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Innovation Diffusion of New Technologies in the Malaysian Paddy Fertilizer Industry

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Abstract

There are a number of players in the domain of agriculture playing different roles as key stakeholders with different level of involvement and influence. Government agencies, agri-entrepreneurs and individual farmers are amongst those who play significant roles in ensuring sufficient food supply for the nation. The agriculture sector contributes significantly to the economic growth in Malaysia and in ensuring food security in the country. The recent occurrence of staple food crisis affecting many countries became severe when India, Vietnam and China had limited the exporting of rice to other countries. The overall development of paddy sector under the agricultural framework initiatives are carefully planned and implemented in the recent Economic Transformation Program (ETP). The aim of the initiatives is not only to ensure national food security but also to tap into the global market as the world population continues to grow driving for an increase in the demand. One of the quick win initiatives by the government in overcoming the crisis is to increase the soil fertility for paddy planting which requires promotion of new technology and rigorous research. The paper critically discusses innovation diffusion in the agricultural context with specific reference on the analysis of how innovation is diffused, its communication channels, and the dissemination movement. Preliminary findings of farmers' experience on innovation diffusion process shall be discussed in this paper. Farmers at the granary area in Perak, under Integrated Agriculture Development Agency (IADA), had taken part in the study. The results indicate the level of farmers' knowledge and information about fertilizer in general, management of the innovation dissemination process, and the extent of readiness in realizing innovations.

Keywords: Innovation Difussion, Paddy Fertilizer, Communication

1. Introduction

Many technologists believe innovations that benefit the communities could readily be accepted and easily diffused amongst relevant stakeholders. However this is often not the case as innovations, even though with obvious benefits, can be diffused at an unexpectedly low rate (Rogers, 2003). Constructive communications between technology developers and potential adopters are hence essential to examine market prospects.

An Innovation is an idea, practice, or object that is new to individuals or organizations. Innovations are mostly meant to improve and promote the quality of processes or products. Implementation of innovations is however always portrayed as a challenging task. Innovation diffusion is a process where newly developed technologies or innovations are communicated to stakeholders through different channels of communication. The communication

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strategies for such purpose are often tailored and the messages are designed for new technologies or new ideas or new products. Diffusion hence refers to a communication process where "the participants create and share information with one another to reach a mutual understanding" (Rogers, 2003:5). Following Rogers (2003), the word technology and innovation shall be treated as synonymous in this paper where technology is seen as "a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (p.31). The newness of technology or process or idea would give unique characteristics to the approach in communications which are related to three stages – knowledge, persuasion and decision in decision-making process for innovation adoption. The communication process involves a certain level of uncertainty which could be reduced through provision of sufficient information.

The food crisis had made innovations in the paddy industry crucial for survival. There was an occurrence of crisis on staple food supply in many countries which became severe when India, Vietnam and China had limited the exporting of rice to other countries. The high demand for food led to an increase in food prices. The price of rice recorded 100% increase which had affected especially the poor. Even though there is vast land area in Malaysia that is cultivated for paddy plantation, where there are 204,297 hectare of granary areas and 284,145 hectare outside the granary areas providing 86% of rice supply to Malaysia, the balance of the rice supply is imported from Thailand, Vietnam, Pakistan and China. The crisis was due to several reasons which include climate change (e.g. extreme climate in South China), insufficient cultivation area for paddy planting due to infrastructure development, limited supply and higher demand of rice. The crisis brought to the fore-front the critical need to ensure food security through expansion of food production. In the third National Agricultural Policies (1998-2010), the strategies for policy thrust and implementation emphasizes several items including food security. One of the quick win initiatives by the government in overcoming the crisis is to increase the soil fertility for paddy planting which requires promotion of new technology and rigorous research. The paddy sub-sector specifically, under the broad agriculture sector in Malaysia, has been selected as one of the sub-sectors to be developed under the Agriculture NKEA in the recent Economic Transformation Program (ETP). The aim is not only to ensure national food security but also to tap into the global market as the world population continues to grow leading to an increase in the demand.

