

Diffusion and Adoption of Green Super Rice among Farmers in Selected Municipalities in Laguna, Philippines

ISABELLA MARI A. JHOCSON^{1*} and ROWENA DT. BACONGUIS²

ABSTRACT. The study investigated the uptake pathways of Green Super Rice (GSR) varieties in Mabitac and Sta. Maria, Laguna, Philippines. Green Super Rice are climate-smart varieties distributed to selected farmers in five municipalities in Laguna, Philippines in 2012. The distribution was a part of the 100 Farmers Project of an international organization in partnership with local government units. It should be noted, however, that no follow-up research on its adoption and uptake pathways has, thus far, been conducted. Thus, it is interesting to determine whether adoption and diffusion of the seeds occurred despite the unusual seed distribution process. The aim of this current study is to trace the reach of GSR varieties promoted through farmer-to-farmer approach; and analyze the exchanges, structures, and relationships among research participants and other farmers in communities through a social network analysis. To investigate the uptake pathways of GSR in the two municipalities, the study was conducted in six sites in Mabitac and Sta. Maria, Laguna with 39 research participants referred to as first-degree research participants. The farmers with whom the first-degree respondents shared GSR seeds and/or information were considered as second-degree respondents. The sites and respondents were purposively chosen. The study used survey interviews, ego-net mapping, and key informant interviews in data gathering. The GSR diffusion in the two municipalities remained within the circles of the respondents with whom the varieties were distributed. The lack of a formal extension system limited the respondents' access to information and technical support. Thus, continued adoption and diffusion were negatively affected.

Keywords: *Climate-smart agriculture, social network analysis, diffusion and adoption, green super rice, uptake pathways*

¹Bangko Sentral ng Pilipinas, Manila, Philippines

<https://orcid.org/0000-0002-3453-6933>

²College of Public Affairs and Development, University of the Philippines

Los Baños, Laguna, Philippines

<https://orcid.org/0000-0002-3300-1208>

*Corresponding author: iajhocson@up.edu.ph

INTRODUCTION

Rice is the staple food of more than 3.5 billion people in the world, 90% of which is primarily produced and consumed in Asia. Unfortunately, the Philippines is commonly hit by typhoons, which negatively affect major livelihoods of its rural communities, such as farming and fishing. With the growing population comes increasing demand for food. Because of the challenges brought about by climate change, sustainable production of agricultural goods is required to meet the growing global demand. One of the strategies to ensure rice production increase is through the development of rice varieties that can withstand unfavorable conditions and produce high yield with minimal inputs. The impact of varietal improvement was observed during the 1960s with the release of IR8 or "miracle rice" where production increased significantly (Baroña-Edra, 2013).

The Green Super Rice (GSR), developed by the International Rice Research Institute (IRRI) in collaboration with the Chinese Academy for Agricultural Sciences (CAAS), are climate-smart varieties designed to withstand abiotic stresses, such as drought, flooding, and saltwater to produce high yields with minimal inputs (Yorobe et al., 2016). The GSR are inbred varieties wherein seeds can be shared using the farmer-to-farmer approach. In 2012, GSR varieties were first released in the province of Laguna, Philippines. The IRRI GSR team went to local communities in Laguna to distribute seeds of five GSR varieties to willing farmers as a part of their 100 Farmers Project (J. Ali, personal communication, February 8, 2016). In contrast to the usual process of coordinating with the local agricultural extension workers and asking for recommendations in identifying farmer-cooperators, the IRRI project team chose to directly coordinate with the farmers. Their major assumption of not going through the formal channels of distribution was the belief that good seeds that can produce higher yields with minimum inputs will result in the adoption and diffusion of these inbred rice varieties without the need for an intermediary.

Given the project team's assumption, this study was guided by the Diffusion of Innovations Theory and the Social Contagion Theory to understand how and why individuals are persuaded to adopt and share a technology with other farmers. The Diffusion of Innovations Theory assumes that a good idea or product diffuses over time throughout the concerned community. Diffusion is the "process where an innovation is communicated through channels over time, among the members of the social system (Rogers, 2003, p. 5)". Moreover, the diffusion process is influenced by factors such as norms and opinion leaders (Rogers, 2003).

Rogers (2003) claims that innovation diffusion can help understand the strategies to reduce uncertainties in the diffusion and adoption of technologies. In the now classic study of the diffusion of hybrid seed corn among Iowa farmers in USA, it was found that while mass media could reach a huge number of farmers at a given period, it was the face-to-face interaction with peers that ultimately persuaded farmers and influenced diffusion of the said variety (Ryan & Gross, 1943). Torres et al. (2013) recommended the identification of local ambassadors in the community to help in the adoption process of the corn variety they investigated.

Following the idea of the importance of local ambassadors, the Social Contagion Theory was used as an analytical lens to determine the role of influencers in the spread of technology in the community. Levy and Nail (1993) trace the earliest reference to the said theory in 1895 and has since been used to explain the spread of information and practices in different fields of specialization, especially in psychology. The premise is that the attitude or behavior and the messages of an influencer enhance the spread of the technology in a local community, given that the context is almost similar.

