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The Agricultural Technology Transfer Agencies Role on Transferring the Biogas Technology to Farmers: A Study Case of Dairy Farmer's Network Analysis in Umbulharjo Village, Yogyakarta Province, Indonesia

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ABSTRACT: This paper aims to describe the process of biogas technology transfer to mixed crops and livestock farmers in Indonesia. The relationship between a formal mechanism model and a farmer to farmer communication network is examined to identify the effectiveness of biogas technology transfer. A case study of dairy farmers in Umbulharjo village, Yogyakarta Province, Indonesia was conducted. A Social Network Analysis (SNA) was employed to identify the group of network centrality –which consists of the Degree of Centrality, Eigenvector, and Betweenness Centrality- and individual farmer attributes. In a network centrality perspective, the formal mechanism model of biogas technology transfer initially selects the elite group of farmers in the core of network as an "injection point" of the biogas technology diffusion into a society. The farmers in the core position within a network may decide to be early adopters of biogas technology which indicates an effective biogas technology transfer at an early diffusion stage. Nonetheless, the biogas technology diffusion acceleration through indigenous farmer to farmer communication is not an easy process. Individual farmers should have better understanding on the complexity of the technology and the capacity to persuade their neighboring farmers.

Keywords: Network analysis, Biogas technology, Tehnology transfer, Dairy farmers

INTRODUCTION

With respect to the limited resources of smallholder farmers, the slow rate technology diffusion becomes problems especially those are characterized by relatively complexity and relatively high risk technology (Batz *et al.,* 1999). Therefore, the acceleration of technology diffusion to smallholder farmers becomes a great effort for stakeholders of technology transfer in Indonesia (Kadir *et al.,* 2002). In the farming system, the technology transfer has been promoted as a linear model linkage which transferring the innovation from researchers to farmers through extension system (FAO, 2000). The Indonesian government has implemented the policy of top-down streaming technology transfer of researcher-extension-farmer relationship model before expanded to adopt a working partnership model. It is an extended model of the linear technology transfer by involving the public-private partnership in which the research institutes, universities, and extension agencies as public institutions cooperate with NGO and farmer organization as private institutions in disseminating the technology to farmers (Rahman, 2002). This partnership actually forms a formal mechanism model in knowledge diffusion and information dissemination network to farmers as recipients of technology (Contado, 2002; FAO, 2000). In the technology transfer context, the formal mechanism model assumes that technology can be effectively disseminated to farmers by more involvement of stakeholders from private and public sectors (Kormawa *et al.,* 2004; Rogers, 2003).

On the other hand, knowledge exchange and innovation transfer networks have been indigenously existed through a farmer to farmer communications network model in which a new technology can be diffused and spread out at a farming society (Alene and Manyong, 2006). In a farmer to farmer communication network model, the communication among the member of society have created a social network within neighborhood in a particular geographical area which may promote the speed of technology diffusion (Banerjee *et al.*, 2013; Grisley, 1994). The knowledge exchange and technology transfer are embedded in the social network and available through the social interaction among the farmers (M. E. Isaac *et al.*, 2007). This paper aims to describe the process of biogas technology transfer to mixed crops and livestock farmers in Indonesia. A case study of the dairy farmers' network was conducted to show how the formal mechanism model plays a role in the network and how biogas technology is disseminated among the network. This study is particularly relevant in the light of a slow rate of biogas technology diffusion among the farmers in Indonesia.

MATERIALS AND METHODS

The case study about farmer's network took place in Umbulharjo, Sleman, Yogyakarta Province during November to December 2014. This study involved nine neighboring farmers as participants. This study also employed an ordered pairs of farmers as a data collection technique which is commonly used to gather the data to estimate the point of network centrality (Galaskiewicz, 1991). With nine farmers participated in the research, this study employs a 9 × 9 matrix as a sample set in the analysis which is able to take advantage of some aspects on explaining the phenomena based on network theory and technique (Costenbader and Valente, 2003).