Through ETP, the Government has listed scaling up and strengthening productivity of paddy farming to increase national self sufficiency and reduce dependency on subsidies. The need for new innovations in the fertilizer technologies hence increases. A transformation is envisioned to move the industry from production-centric to meeting market demands which encourages the transformation from low value to higher value products that require innovations and technology adoption (Economic Transformation Program: A Roadmap for Malaysia, p.525). In intensifying the adoption of technologies across the value chain, the R&D activities shall be rigorous including innovations on the use of microbes to enhance soil fertility, and nano fertilizers to improve absorption of nutrients (p.539).

Straight fertilizer was used in the earlier days of farming in which it only contains only one type of fertilizer such as nitrogen. Compound fertilizer has been widely used in the industry today that contains the essential nutrients for the plants to grow. The compound fertilizer used to be in the form of powder which was not easy to manage as it is prone to mix with moisture that consequently hardens the texture of the fertilizer. Most of the fertilizer used today is however in granular form which is easier to manage and be administered by the farmers. New development in the fertilizer industry introduced controlled release technique that allows nutrients to be released on a timely basis according to the needs of the plant for its growth. This would allow for only one time application which could be economical to the farmers. The latest development in the fertilizer technology also includes 'Precision Farming' that uses 7R approach, among which include The Right Place, the Right Fertilizer, and The Right Timing. In order for it to be right is highly dependent on the economic capability of the country and its human resources. Lack of efficiency in the fertilizer may cause low yield which could be caused by various reasons. Inefficiency of fertilizer includes untimely release of the nutrient that does not meet the need by the plants – either too late or earlier than needed. Small amount of nutrients contained in the fertilizer that does not match the actual need by the plants.

Fertilizer is a necessity for the growth of paddy in Malaysia due to several reasons. The intensive paddy planting which is two seasons per year requires the use of fertilizer to ensure fertility of the soil. The use of a variety of paddy that is highly responsive to fertilizer also encourages the use of fertilizer. The soil that has long been cultivated for paddy planting requires sufficient nutrients for continuous high yield. The nutrients in the soil that have been usurped need replacement to continue providing sufficient nutrients for the subsequent planting seasons.

There has also been emphasis on environmentally friendly technology however application of new and green technology poses some challenges, with its high cost as its main concern. Green technology could be very costly and may cause hesitance for purchase by the consumers. The hesitance in purchasing fertilizer with green technology is highly relevant to the mentality and attitude towards the environment. The more developed countries are very much aware about the importance of using green technology in sustaining the world.

As technology is meant to be implemented within communities, studies in understanding the livelihood of the people is hence imperative to understand the potential end-users of the technology adopters. The International Fertilizer Industry (1999) asserts the importance of involvement of the farmers in new technology development which could accelerate adoption of improved or new technologies. The objective of this paper is to critically discuss innovation diffusion of new technologies amongst farmers and gauge the extent of their awareness on improved technologies and innovations in the Malaysian paddy fertilizer.

2. Background – Innovation Diffusion and Technology Dissemination in Malaysia

Department of Agriculture (DOA) was established in 1905 where the emphasis revolved around crop research, equipping the farmers with technical skills, and business development for farmers. In 1974, departments of agriculture were set up in each state of the country with their core function to conduct development programs especially for small-scale farmers. Various government agencies had been set up to facilitate the growth and advancement of the agriculture sector including Malaysia Agriculture Research and Development Institute (MARDI) in 1970 with the main function to develop cutting edge technologies for rapid growth in the agricultural sector. Besides providing technological support, MARDI plays an important role in Transfer of Technology (TOT). Hence the strategic mission of MARDI is to support the agriculture sector by developing and promoting newly improved technologies to increase productivity, efficiency and competitiveness (www.mardi.gov.my/). Research officers employed by MARDI, are to carry out activities for transferring of technologies. In intensifying the effort, the DOA provides agricultural extension services to the farmers to disseminate improved technology and new innovations to the farmers. Technology dissemination is done through various communication channels using the local language. Website is one of the main channels to disseminate information to the farmers. One of the strategic initiatives by the government to reach out to the farmers is through establishment of National Information Technology Agenda (NITA) in 1996. The framework developed had incorporated efforts for internet penetration into the rural areas where a large number of farmers reside.