The initiator that starts the process of the spread of knowledge serves as the stimulus "for the imitative actions of another" (Lindsey & Aronsson, 1985, as cited in Marsden, 1998, p. 1147). It can be referred to as non-intentional spread, much like a contagious disease where the initiator did not intentionally aim to spread the idea. In the Social Contagion Theory, the tipping point or *magic moment* is when an idea, innovation, or behavior crosses a threshold and *spreads like wildfire* throughout society (Gladwell, 2000). The three principles that facilitate the tipping point are the Law of Few or messengers, Stickiness Factor or message content, and Power of Context or the specific nature of the social environment.

The exploration of diffusion and the role of the Social Contagion Theory in the diffusion-adoption process guided the following questions: How do social, technological, and economic factors affect adoption decision of farmers? Who are the influencers in the different locales of the study? How is knowledge shared per municipality? What are the types of messages communicated about Green Super Rice? With no formal extension system in place and relying solely on farmer-to-farmer diffusion, it is interesting to study how the GSR was diffused and adopted.

METHODOLOGY

The research explored the diffusion of GSR varieties in Mabitac and Sta. Maria, Laguna, Philippines among the participants of the 100 Farmers Project in 2012. There were no formal systems or intermediaries between the farmer communities and scientists related to the 100 Farmers Project of IRRI. The IRRI GSR team went to local communities in Laguna to distribute seeds (J. Ali, personal communication, February 8, 2016). No study has been conducted on the adoption or diffusion of GSR varieties since their release. Previous studies related to GSR looked at the rice breeding strategies and economic effects of GSR production in Laguna. The economic effects study covered the yield and income effects of GSR versus non-GSR rice varieties in 2011 and 2012, and farmers' technological preferences. There have been no follow-up studies in the locality in relation to the 100 Farmers Project.

Data gathered were for 2016 wet and dry seasons, and data collection was conducted from August to November 2017. Yorobe et al.'s (2016) study on yield and income of these 100 farmers originally covered five municipalities in Laguna, the other three where in Siniloan, Famy, and Majayjay. The authors of this study chose Mabitac and Sta. Maria because they have the greatest number of participants in the project. The farmers in the other three municipalities were mostly unknown to the local technicians and were highly dispersed in locations identified to have recent rebel activities. Thus, only two municipalities were included in the study.

All of the 54 farmers of the 100 Farmers Project, the research participants of the study, came from the two municipalities (Table 1). They were considered as first-degree participants. Ten farmers, however, could no longer be located as they have moved out of the area, reducing the total number of first-degree participants to 44. Among the first-degree participants, there were 39 adopters and five non-adopters. From the first-degree participants, six second-degree farmers were identified through snowball sampling. Of the six, only two remembered being introduced to GSR. In total, there were 46 participants of the study, 44 first-degree participants and two second-degree participants. It should be noted that five from the first-degree participants and the two second-degree participants were non-adopters. The respondents of the study included both adopters and non-adopters of GSR because GSR adoption decision covers adoption, non-adoption, and discontinuance of adoption.

Table 1. Distribution of farmer-respondents

CATEGORY	FREQUENCY	PERCENTAGE
First-degree Participants (n=54)		
Able to participate	44	81
Could not be located, thus, no participation in the study	10	19
Adopters and Non-adopters among First-degree Participants (n=44)		
Adopters	39	89
Non-adopters	5	11
Second-degree Participants Identified through Snowball Sampling (n=6)		
Non-adopters	2	33
Cannot remember using GSR	4	67

Survey, ego-net mapping, and key informant interviews were the methods used to collect data. A key method in this study was Social Network Analysis. According to Edwards (2010), the Social Network Analysis presents a good opportunity for a mixed methods approach because of its dual interest in both the structure and form of social relations. In analyzing the diffusion pathways, the network structure, frequency, and content of interactions were investigated to provide both insider and outsider views of the network. Data on diffusion pathways were collected through ego-net mapping and survey interviews. Semi-structured interviews were conducted to find the number of people with whom they shared the GSR seeds or information, and as a result, how many of them adopted the GSR varieties.

Analysis was done through coding and visualization through the software Gephi (version 0.9.2). Gephi is an open-source software for network visualization and analysis. It is based on a visualize-and-manipulate paradigm which allows any user to discover networks and data properties (Gephi.org, 2017). It also helps researchers analyze trends and patterns in social networks. Arrows generated by Gephi denote direction of interaction, while the colors denote the interaction with the person or institution identified to be as either influential or less influential, and the thickness of line denotes the frequency of interaction. For the messages shared, colors denote whether the exchanges were about sharing of GSR information or seeds.

