultivation Information		Breeding Information		Institution Information		Marketing Information		Health Information	
		Out close	*In close*	*Out close*	*In close*	*Out close*	*In close*	*Out close*	*In close*	*Out close*	*In close*
1.	1	476	650	440	552	439	552	482	600	575	650
2.	2	505	650	442	552	552	552	441	600	625	650
3.	3	505	650	441	552	485	552	484	600	625	650
4.	4	503	650	529	552	439	552	458	600	550	650
5.	5	479	650	529	552	484	552	483	600	600	650
6.	6	504	650	441	552	484	552	600	600	625	650
7.	7	455	650	529	552	485	552	576	600	625	650
8.	8	504	650	441	552	484	552	576	600	600	650
9.	9	502	650	416	552	461	552	483	600	527	650
10.	10	502	650	440	552	438	552	482	600	527	650
11.	11	502	650	416	552	460	552	459	600	502	650
12.	12	502	650	440	552	484	552	412	600	600	650
13.	13	455	650	439	552	461	552	457	600	526	650
14.	14	503	650	438	552	439	552	459	600	526	650
15.	15	478	650	461	242	438	552	459	528	477	650
16.	16	525	225	460	231	506	299	504	265	575	650
17.	17	478	625	416	552	483	552	482	600	600	650
18.	18	502	625	439	552	506	437	411	600	600	650
	Average Value	493.33	623.61	543.17	516.94	473.78	531.56	583.78	577.39	571.39	650.00

Tab. 6. The global centrality value of sarimulya mandiri farmer group in SPR subang based on the topic of communication networks regarding cultivation, breeding, institutions, marketing, and animal health

No.	Node	Cultivation Information		Breeding Information		Institution Information		Marketing Information		Health Information	
		Out close	*In close*	*Out close*	*In close*	*Out close*	*In close*	*Out close*	*In close*	*Out close*	*In close*
1.	1	20	144	19	238	13	104	225	240	180	240
2.	2	271	136	306	225	25	109	240	240	210	240
3.	3	35	151	306	225	182	97	225	240	210	240
4.	4	35	151	35	241	25	109	240	240	225	240
5.	5	34	151	289	225	25	109	240	240	225	240

No.	Node	Cultivation Information		Breeding Information		Institution Information		Marketing Information		Health Information	
		Out close	*In close*	*Out close*	*In close*	*Out close*	*In close*	*Out close*	*In close*	*Out close*	*In close*
6.	6	272	136	306	225	182	97	240	240	225	240
7.	7	30	151	33	241	169	97	240	240	210	240
8.	8	35	151	272	225	182	97	240	240	210	240
9.	9	256	136	289	225	25	109	225	240	210	240
10.	10	35	151	34	241	25	109	210	240	210	240
11.	11	30	151	34	241	182	97	225	240	210	240
12.	12	35	150	289	225	25	109	240	240	225	240
	Average Value	90.67	146.58	184.33	231.42	88.33	103.58	232.50	240.00	212.50	240.00

The maximum value of global centrality for institutional information on beef cattle reaches 552, and the minimum values are 438 (out-Close) and 299 (in-Close), while the average global centrality values are 473.78 (out-Close) and 531.56 (in-Close). The individual with the largest global centrality for the beef cattle institutional information gathering communication network is shown by node 2. This means the node with the maximum value is the individual with the most difficulty contacting all individuals who are members of the network system. The individual with the lowest global centrality value in the beef cattle institutional information gathering communication network is node 16. This means node 16 is the fastest individual in contacting everyone in the system.

The global centrality maximum value for marketing data on beef cattle reaches 600, and the minimum value is 411 (out-Close) and 265 (in-Close), while the average global centrality values are 483.78 (out-Close) and 577.39 (in-Close). The individual with the largest global centrality for the communication network for collecting beef cattle marketing information is shown by node 6. This means that the node with the maximum value is the individual with the most difficulty contacting all individuals who are members of the network system. The individual with the lowest global centrality value in the communication network for collecting marketing data is node 16. This means that node 16 is the fastest individual in contacting everyone in the system.