Agriculture sector received a stronger boost through the Ninth Malaysia Plan (2006-2010) with an emphasis on "New Agriculture". Amongst its new focus areas were large-scale commercial farming, application of modern technologies, and advancement of biotechnologies which all require greater extension services to reach out to the farmers. MARDI is then expected to disseminate the results of research and development work in a more rigorous manner. The diffusion of improved technological advancements or newly developed innovations should effectively result in adoption of the innovation. Adoption of improved technology vitally requires sufficient information relayed to the farmers (Jamsari *et al.*, 2012) as knowledge and its accumulation could be a foundation to people's perception (D'Silva, 2011) and one of the important factors for decision-making. Another initiative was taken up in order to shoulder the extension responsibility especially for knowledge dissemination when a center was established in 2006 named Center for Extension, entrepreneurship and Professional Development (APEEC). Its major roles include contributing toward effective process of technology transfer in agriculture, functioning as an enabler in

agricultural extension and consulting agency and as a referral centre for agricultural extension, entrepreneurship and lifelong learning, at national and international levels.

The diffusion of innovation in the Malaysian Fertilizer Industry can be described as an example of the classical centralized diffusion model where diffusion spreads and moves outward from a center to users (Dearing, 2008). The process of dissemination, training, and provision of resources and incentives (Schon, 1971) is typically centrally managed and in the case of agriculture in Malaysia, the processes are managed by the Ministry of Agriculture and its agencies like MARDI through its appointed Extension Officers. The function of these extension officers include to increase farm productivity through effective technology transfer and research findings; to effect attitudinal change amongst farmers to be responsive to new technology and participate actively in agricultural development; and to increase the contribution of the agricultural sector to national economy through the promotion and development of specific crops (Mohd Samsudin, 2012)

3. Literature Review

Discussions on the process of new technologies adoption has been studied for more than 30 years (Sahin, 2006). The theory of innovation diffusion was originally developed due to concerns on how innovations spread throughout the communities. Diffusion can be seen as the process which an innovation is communicated through certain communication channels over a certain period of time among the members of a social network (Rogers, 2003) that could be individuals, companies or governments. Innovations may include technologies, processes or ideas perceived as new in the community. For example a new innovation maybe a new type of fertilizer for adoption which can increase the yield of the crops in the future. The theory was also applied to describe observed past occurrences of the diffusion of specific innovations to serve as a foundation for decision-making on policies by the government, organizations and communities for planning of future technology transitions (Stoneman and Diederen, 1994 cited in Kasmire, Dijkema and Nikolic, 2010). An Innovation is said to be have a successful diffusion when the spreading is like a virus which begins with a persuasion to a group of individuals on the advantages of the innovation. This is followed by adoption of the innovation by the individuals, implementation of the innovations and finally confirmation. Communications are imperative in innovation diffusion to determine its success, which may involve the use of mass media or interpersonal communication channels. With the rapid development in the information technologies, for example the internet, smart hand phones, and the use of social networking tool like Facebook, diffusion can be both at the interpersonal level and mass media levels. Communications allow the information about the innovation to spread (Kasmire, Dijkema and Nikolic, 2010) allowing diffusion to take place throughout the target communities. Hence identification and strengthening of communicative networks are essential to drive the spreading of information.