RESULTS AND DISCUSSION

Socio-demographic Characteristics of the Respondents

Most of the adopters are male (87%), married (82%), and middle-aged (51%). The adopters' average age is 58. Some (41%) have finished at least 10 years of schooling, and have spent most of their lives in the farm with an average experience of 33 years. Only 28% of the adopters have household members helping them in the farm, with the respondents either doing all the work or hiring people to help out. This means that majority of the young family members are not involved in rice farming. On the other hand, majority of the non-adopters are also male (86%), middle-aged (86%), and married (71%). The average year of farming experience is also high at 32 years (Table 2).

The respondents are mostly 51-65 years old, which confirms the ageing population of Filipino farmers (Philippine Statistics Authority, 2015). In a study conducted in the Mekong Delta, results showed that age is negatively correlated with adoption. This means that the older the farmer, the more conservative and more unlikely it is for him/her to adopt an innovation. Young farmers are said to be more progressive when it comes to dealing with new technology (Chi & Yamada, 2002). Farmers who are also more experienced are hesitant to adopt new technologies because they have practices that they consider effective (CIMMYT Economics Program, 1993).

The ageing population is also reflected in the lack of involvement of the younger family members in rice farming, which is problematic because the average age of respondents is nearing 60 years old. The engagement of the youth in agriculture has been declining over the years. In a study on youth's perceptions and attitudes concerning the Ifugao Rice Terraces, only 25% of the research participants wanted to be engaged in an agricultural career while only 2% wanted to enroll in an agriculture-related course from 1999/2000 to 2010/2011 (Dizon et al., 2012).

Majority (67%) of the adopters are members of farmers' organizations in their respective communities, 38% of whom hold job positions (e.g., chairman of board of directors, president, vice president, auditor). Majority (79%) of them have access to learning resource events, with attendance to seminar (59%) identified as the most common learning event. They consider communication materials such as leaflets and brochures as supplements from these sessions rather than an

Table 2. Socio-demographic characteristics of respondents

SOCIO-DEMOGRAPHIC CHARACTERISTICS	ADOPTERS (n=39)		NON-ADOPTERS (n=7)	
	Frequency	%	Frequency	%
Age				
30-40	1	3	0	0
41-50	5	13	1	14
51-60	20	51	6	86
61-70	10	26	0	0
71-80	3	8	0	0
Mean	57.6		55.7	
Sex				
Male	34	87	6	86
Female	5	13	1	14
Civil Status				
Single	3	8	0	0
Married	32	82	5	71
Separated	0	0	1	14
Widowed	4	10	1	14
Years of Formal Schooling				
1-6 (Elementary)	14	36	0	0
7-10 (High School)	16	41	3	43
> 11	9	23	4	57
Mean	8.95		11.14	
With Household Members Who Help with Farm Work				
Yes	11	28	2	29
No	28	72	5	71
Years of Farming Experience				
5-20	10	26	1	14
21-35	10	26	3	43
36-50	18	46	3	43
51-65	1	3	0	0
Mean	32.7		32.43	

important source of information. Majority (71%) of the non-adopters are also members of farmers' organizations, while seminar and training (86%) are identified by most as the learning resource or event that they have access to. There are adopters and non-adopters who are currently no longer involved in farming because they have sold their farm or have decided to stop tilling the land (Table 3).

Table 3. Membership in farmers' organizations and access to learning resources

MEMBERSHIP IN ORGANIZATIONS AND ACCESS TO LEARNING RESOURCES VARIABLES	ADOPTERS (n=39)		NON-ADOPTERS (n=7)	
	Frequency	%	Frequency	%
Membership in Farmers' Organizations				
Yes	26	67	5	71
<i>With position</i>	10	38	1	20
No	11	28	1	14
Not farming anymore	2	5	1	14
Access to Learning Resources				
Yes	31	79	6	86
No	6	16		
Not farming anymore	2	5	1	14
Type of Learning Resource*				
Seminar	23	59	6	86
Training	16	41	6	86
Leaflets and brochures	19	49	2	29
Posters	4	10	1	14
Computers with internet for research	3	8	1	14
Books	2	5	2	29

*Multiple response

Green Super Rice Diffusion Pathways

Figures 1 and 2 show the interactions of respondents and their source of information. The respondents identified IRRI and the Municipal Agriculture Office (MAO) as influencers in their rice farming practice. Other farmers and family members, especially those who are involved in rice farming, are also identified as most influential.

In the ego-net mapping, the yellow circles represent the ego or respondents. The identified influencers are divided into two categories, which are *institutions* (green circles) and *individuals* (blue circles). The lines with arrowheads denote one-way communication with the end as the receiver, and lines without arrowheads denote two-way communication. The thickness of line denotes the frequency of interaction – the thicker the line is, the more frequent the interaction between nodes. Lastly, the pink color represents connections that are more influential while the blue line represents connections that are less influential.