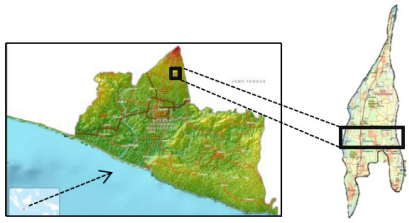

Figure 1. Map of the Umbulharjo Village and the sub-village survey area

Every response of farmers, represented by alphabet nodes from A to I, was entered into the the 9 × 9 matrices in UCINET 6, a social network analysis software package (S.P. Borgatti *et al.*, 2002). The graphic network (socio-gram) presents a network of information flow of biogas technology diffusion stages of the farmers based on their information sharing in the society. The formal mechanism model is attributed to the nodes by acquiring the respondent information about first information source of biogas technology and time of firstly getting information about biogas. To fulfill the objective of this study, we specifically asked "with whom do you share the biogas technology information?" and "from whom do you receive the biogas technology information?". A farmer, then, put a sign to the eight neighboring farmer's name list, as if they share to or receive from, to answer those four questions. The farmer's responses were coded as binary variables indicating the presence (1) or absence (0) of a tie and tabulated into a matrix (Hanneman and Riddle, 2005). Data were analyzed by descriptive approach by considering the analysis of social network results.

With the respect to information flow of biogas technology through the farmer's network,

network centrality approach was used as a network feature to study the structure of information flow network in relation to biogas technology diffusion at farm level. The network centrality can be expressed as a concept that structuralizes the network in accordance to the importance roles of a node in its position (Stephen P Borgatti *et al.,* 2013). The network centrality may usually be defined by its degree of core centrality, its closeness to other nodes, and its shortest path to other nodes. This study employed the degree of centrality and eigenvector value as indicator of closeness centrality (Hanneman and Riddle, 2005). Those measurements may show the actor's role on knowledge and information exchange about biogas technology among the neighbors.

RESULTS AND DISCUSSION

The dairy farmers are characterized by an age average of 49.5 years old which ranges from 30.92 to 72.92 years old. There are four farmers who are older than the average while the rests are younger than average. The MCL farmers mostly have finished primary and secondary level while only one farmer who attained the high secondary level. Meanwhile, the farm household income level is mostly at lower income while only one farmer has higher level income and three farmers have medium level income. Regarding to farm characteristics, the average of land tenure among nine farmers is 0.24 Ha which range from 0.1 Ha to 0.5 Ha. The cattle ownership shows that the average of cattle ownership is 4.6 TLU which ranges from 1 TLU to 10 TLU at farm households. The table 1 also shows that the information about biogas initially diffused to the MCL farmer network in 2009 supported by the initial information injected to the society and the first farmer adopted the technology. The information about biogas technology was transferred by NGO and Government agency within a formal mechanism model and neighboring farmers within a farmer to farmer communication network.

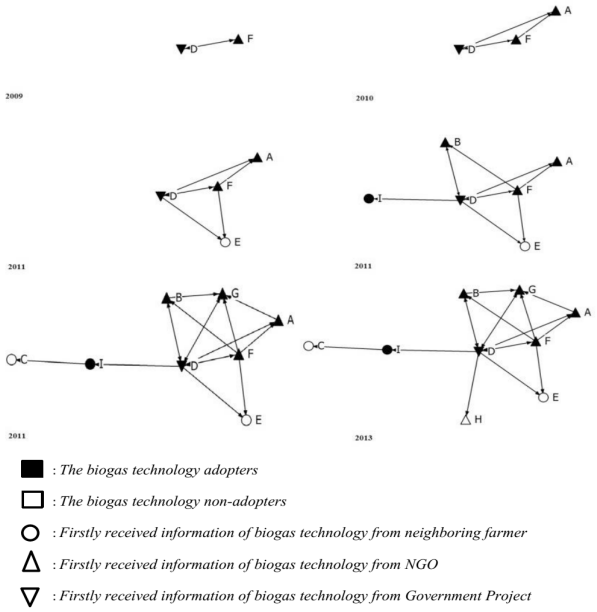

Figure 2. The diffusion process of biogas technology among the DAIRY farmers

In a connection to the network centrality, the socio-gram of diffusion process shows that the biogas adopters have advantages from their position in the networks (Figure 2). The biogas

adopters are more in the core position of the network while the biogas non-adopters are more in the periphery of the farmer's network. The tendency of centralized position of biogas adopters in the network confirm that information of technology is more likely to flow from the central of the network to the periphery (Spielman *et al.*, 2011). With the core position in the network, potential farmers can be the earlier adopters of biogas technology. It support the previous finding that the knowledge transfer among the farmers and the technology adoption can be identified from the social network relationship which is indigenously structuralized in the agrarian networks (Marney E. Isaac, 2012).