However, technologies and industries can be more complex and requires more than just diffusion as it needs evolution in its adaptive system (Kasmire *et al.*, 2011). Rogers (2003), whose adoption models is one of the most referred to in the literature of innovation diffusion, outlines four main elements in the diffusion of innovations which are the innovation, communication channels, time and the social system. Rogers describes innovation "as an idea, practice, or project that is perceived as new by an individual or other unit of adoption (p.12). One of the obstacles to adoption of innovations is uncertainty. To reduce the risk of rejection due to uncertainty, stakeholders should be well-informed through appropriate channels. Communication is a "process in which participants create and share information with one another in order to reach a mutual understanding" (p.5). The communication channels are the means for the messages to reach the target recipients. As diffusion is a highly social process, interpersonal communication relationships and communication channels can be most influential for acceptance (cited in Sahin, 2006). Rogers (2003) asserts that time however is very important in innovation however its importance has been downplayed in many behavioral studies. As innovations are diffused within a community, the social system is one of the elements in the innovation diffusion.

Zhou *et al*. (2010) had conducted a study to investigate factors affecting farmers' decision on fertilizers use in Northern China. Three hundred and forty nine farmers were involved in the study. The results indicate that

irrigations, gains in crop yield and higher earning goals are correlated with fertilizer use intensity. There has been many studies reported in the literature that decisions on fertilizer usage is based on marketing, agro-climatic conditions or utility maximization, however it is also essential to examine other factors influencing decisions for example perceptions of the farmers.

4. Methodology

The study discussed in this paper is a part of a bigger scale study which includes many other relevant dimensions in development of new technology including economic impact, sociological analysis, market trend, demand factors, willingness to pay and stakeholder communications. This paper however limits its discussion within the scope of communications in diffusion of innovations which the aim is to gauge the extent of farmers' awareness on improved technologies and innovations in the Malaysian paddy fertilizer.

The preliminary study had adopted a quantitative research design where questionnaire was developed as an instrument for the data collection. The first section of the questionnaire is the demographic items which were basically to understand the respondents and background of the respondents which is statistically necessary (Pallant, 2001). The other three dimensions include Knowledge and Information which entails 11 items, followed by the Management and Innovation dimension consisting of 4 items, the Level of Acceptance of New Productwith 9items while the last dimension of the questionnaire was structured for the farmers to list their observation about the innovation of new farming technologies particularly fertilizer.

The study employed a convenient sampling method as it is a common practice that a preliminary study of this kind may adopt a minimal sample method (Sekeran, 2009). Sixty (60) respondents were selected from the population. The scientific priority of any kind of sample method adopted in any social science research is justified by the level which the method can prove the representativeness of the larger population (Babbie, 2010). Abiding to this, the sample selections were strictly based on the officers' suggestions at the Integrated Agriculture Development Agency (IADA). IADA is a statutory body assigned by MOA as a representative body for regulations and assistantship to the paddy farmers. The obligation of IADA is to manage the whole plantation of paddy, such as when and how to harvest, and providing the necessary and sufficient mechanism for the harvest of paddy. This study was conducted in Perak State, the IADA Perak branch guided the suggestion of the sampling location and selection of respondents for this study represented two zones in IADA – Kerian Laut and Kerian Darat.

IADA is one of the granary areas for paddy plantation under Northern Corridor Economy Region (NCER), where one of the objectives is to make two third of the community within this region to be involved in paddy plantation. Granary Areas refer to major irrigation schemes (areas greater than 4,000 hectares) and recognized by the Government in the National Agricultural Policy as the main paddy producing areas. There are eight Granary Areas in Malaysia, namely Muda Agricultural Development Authority (MADA); Kemubu Agricultural Development Authority (KADA); Kerian-Sungai Manik Integrated Agriculture Development Area; Barat Laut Selangor Integrated Agriculture Development Area; Seberang Perak Integrated Agriculture Development Area; Penang Integrated Agriculture Development Area; North Terengganu Integrated Agriculture Development (KETARA) and Integrated Agriculture Development Kemasin Semerak (Malaysia Economic Statistic 2011, pp. 100,). Out of the total 800,000 hectares of prime agricultural areas, almost 42% is used for paddy. Perak is one of the states that covers a relatively large paddy area (NCER Report, 2011, pp. 21). Statistics in 2011/2012 by Jabatan Pertanian Perak shows that Perak has 43 276 hectare of paddy area with 34 826 hectar granary area. Perak has three granary areas which are Kerian, Hilir Perak and Perak Tengah. Kerian has the biggest granary area in Perak with 20 953 hectar, in which the study was conducted.