Influencers and Interaction on Farm Management Decisions

In identifying farm management decisions, all 39 adopters and seven non-adopters were asked to identify who influenced them in adopting or rejecting a technology. Figure 1 shows nine individual influencers and seven institutions identified. Farmers or co-farmers and the MAO are the most influential, with more frequent and two-way interactions. In terms of institutional influences, the MAO was identified as more influential as the office disseminates technologies to farmers on the ground. They also provide training programs and seminars for farmers; thus, farmers have more interaction with them. Agricultural companies, such as SL Agritech, Bayer, and other *palay* rice buyers and seed growers, which also provide financial arrangements for farmers, are considered influencers. They loan the seeds during planting season and get the payment once the farmers are able to sell their harvest. Rural banks may have tie ups with cooperatives who push for particular rice varieties of their choice. While IRRI is said to be influential because of its global standing as a lead research center in rice, the research participants have more trust in people or institutions that are physically within the vicinity or those who can be easily reached.

Among individuals, a farmer-leader was identified by many as most influential. Farmer-leaders are considered successful peers; therefore, their insights on farm management are respected. Farmers who have children or spouses involved in farming identified *family* as influential. Local councilors and the caretaker or laborer of the farm also influence the respondents' farm decisions. For both GSR adoption decision and farm management matters, isolates, or respondents who did not interact with anybody, do not consider anyone as influential to them because they claim that they know their farm more than others. They acknowledged that they get new information from others, and deny that they are influenced by the information that they receive.

Influencers and Nature of Interaction in GSR Adoption-Decision Making

Figure 2 shows the interactions of the 39 adopters with the institutions and individuals whom they considered influential. Compared to farm management decision-making (Figure 1), there are fewer institutions and individuals identified as influencing GSR adoption decision making process of research participants. Results reveal a highly weak interaction among adopters, with very seldom interaction among them. In fact, 12 of the adopters are isolates who never interacted with the other adopters nor considered any institution or individuals as influencers in their decision to adopt.

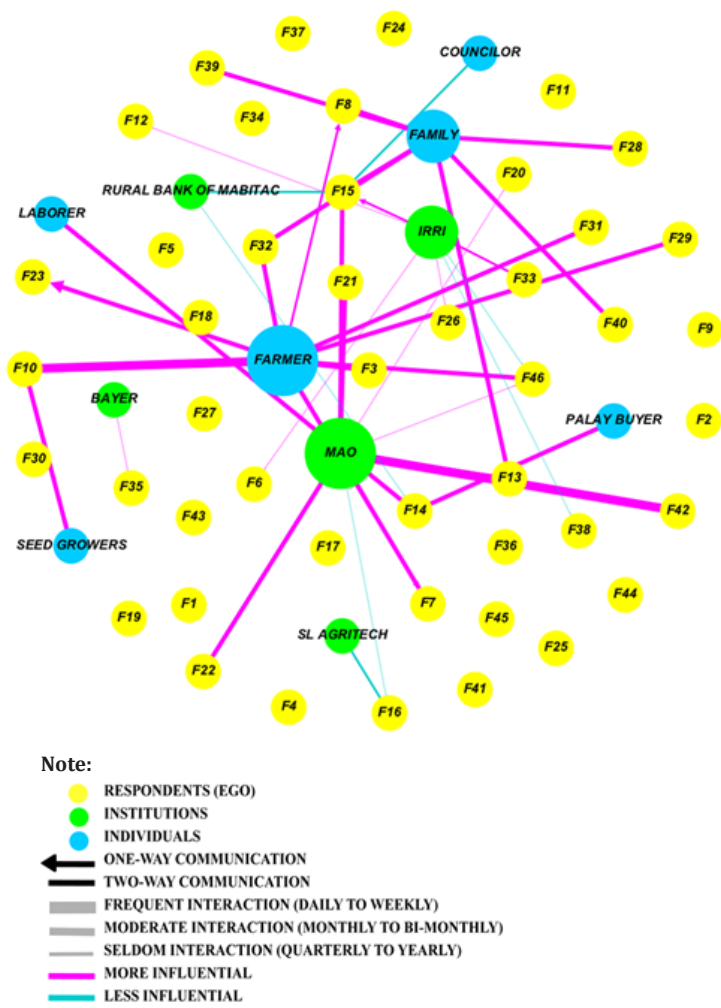


Figure 1. Sociogram of influencers and interaction on farm management decision-making