The global centrality maximum value for health information reaches 650, and the minimum value is 477, while the global centrality average values are 571.39 (out-Close) and 650.00 (in-Close). The individual with the largest global centrality for the communication network for beef cattle health information collection is shown by nodes 2 and 3. This means the node with the maximum value is the individual with the most difficulty contacting all individuals who are members of the network system. The individual who has the lowest global centrality value in the communication network for beef cattle health topic collection is node 15. This means that node 15 is the fastest individual in contacting everyone in the system.

In these five communication networks, the global centrality average is still high and is close to the maximum, especially the cultivation of an average value of 493.33 with a maximum value of 525; nurseries with an average value of 453.17 with a maximum value of 529; institutional average score of 473.78 with a maximum value of 506; and marketing average value of 483.78 with a maximum value of 504. The average value of livestock health is 571.39 with a maximum value of 625. This shows the ability of farmers in the Bina Insani farmer group to contact other farmers in the group is still not good for all information. This shows that institutional model farmers are not well connected.

Table 6 shows the global centrality maximum value for cultivation data on beef cattle reaches a value of 272, and the minimum value is 20 (out-Close) and 136 (in-Close), while the average global centrality value is 90.67 (out-Close) and 145.58 (in-Close). The individual with the largest global centrality for the communication network for information gathering on beef cattle is shown by node 6. This means that the node with the maximum value is the individual with the most difficulty contacting all individuals who are members of the network system. The individual who has the lowest value of global centrality in the communication network for collecting information about cultivation topic is node 1. This means that node 1 is the fastest individual in contacting everyone in the system.

The maximum value of global centrality for beef cattle breeding information reaches a value of 306, and the minimum value is 19 (out-Close) and 225 (in-Close), while the average global centrality values are 184.33 (out-Close) and 231.42 (in-Close). The individuals with the

greatest global centrality for the communication network for gathering information on beef cattle breeding are shown by nodes 2, 3, and 6. This means that the node with the maximum value is the individual with the most difficulty contacting all individuals, who are members of the network system. The individual who has the lowest global centrality value in the communication network for gathering information on beef cattle breeding is node 1. This means that node 1 is the fastest individual in contacting all members in the group.

The maximum value of global centrality for institutional information of beef cattle reaches 182, and the minimum value is 13 (out-Close) and 97 (in-Close), while the average global centrality values are 88.33 (out-Close) and 103.58 (in-Close). The individuals with the greatest global centrality for the communication network for institutional information gathering of beef cattle are shown by nodes 3, 6, and 8. This means that the node with the maximum value is the individual with the most difficulty contacting all individuals who are members of the network system. The individual who has the lowest value of global centrality in the communication network for institutional data gathering is node 1. This means that node 1 is the fastest individual in contacting everyone in the system.

The global centrality maximum value for marketing topic reaches 240, and the minimum value is 210, while the global centrality average value is 232.50 (out-Close) and 240.00 (in-Close). The individuals with the greatest global centrality for the communication network of beef cattle marketing information gathering are shown by nodes 2, 4, 5, 6, 7, 8, and 12. This means that the node with the maximum value is the individual with the most difficulty contacting all members in the system network. The individual who has the lowest global centrality value in the communication network to get information about marketing topic is node 10. This means node 10 is the fastest individual in contacting everyone in the system.

The global centrality maximum value for health information reaches 240, and the minimum value for health topic is 180, while the global centrality average values are 212.50 (out-Close) and 240.00 (in-Close). The individuals with the largest global centrality for the communication network for beef cattle health information collection are shown by nodes 4, 5, 6, and 12. This means the node with the maximum value is the individual with the most difficulty contacting all individuals who are members of the network system. The individual who has the lowest closeness centrality value in the communication network for health topic collection is node 1. This means that node 1 is the fastest individual in contacting everyone in the system.

The average global centrality in these five communication networks, is still high, ranging from 90.67 to 240.00. Individuals who have a maximum global centrality value of 272 include one respondent for cultivation information, two respondents scored 289 for nursery information, with 182 values, four respondents for institutional information, seven respondents scored 240 for marketing information, and four respondents scored 225 for animal health information. This shows that institutional model farmers are not well connected. Therefore, the connectivity among farmers in in the Sarimulya Mandiri are still low on all aspects (cultivation and breeding, institutions, marketing, and animal health information).