5. Results and Discussion

The instrument was tested for its internal consistency and the validation of the questionnaire discloses convenient Cronbach Alpha values (see Table 1), which are acceptably high in social science studies requiring minimum alpha value of 0.6 (Pallant, 2001). The fourth dimension in the instrument is subjective in nature hence the Cronbach Alpha was not computed.

Table 1 Reliability Coefficient of the Instrument

Dimensions	Reliability Coefficient (α)
Information and Knowledge	0.79
Innovations Diffusion Management	0.76
Acceptance of Innovations	0.71

The respondents were mostly male farmers (74%) who are very likely the bread-winners to their families. A large number of the farmers (75%) operate on sole proprietorship, while the other 24% farmers operate mini estate farming, under the agricultural institution of IADA. The respondents are from two locations which are BaganTiang (41%) and Beriah (59%). Most of the farmers are amongst the elderly where majority (61%) of the farmers in this study is 50 years of age and above. A handful of these farmers (48%) either have no educational background or received education only at the elementary school education level, while the remaining 51% hold a secondary school certificate or above. 84% take farming as their main business and 16% farmers use farming as their supplemental business. The respondents who take farming as their main business were further asked if they have other side businesses. 53% claim to have no any other businessesbesides paddy plantation, 2% of the farmers claim to be businessman, another 2% of the farmers are carpenters, another 2% are fisherman, 16% work on other agricultural businesses and 24% farmers work on other activities to earn income. When farmers are engaged in many other activities besides paddy cultivation, it implies that they have other sources of income. The social structure and socio-economic background are significant influential determinants in allowing access to information. Farmers with higher socioeconomic status may have more opportunities to communication channels and latest information on new agricultural technologies.

Under the dimension of knowledge and information about innovations of fertilizers, it can be deduced from the descriptive analysis (see Table 2) that most of the respondents are not well informed about new innovations of fertilizers and have little knowledge about new agricultural innovations. More knowledge and better access to information about fertilizers is however essential as the level of knowledge significantly influences decisions on fertilizer use (Zhou, 2010).

Table 2: Dimension 1 Knowledge and Information about Fertilizer Technology

Dimensions	Mean	Std. Dev.
I receive information about various new fertilizer products and technology introduced for paddy	2.67	.786
I have been informed by related agricultural institutions on the types of new fertilizer for paddy	2.60	.780
I have been frequently informed about latest developments in fertilizer technology relevant to paddy cultivation	2.81	.932
I seek information on new fertilizer and innovations for paddy plantation	3.07	.863
I have sufficient knowledge about the best types of fertilizer to use for plantations	2.72	.807

I am knowledgeable and well informed about the proper usage and amount of fertilizer	2.87	.687
I am well informed of the types of fertilizer suitable for the soil in my paddy plantation	2.93	.712
I am influenced by other farmers on the usage of fertilizer	2.93	.611
Information on new types of fertilizers in the market is beneficial to me	2.89	.674
I often share information about the fertilizer that I use and its effectiveness with my friends	3.04	.515
Total mean score	2.75	

1 – Strongly Disagree to 4 – Strongly Agree

The farmers are however eager to obtain information about new fertilizers available in the market and new technology developments in the paddy fertilizer industry (3.07). This indicates that the farmers put an effort in obtaining information about technological innovations but have not received sufficient information from relevant sources, such as the IADA, the fertilizers sales companies and the producers on the new innovations on fertilizers. From the demography analysis, only 57% farmers claim to have attended a course about paddy plantation and 43% farmers among the respondents have not by any chance attended a paddy plantation course. The International Fertilizer Industry Association (1999), strongly suggest that manufacturers play a more significant role in promoting fertilizers. Farmers in France for example, receive 70% of advice from the distribution sector. Hence, the private sector can play a very important role in extension services to the farmers.