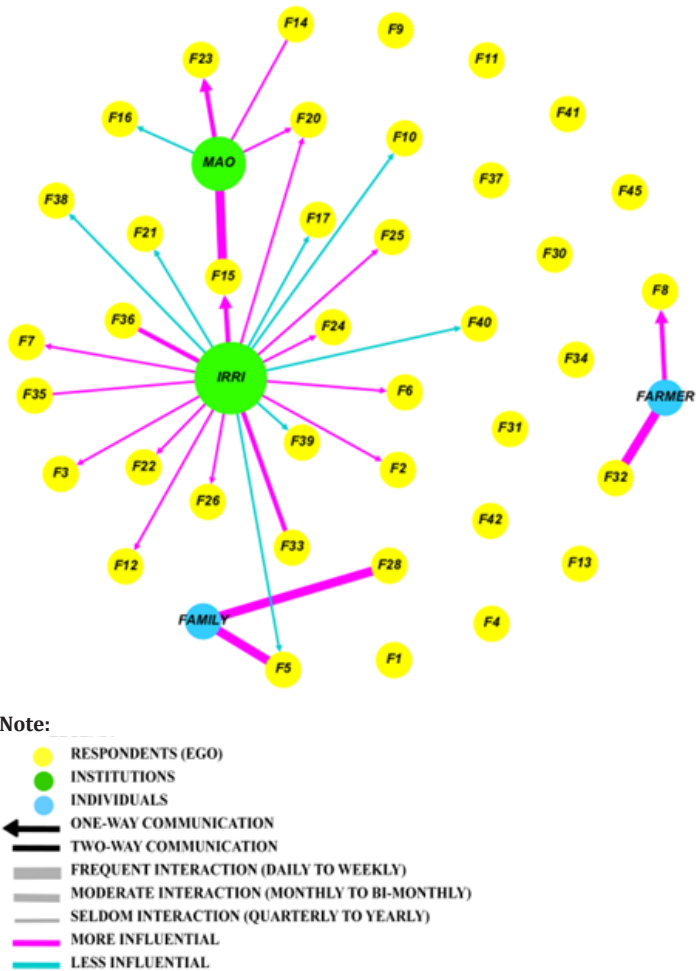


Figure 2. Sociogram of influencers and nature of interaction in GSR adoption decision-making

This community of adopters identified only two influencers in the use of GSR, i.e., IRRI and MAO. Majority of the respondents identified IRRI as the most influential in their GSR adoption decision. Aside from being the provider of GSR seeds, IRRI was identified as most influential in GSR adoption decision because of the institution's global standing as respondents said "IRRI *na 'yan eh*." IRRI is also trusted in the *barangays* (villages) because the respondents joined previous IRRI activities. However, this trust is fragile. When IRRI was not present to provide an explanation to a problem they encountered, trust towards IRRI spiraled.

"If you think about it, since it came from IRRI, you are 100% sure that the *palay* is good. That's why now, I'm skeptical about technologies coming from IRRI." – *An adopter who encountered tungro infestation with GSR*

Their rice yield was low because of tungro infestation and they thought that the seeds were good enough to withstand tungro. It was also observed that the more personal the relationship, the more frequent the interaction is. While IRRI is considered influential, most of the interactions happened rarely (quarterly or annually) as the relationship is not personal. It also reflected a one-way interaction with IRRI as the source.

The MAO was the other institution identified as influential. This is because the MAO is accessible to the farmers even though they are not directly involved in GSR distribution. Other influencers mentioned were co-farmers, whose experiences are valued by their peers. Family members were mentioned by adopters as influential in their GSR adoption decision because they evaluate whether any technology will help them earn more. Thus, family members are at the forefront of consideration and the partner of the household head. Those involved in farming are normally consulted. Overall, the role of influencers in this adoption process is weak given the infrequent and one-way communication trend among the key players.

Figures 3-8 show the detailed farmer-farmer diffusion pathways of GSR in each town which was generated using the social network visualization tool Gephi. All respondents from each town were asked to identify the first-degree participants they exchanged information with who then were asked the possible second and third-degree participants. As explained in the methodology, there were only two second-degree participants who qualified in the study upon verification as the other individuals identified could not remember receiving a GSR variety

or information. As such, the gray ones in the diffusion pathways were verified to be unqualified second-degree respondents or are referred to as *overflows* while the red ones are the qualified second-degree respondents who turned out to be non-adopters. The light pink circles represent the first-degree non-adopters. All yellow circles represent the first-degree adopters.

The lines represent the type of resource shared: blue for information only and pink for both information and seed shared. The lines with arrowheads denote one-way communication with the end as receiver while those with no arrowheads refer to two-way communication. Circles that are larger than others are influencers with whom other adopters communicated with during the GSR adoption process.

It was observed that *barangays* with a dense pool of respondents, such as in Figures 3 and 6, have more interactions. The exact opposite is observed in minimal pool of respondents as evidenced in Figures 4, 5, and 7 which had three original adopters. Figure 8, on the other hand, more or less represents the middle ground with seven original adopters. Just like the dense networks in Figures 3 and 6, Figure 8 also shows similar activity in terms of communication among the respondents. It should be noted, however, that for Figures 3, 6, and 8, most of the interactions were among the research participants themselves and only about information regarding GSR performance in their fields. There are farmers who have stronger ties than others.

Figures 3 to 8 show that there is very little sharing of seeds or information outside the original users of the GSR seeds. In fact, in Figure 6, the non-adopters were the ones who shared seeds with the original GSR adopter. This implies that even if they have heard of the GSR seed varieties, these non-adopters did not seek out the varieties and even shared their own varieties to an already GSR adopter.

While the study of Nakano et al. (2018) showed that adoption of rice seeds among farmers with no training programs attended were diffused to close kins and took longer than those farmers who attended the training programs related to the varieties being promoted, it appeared that farmer-to-farmer diffusion was possible, albeit slower than those who attended training programs. However, this was not the case for the 100 Farmers Project where farmers desired additional information from IRRI and the extension workers.