The average value of global centrality in these two groups showed that institutional model farmers are not well connected. Different finding was found in [53]. Their research found that model farmers were institutionally and politically better connected.

4.3. Communication network behavior

Table 7 illustrated two farmer groups' communication network behaviour in receiving, giving, and disseminating information in agribusiness activities.

The degree centrality of two groups illustrates that the group leaders still play a role as a source of information for their members. This is in line with the findings of [55], [56], and [57] that the group leaders often deal with sources of information outside the group, such as with the association of livestock groups, universities, local livestock service officers, such that they have much information. Their good position in the group and relationship with stakeholders allows them to access a variety of information. The heads of farmer groups are able to become the motor of change, put themselves in difficult issues, emphasize trust, and show the most important values [58].

Tab. 7. The performance-based on the communication structure in agribusiness activities

	Sarimulya Mandiri Farmer Group	Bina Insani Farmer Group
Class	the beginner farmer group	the advanced farmer group
A source of information	the group leader	the group leader
Local Centrality	The members have the ability to build relationships with 1-2 individual in the system	The members have the ability to build relationships with 2-3 individual in the system
Global Centrality	the individual ability to access all individuals in the whole system is still relatively low	the individual ability to access all individuals in the whole system is still relatively low
Pattern	semi-open	semi-open
Roleplay	dominantly interact as mutual pairs	many more group members who play a neglected role communication
The role of star	high	high

Members have the ability to build relationships with 1-3 other individuals in the system. Communication interactions carried out by each member have formed a communication network with a trending semi-open pattern. This is in line with the finding of [59], that in addition to communicating with beef cattle extension services, fellow members in the network also communicate with other communities.

In the advanced group (Bina Insani), there tend to be many more group members who play a neglected role communication. Whereas in the beginner group (Sarimulya Mandiri), members dominantly interact as mutual pairs. This is in line with the finding of [59] that advanced group members tend to play a neglected role in communication, while less advanced members play roles in mutual pairs. Regarding the role of star, it is still high in the two groups.

The performance based on the communication structure in Bina Insani and Sarimulya Mandiri farmer groups' communication networks shows low connectivity and has not yet become a good coordination forum. The average global centrality in the five communication networks is still close to a maximum. This shows that the farmer group members' ability to access all members in the system is still not good. This is in line with those of [57] and [60] that group members are still lacking in cooperation and sharing information.

As the theoretical implications, the study of communication networks was conducted on the actor networks based on the relation and interaction of actors to characterize the information transmission of messages throughout the network [6] and focused on actor relationships [2]. The research found that there is a leader centrality. They explained this with the signaling effect of leader centrality, such that subordinates tend to view more centrally positioned leaders as more charismatic and inspiring, and subsequently are more prone to accept and carry out leaders' instructions [31]. Communication network studies also measure member collaboration and team performance. This study measures the level of strength of cooperation between members and group dynamics. The research found that the groups have low connectivity and have not become a good coordination forum.

By speaking to the network centrality, this study also has managerial implications. As a practical implication, the team leaders can actively seek advice-giving roles in the team network of social interactions. The global centrality demonstrates the power of collaboration among members and shows the group dynamics. The research finding contributes to stakeholders in agriculture regarding group dynamics through performance based on the communication structure of the farmer group communication network, by conducting several analyses that describe the social capital in the region. The study of communication networks as social capital deserves attention in the empowerment program and farmer institutional development through joint efforts in all fields of agribusiness from upstream to downstream.

5. Conclusion

Bina Insani and Sarimulya Mandiri farmer groups' centrality degree illustrates that the heads of the farmer groups still act as a source of information for their members. The members are able to build relationships with 1-3 people in the system. The heads of the farmer groups as a

group mover develops knowledge, learns together, and works together.

Performance based on the communication structure on the communication network of Bina Insani and Sarimulya Mandiri farmer groups shows low connectivity and has not become a good coordination forum. The group members are still lacking in cooperation and sharing information.

The limitation of this study is that it is only in quantitative approach. Therefore, it is recommended to conduct further research in qualitative approach to analyze further about the role plays in the networks that can be taken into consideration in increasing group social capital.

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