The findings from the second dimension, Management of Innovation Diffusion dimension, (where the total mean score is 2.72) indicate that there is a need for improvement in managing the information on new technology development and innovations. The farmers feel that the related government agencies and institutions are not concerned with their views on fertilizer technology and innovations (2.58). Similarly, the fertilizer producers have not sufficiently asked the opinions and needs of the farmers in producing new technologies (2.42). The farmers feel that it would be beneficial if the farmers' views are solicited to improve the efficiency and effectiveness of the fertilizer (3.09) and most are willing to share their experience in the usage of fertilizer (2.89). As majority of the farmers in the study are above 50 years old (61%), these farmers relatively have vast experience in paddy cultivation where 24% with more than 36 years of experience, 15% between 21-30 years, 26% between 11 to 20 years of experience. Hence, their experience and knowledge could be beneficial in research and development in improving the efficiency and effectiveness of the fertilizer. Zhou (2010) similarly found that majority of farmers in the Northern China regard their experience is highly important influencing their decision in fertilizer use. The farmers should be given the opportunity to express their ideas and views through proper channels. As propagated by Salawu and Abu Bakar (2008), a better decision would be made if the voice of the majority is heard instead of decisions made solely based on outsiders' views.

The findings are however related to the way diffusion of innovation in the Malaysian Fertilizer Industry is carried out. The overall process is a classical example of centralized diffusion model where diffusion spreads and moves outward from a center to users. The process of dissemination, training, and provision of resources and incentives is typically centrally managed and in the case of agriculture in Malaysia, the processes are managed by the Ministry of Agriculture through its appointed Extension Officers. The DOA extension service has three main objectives which are: to increase farm productivity through effective technology transfer and research findings; to effect attitudinal change amongst farmers to be responsive to new technology and participate actively in agricultural development; and to increase the contribution of the agricultural sector to national economy through the promotion and development of specific crops (Mohd Samsudin, 2012). The extension programs include technology transfer activities from research activities to extension agencies, farmers and investors. However there is a need to strengthen the role and function of the extension officers in Malaysia as the descriptive findings indicate that majority of the farmers are heavily influenced by their fellow friends rather than the official officers. The findings reveal that 76% of the farmers receive most information about new fertilizers informally from their friends. Only 14% percent are informed by agricultural institutions and the remaining farmers are either informed by the fertilizer producers (4.7%), fertilizer sales companies (1%) or agricultural officers (2.3%). Oyaro (2008) asserts that the extension officers are the connector between the researchers in Research and Development (R&D) and the farmers. On a

similar ground, Ramaru *et al*. (2009) argue that the extension officers will be able to be effective if sufficient exposure to scientific knowledge, new products and technology development are given.

The role of extension officers is pertinent to help the farmers especially in technology transfer supporting services including fertilizer application. In penetrating the global market for example, it is highly essential to comply with international standards such as Global Good Agriculture Practices (GAP) that require pesticides and fertilizers are free from harmful chemicals. Sufficient information needs to be relayed to the farmers on the importance of selecting high quality fertilizer for higher yield and to maintain the nutrients in the soil for a longer period of time. The extension officers however need to realize their important role in helping the farmers make decisions. Khalil *et al*. (2008), for example emphasize on the importance of leadership, competencies and commitment that extension officers need to poses. Their findings suggest that the Ministry of Agriculture should incorporate leadership characteristics besides competencies to increase organizational commitment and at the same time farmers' productivity. Continuous assessments need to be conducted to gauge the impact of agriculture extension on production and adoption rate of new technology disseminated by the extension officers (Dinar *et al*., 2007).