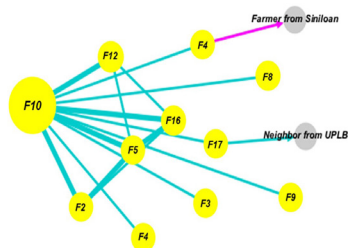


Figure 3. Diffusion pathway of GSR varieties in Brgy. Nanguma, Mabitac, Laguna

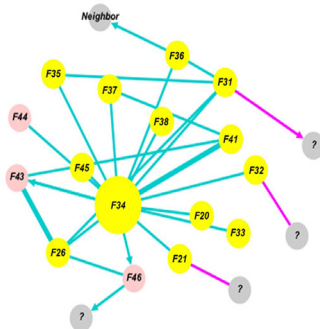


Figure 6. Diffusion pathway of GSR varieties in Brgy. Coralan, Sta. Maria, Laguna

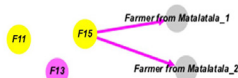


Figure 4. Diffusion pathway of GSR varieties in Brgy. Matalatala, Mabitac, Laguna



Figure 7. Diffusion pathway of GSR varieties in Brgy. Bagumbayan, Sta. Maria, Laguna

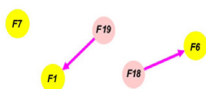


Figure 5. Diffusion pathway of GSR varieties in Brgy. Paagahan, Mabitac, Laguna

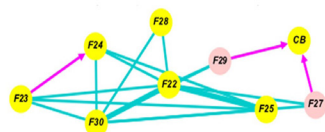


Figure 8. Diffusion pathway of GSR varieties in Brgy. Cambuja, Sta. Maria, Laguna

Note:

- 1ST DEGREE ADOPTERS
- 1ST DEGREE NON-ADOPTERS
- 2ND DEGREE RESPONDENTS
- OVERFLOW
- INFORMATION SENT/EXCHANGE
- SEED SENT/EXCHANGE

In Figures 3 and 6, two first-degree respondents were identified as *stars* from among the group of farmers based on the number of respondents who have interacted with them during the course of GSR adoption. In Figure 3, F10 was identified as a star because of his many years of experience in farming. His family is active in rice farming (i.e., all of his children and sons-in-law are involved in rice farming) and is well known in the community. He is considered a father by many and was called *father*, which makes his opinions considerably important. In Figure 6, F34 is considered a star because he is a volunteer of the MAO and has positions in several farmers' organizations. His clout and number of networks involved made him a popular source of information in the community. He was always tapped by the MAO of Sta. Maria to coordinate with and inform farmers in their *barangay* of seminars, training programs, and other agriculture-related activities because of his position. Because of his multiple roles, F34 could also be considered as a liaison between his co-farmers and institutions like the MAO. In Gladwell's (2000) the Law of Few, F10 and F34 can be identified as the connectors in the community because of their reach and connections.

Informal social relations and interpersonal interactions are screened through perceived credibility and trust (Sligo & Massey, 2007). According to F43, they adopt a technology right away when a trusted farmer in their area tests an innovation and proves it effective. The adopter's actual experiences serve as the stimuli for potential adopters to respond, i.e., to adopt or not to adopt. This also convinces their co-adopters to continue or discontinue adoption. It is important for farmers to observe the performance of an innovation firsthand from their peers rather than just listen to talks about its potential benefits and advantages. They also trust their peers with whom they share a common field of experience with, i.e., GSR adoption. The sharing of positive experiences by farmers was expected by IRRI to lead to the adoption and diffusion as explained by Ryan and Gross (1943). In addition, the Social Contagion Theory posits that good technologies can spread very quickly, like a contagious disease, if shared by farmers. However, the limited sharing constrained the diffusion of the use of GSR seeds, much less widespread adoption.

In the case of the isolates or respondents who did not interact with anybody, mostly evident in Figures 4, 5, and 8, these respondents show during the interviews that they do attend training programs on new technologies. However, as they were unsure of the performance of GSR varieties, they decided not to exert effort to share them with others. They also believed that if the performance of their crop is good, their neighbors will actively seek information from them.

The interviews imply that farmers actively take interest in other farmers' practice when they see there is something good happening in the other farmer's plot (Oreszczyn et al., 2010). However, the isolates counter that the other GSR recipients were far from their farms, and they had no formal means to communicate about their experience.

In terms of diffusion, very few shared information outside of their circles. Only two respondents, who turned out to be non-adopters, received information and seeds. This contradicts the assumption that *diffusion works while you sleep*.

Structure-wise, no external networks are linked within the actors and no clusters (or *barangays*) had overlapping connections or interactions. Not only did GSR information and seeds stayed within the overall circle of the 100 Farmers Project participants in Mabitac and Sta. Maria, Laguna, they also stayed within the circles of each *barangay* respondents. The research participants mainly discussed and diffused information about the GSR seed varieties with people whom they have a common field of experience. This type of social learning was only confined to those who had initial access to the new technology, and did not scale out to those who might have the opportunity to test it. According to Minas (2015), this is called the social circle typology of social learning where training participants only share and receive information with their co-participants. In this case, only those who adopted and were exposed to GSR reached out to those who are in the same situation as them.