The results in table 2 show that the score of centralities in the network indicates the centrality roles among individual farmers in the networks when share biogas technology knowledge. There are, at least, two farmers, D and F, with higher score of centralities in the networks. Those farmers are considered as early adopters of the biogas technology in the network by receiving information through formal mechanism model of biogas technology transfer from both NGO and Government Project (see figure 2). It may indicate that farmers with more central position have better opportunity to interact with the stakeholder of technology transfer. From network perspective, individual farmer with higher degree of centrality with more ties in the network have better information access even beyond the farmer network.

Table 2. Individual farmers' centrality in the networks

Actors	Degree of Centrality	Eigenvector Value
A	3	0.348
B	3	0.348
C	1	0.034
D	7	0.519
E	2	0.245
F	5	0.466
G	4	0.417
H	1	0.129
I	2	0.137
Centralization Index	62.50%	55.45%

CONCLUSIONS

A case study of DAIRY farmer's network in Umbulharjo village has shown that, in a network perspective, the formal mechanism of biogas technology transfer specifically target the elite group of farmers in the network to be selected as an "injection point" of the biogas technology diffusion among the farmers. This indicates that the farmers with more ties and well-connected to each other in the network have better information access about biogas technology beyond the network boundary. At the early stage of new technology diffusion, the biogas technology is effectively diffused at mixed crops and livestock farm through the elite group of farmers in the network. Another finding shows that speeding up the biogas technology diffusion through indigenous farmer to farmer communication network is not an easy process. Individual farmers should have better understanding on the complexity of the technology and the capacity to persuade their neighboring farmers.

REFERENCES

Alene, A. D. and V. M. Manyong. 2006. Farmer-to-farmer technology diffusion and yield variation among adopters: the case of improved cowpea in northern Nigeria. Agricultural Economics 35:203-211.

Banerjee, A., A. G. Chandrasekhar, E. Duflo and M. O. Jackson. 2013. The Diffusion of Microfinance. Science 341.

Batz, F. J., K. J. Peters and W. Janssen. 1999. The influence of technology characteristics on the rate and speed of adoption. Agricultural Economics 21:121-130.

Borgatti, S. P., M. G. Everett and J. C. Johnson. 2013. Analyzing social networks SAGE Publications Limited.

Contado, T. E. 2002. Integration of Agricultural Research and Extension: Mechanism for The Transfer of Agricultural Technology among Countries in Asia and The Pacific. Edited by R. Sharma. *Asian Productivity Organization*. *Tokyo, Japan.*

Costenbader, E. and T. W. Valente. 2003. The stability of centrality measures when networks are sampled. Social networks 25:283-307.

FAO. 2000. Understanding Farmers' Communication Networks: An experience in the Philippines (Online). http://www.fao.org/docrep/V9406E/V9406E00.htm, Accessed in February 2013.

Galaskiewicz, J. 1991. Estimating point centrality using different network sampling techniques. Social Networks 13:347-386.

Grisley, W. 1994. Farmer-to-farmer transfer of new crop varieties: an empirical analysis on small farms in Uganda. Agricultural Economics 11:43-49.

Isaac, M. E. 2012. Agricultural information exchange and organizational ties: The effect of network topology on managing agrodiversity. Agricultural Systems 109:9-15.

Isaac, M. E., B. H. Erickson, a. S. Quashie-Sam and V. R. Timmer. 2007. Transfer of knowledge on agroforestry management practices: the structure of farmer advice networks. Ecology and Society 12(2): 32. [online] URL: http://www.ecologyandsociety.org/vol12/iss2/art32/.

Kadir, I., M. Dawi, a. S. Human and M. T. Razzak. 2002. Integration of Agricultural Research and Extension: Country Report of Indonesia. Edited by R. Sharma. Asian Productivity Organization. Tokyo, Japan.

Kormawa, P., C. Ezedinma and B. Singh. 2004. Factors influencing farmer-to-farmer transfer of an improved cowpea variety in Kano State, Nigeria. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS) 105:1-13.

Rahman, M. M. 2002. Integration of Agricultural Research and Extension: Recent Development in Agricultural Research and Extension Systems in Asia and The Pacific. Edited by R. Sharma. Asian Productivity Organization. Tokyo, Japan. .

Rogers, E. M. 2003. Diffusion of Innovations. Fifth Edition. Fifth Edition ed.The Free Press, A Divison of Simon and Schuster, Inc., New York. USA.

Spielman, D. J., K. Davis, M. Negash and G. Ayele. 2011. Rural innovation systems and networks: findings from a study of Ethiopian smallholders. Agriculture and Human Values 28:195-212.