Despite the limited information obtained from official sources and the limited opportunities to express their views and share their experience, the level of the farmers' acceptance of new product and technology is very encouraging (see Table 3). The farmers are open and ready for new innovations in paddy cultivation as majority believe in the benefits of new innovations on the increment in yield (3.25). They are open in trying out new products as agricultural institutions do not discourage them in doing so nor are they obliged to wait for directives from the relevant government institutions. Paddy farmers in Malaysia are fortunate as subsidy is given by the government for a number of other facilities and items including the fertilizer. The subsidy is given as a form of encouragement to these farmers to continue their farming activities. However the findings of this study indicate that the farmers are willing to adopt new fertilizer if believed that it could help enhance productivity. Majority are also willing to adopt environmentally friendly innovations (3.33) and are willing to try using fertilizer that enhance the growth rate of paddy plants (3.44).

Table 3: Dimension 3 Willingness to Accept New Fertilizer Products

Dimensions	Mean	Std. Dev.
I am ready to use new fertilizer introduced by producers if I am convinced of its effectiveness.	3.11	.573
Agricultural Institutions do not encourage me to use new fertilizers in the market for my paddy plantation.	2.13	.919
I have to wait for directives from related agricultural institutions in making decisions to adopt new fertilizers.	2.30	.823
I am often encouraged by the agricultural institutions to use new fertilizers.	2.88	.793
I believe new innovations in production technology or improved quality of fertilizer has effect on plantation.	3.25	.438
I believe new innovations have positive impact on yield.	3.20	.505
I believe innovations could encourage healthy competition.	3.23	.476
Innovations will positively boost family income.	3.25	.488
I am willing to adopt environmentally friendly innovations.	3.33	.477
I am ready to use fertilizer that is only applied once per harvest if there is any newly developed innovation.	3.51	.506
I am ready to use fertilizers that can overcome underground water pollution.	3.16	.814
I am willing to adopt using fertilizer that enhance the growth rate of paddy plants	3.44	.503
I am willing to adopt using fertilizers that can release sufficient nutrients according to the needs of the plants.	2.67	1.248
Total Mean Score	3.99	

1 – Strongly Disagree to 4 – Strongly Agree

The findings indicate that despite their old age, these seasoned farmers are open to new innovations that could help increase their yield. Despite their openness and willingness for new fertilizer technology or product adoption,

fertilizer suppliers and manufacturers need to bear in mind that the average income earned by paddy farmers in Malaysia is RM1400.00 per month which is considerably low. In consideration of these factors, farmers are less advantaged to invest in new forms of mechanization and adopt innovative agricultural practices, or high-yield fertilizers with latest technologies. As a result, these farmers are heavily subsidized through Government intervention initiatives. Malaysian government is not the only country that subsidizes fertilizer to encourage yield. Twomlow (2010) reported that 160 000 farmers have been receiving free fertilizers in Zimbabwe which effort has seen an increase in the yield.

There is however a tendency that the subsidy could cause high dependency of its recipients on the Government, as the farmers have been subsidized for many years. This may affect penetration of new fertilizer products introduced in the market. The subsidy program may stifle the overall market of the fertilizer for paddy in Malaysia. National Farmers Association (NAFAS) has been given the prerogative as the sole distributor of fertilizer to the farmers in the paddy field since 1998 under Skim Baja Padi Kerajaan Persekutuan (SBPKP). This poses some challenges for penetration of new fertilizers into the market as adoption would be subjected to persuasive communication strategies. Majority of the farmers however believe that innovations in the paddy fertilizer could encourage healthy competitions (3.23).