The poor diffusion rate represents the problems related to the promotion of a new technology. New technologies that are seen as promising are normally expected to reveal high initial uptake and assumed to diffuse within the community through farmer-to-farmer exchanges. The results show that deeper problems regarding the adoption and diffusion processes may have hampered the uptake.

Problems in the Adoption and Diffusion Process

One of Rogers' (2003) innovation characteristics is relative advantage or when the new technology supersedes and provides more advantages than the old one in terms of economic and social factors, ease of use, and overall satisfaction to the new technology. According to the adopters, the GSR varieties that they planted taste and smell good, and produce good yield. A third of the adopters were impressed with the turnout of the yield for the first planting season. Farmers prefer rice varieties that are high-yielding and have good grain quality (Rodondo et al., 2007; Laborte et al., 2015).

A number of respondents said that one benefit of GSR adoption is that the seeds were provided free of charge, which also meant that they had the opportunity to test a new variety. The respondents said that the fact that GSR was given by a distinguished international organization was a positive start. However, the positive factors were inadequate for the farmers to continue adopting the GSR varieties and were not enough reason for it to be diffused. Apparently, lack of understanding and negative experiences outweighed its potential.

Lack of Understanding of the Technology. Based on interviews, farmers said that nobody returned to discuss GSR with them after the initial distribution. Despite the fact that the seeds were inbred, farmers did not seem to understand that they can use the harvested grains for planting in the next season. For respondents who were satisfied with GSR, they also shifted to a different variety after one or two planting seasons because the providing institution did not return to give more seeds and they do not know where to look for a supply of the seeds.

"They did not provide seeds anymore that is why we did not plant it again." – F2, 56, *Mabitac, Laguna*

"No one provided seeds again and no one tried it again." – F12, 63, *Mabitac, Laguna*

Khandker and Thakurata (2018) aver that good demand for hybrid seeds being promoted encourages adoption. In this case, farmers did not see using or demanding GSR seeds, and thus, could have led them to try other seeds that are currently used by most farmers they know:

"I looked for the seeds in stores, but they say they are not available anymore. I could not find it." – F3, 56, *Mabitac, Laguna*

Lack of Institutional Follow-up. For farmers to continue adoption, technical support should be provided (Abdollahzadeh et al., 2017). However, this was not the case for GSR varieties as there was no support from IRRI after the distribution of seeds nor was there continued technical support nor clarification from the local government units.

"IRRI did not provide seeds anymore." – F36, 61, *Sta. Maria, Laguna*

"I did not plant again. I waited for the people who provided the seeds so I can show them how it performed in my field but they did not come back." – F37, 68, *Sta. Maria, Laguna*

To facilitate the adoption diffusion process, it is important for institutions who can provide information and support to shift their practices (Roling, 1990, as cited in Carrasco, 2001). Chandio and Yuansheng (2018) affirmed that contact with extension workers significantly and positively influence the adoption of improved rice varieties. Mesfin and Zemedu (2018) established that the nearness of extension office, which implies access to support and information, affects adoption of seed varieties.

Those who initially adopted reversed their decision during the confirmation stage when they were *seeking for reinforcements* whether they made the right decision. Considering that more negative experiences emerged, this eventually led to the discontinuance of GSR adoption after two planting seasons.

Negative Experiences. While adopters recognize GSR's good qualities, bad qualities were also enumerated, such as it is susceptible to pests and diseases (e.g., rats and tungro), low yield, and is incompatible with the land they were planted in. Because IRRI is a leading institution in rice research, they expected that GSR would perform well. A research participant shared that other farmers lost interest when they found the poor viability of the seeds. He also said that because of this, he and his neighbors are now cautious of receiving technologies from the institution because of this negative experience with GSR.

"They gave it during the wet season that is why we were unable to fully take care of it. The timing was not right." – F6, 58, *Mabitac, Laguna*

Another participant echoed this sentiment, and said that if the variety performed well, the news would also spread and more farmers would have planted it.

Susceptibility to Diseases. Disappointed respondents were more vocal with their negative experience as they go into detail at the start of the interview with how GSR performed poorly in their field. Pest and disease infestation, particularly rodents and tungro, was the major issue reported. When asked if they planted GSR, the variety that was provided to them by IRRI in 2012, the responses include:

"The two kilos of seeds given? I was not able to harvest any. It was infested by tungro." – F12, 63, *Mabitac, Laguna*

"The yield was low and it required high maintenance. It has a good aroma that is why rats are attracted to it. Plus, the fact that it was given during the wet season [when palay is more susceptible to pests and diseases] did not help." – F22, 56, Sta. Maria, Laguna

The respondents acknowledged the potential of GSR. However, they felt that they cannot afford to risk another trial for a different planting season, as it will incur additional expenses if it does not work. There is still uncertainty that the variety given to them will do well in the dry season and be profitable in the long term. Kondouri et al. (2006) identified that farmers' access to information about new technology is significant to help them to be less risk-averse and worry about future profitability.

In the adoption and uptake pathways of biotech corn, the roles of farmers in their respective local communities were highlighted especially if the providing institution is an external party. Farmers served as the ultimate disseminators of information as well as *local ambassadors* to attest to the benefits of the technology (Torres et al., 2013).

Only a few GSR adopters did well, making them special cases rather than the norm. Hence, there were more negative news that spread compared to good ones, which typifies the flip side of the Social Contagion Theory. What quickly spread were the negative experiences relative to GSR seeds.

CONCLUSION AND RECOMMENDATIONS

Overall, the diffusion pathways of GSR among the networks of respondents from Mabitac and Sta. Maria were contained in their circles. During GSR adoption decision, they communicated mostly with their peers who were also planting GSR or with whom they share a common field of experience. Research participants interacted or shared GSR information with their neighbors. Because of their familiarity with one another, sharing new technologies was seamless, which is an important feature in strengthening ties among farmers in a network of practice.

For farmers outside of the project, the negative experiences outshone the positive. As there were only few positive comments, and those with negative experiences were more vocal, the positive experiences were considered isolated cases, rather than the norm.

Using the Social Contagion Theory, it can be said that GSR diffusion did not *cross the threshold* to the point that the innovation *spread like wildfire*. What spread were the negative experiences, and these, in turn, created the stimuli for the research participants to discontinue adoption. The GSR varieties were distributed during the wet season where more challenges in rice production occur. While messaging proved influential in the initial orientation about GSR, observed actual experiences (power of context) outweigh message content or referred to as the stickiness factor. The stickiness factor of information about GSR is largely contributed by IRRI, which is considered a credible and respected institution by rice farmers. The respondents also have no peers within their circles who acted as salespeople to persuade them to continue adoption. Consequently, the initial adoption resulted in the discontinuance after two planting seasons.

The respondents exhibited a typology of social learning identified by Minas (2015), which is contained within a social circle where participants in training programs only share and receive information with their co-participants. In general, GSR information and seeds stayed within the circles of the first-degree farmers and did not spread outside the circle. Furthermore, even though some research participants said that an individual or institution influenced them in their decisions, the farmers ultimately made an individual innovation-decision. In the absence of a well-structured and dense social network necessary to influence community-based decision-making, the respondents individually discontinued adoption of GSR. Their experiences and observations served as disincentives to adoption.

Adoption decision does not happen in a vacuum. As respondents engage in discussions, they alter initial negative impressions and, thus, may lead to adoption. However, the dissemination process of GSR did not include close interaction and relationship-building with the farmers, as the seeds were only distributed. The resulting social network analysis revealed that information was only shared mostly among those who received free GSR seeds, and only during the trial period. Worse, GSR's performance as reported by the research participants in the same community was inconsistent. The negative feedback overpowered the positive experiences, making the former the norm and the latter, special cases. The lack of extension system to support adoption and diffusion worsened the situation. No follow ups were done by either the international or the local agriculture office. As such, the uptake pathway revealed only two adopters from the original 44 recipients of free GSR seeds. After two planting seasons, all adopters discontinued using the GSR varieties.

Clearly, access to feedback is crucial in communicating innovations to farmers. Details on the follow-through and access, such as contact information, where they can avail of the product, are equally important as the new technology's benefits. It is important that farmers are aware that feedback channels are easily accessible. This is clearly a policy issue where institutional support to any intervention is necessary. Further, coordination with local government units in distributing and promoting new varieties is essential to better monitor farmer feedback and coordination among all actors involved in the extension process. This also provides farmers with easy access to information and technical support. Institutions may consider working with associations for easy distribution, monitoring, and evaluation. Likewise, executing a memorandum of agreement with institutions will identify responsibilities, which can lead to better project implementation.

Diffusion and adoption did not happen as expected based on the Diffusion of Innovations Theory. The results imply that new technologies should be introduced in dense communities or through farmers' organizations where regular meetings are organized so that farmers can talk about their experiences about technologies. Technology introduction should be accompanied with facilitated meetings to ensure that farmers are able to share information and get additional relevant information from technical people. It is, likewise, important to identify *stars* and make them part of the original users of technology as they can be credible sources of knowledge for a larger group of community members. Community seed banking can also be promoted to ensure that good seeds can be accessible in the next planting season.

As with other varieties, GSR varieties are imperfect. Nevertheless, trials conducted in different countries have proven that these are inbred climate-resilient varieties. The failure of the adoption process highlighted mostly the weaknesses of the diffusion process as the technology was distributed during the wet season when pests and disease abound. The social network analysis and the resulting diffusion pathway analysis clearly show the importance of right timing in the distribution of a technology, a key consideration in distributing a technology in a dense population where social learning is supported by technical experts whose main task is to facilitate a positive experience.

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