Positive perceptions are depicted in the results of descriptive analysis on the level of agreement on a number of items. Majority of the farmers (67.3%) believe that new fertilizer will boost the level of competition amongst farmers. 65.3% believe that new fertilizer production can help increase the farmers' income. If new innovation on fertilizer is successfully adopted it will influence the farmers' income and can resultantly reduce poverty among them. The farmers (63%) agree and strongly agree that new fertilizer will positively influence production and will facilitate their farming activities. Productivity and yield rate of paddy in Malaysia is generally considerably low in some areas which is 4 tonnes per hectare as compared to other areas with higher yield up to 10-12 tonnes per hectare. The farmers hence believe that the yield could be higher with the use of good quality fertilizer. Salawu and Abu Bakar (2008) emphasizes the role of extension officers should also include encouraging farmers to take the right actions in finding solutions to their problems to the extent of becoming a financial consultant. As asserted by Khalil *et al.* (2008), agricultural extension is a professional communication intervention which is highly related to agriculture research and development (Karbasioun *et al.* , 2007).

A number of extension communication methods have been suggested by International Fertilizer Industry Association (1999). Engagement sessions with the farmers can be conducted during the growing period in the cropping season. Value-cost ratio could be calculated for representative sample of the treatment (fertilizer used). Farmers would be able to see the increase in yield and its financial benefit by using the newly produced fertilizer. Communications with regards to the new innovations can also be channelled through meetings with farmers. The IFA suggested inviting the wives of the farmers to the meetings as well, as a way of encouragement. The media like radio and television programmes specifically directed to the farming audiences can be used to convey messages, stimulate interest and to reach a wider communities. Printed materials such as charts, posters, leaflets, bulletins and handbooks can also be used. As a handful of the farmers as revealed in this study are not well educated, it is probably best to also consider the level of literacy of the farmers. Pictures and diagrams could be used extensively to aid understanding.

6. Conclusion

The overall findings indicate a high level of openness amongst the farmers in accepting newly introduced innovations of fertilizer in cultivation of paddy. The farmers have made their own initiatives in seeking information on new technologies in fertilizer. There is however a lack of information provided to them by the official sources. Most of the information about new technology development or products would largely come from amongst the farmers themselves, informal networking, who are mostly active in soliciting information on their own. Slightly more than half of the respondents have attended relevant courses, seminars and trainings, however the hunger for more information and knowledge is evident in the findings indicating an area for improvement in the

communications amongst the producers, regulators, government agencies and the farmers. The role of the extension officers needs to be fully utilized to disseminate knowledge and further strengthened as their function is crucial especially in transfer of technology. Extension services need to focus more on raising awareness and providing knowledge to the farmers on the choices they have and keeping themselves abreast with newly developed technologies. Manufacturers and distributors from the private sector should also play a primary role in disseminating knowledge about new technologies and products in the fertilizer industry. A coordinated effort between the government extension officers and liaison officers from the manufacturing companies in providing extension services through communications, joint trainings and preparation of extension materials would be very beneficial.

In the case of new technology development and diffusion of innovation, the attitude of the farmers shall not be an obstacle for technology adoption. However, the communications in creating awareness and building knowledge could pose an obstacle as the system for social networking to channel the information needs further strengthening. More education programs should be conducted focusing on fertilizer usage, however alternative channels for knowledge dissemination with the farmers should also be further explored. Zhou (2010) for example suggested technical training for fertilizer traders to disseminate information on fertilizer use to farmers.

An efficient link between research, technology development and extension to the farmers is crucial in innovation diffusion. Farmers' experience must be channelled back to research and development. Future studies should also look into the overall process of innovation-decision in implementing innovations on the different stages of knowledge dissemination, persuasion communications, decision-making, implementation and confirmation of adoption. Another dimension to adoption of innovation that requires probing is the extent of willingness amongst the farmers to pay for high-end fertilizers. Financial liquidity constraint has always been referred to as an important determinant in decisions on fertilizer use (Abdoulaye & Sanders, 2005). Malaysia used to import fertilizer however through the downstream activities, its national oil company, PETRONAS, had built its own urea manufacturing company to produce urea fertilizer. Unfortunately, the 1.2 million ton per year of urea is largely exported because of its high price due to its premium grade in quality. The Malaysian farmers prefer and tend to buy urea fertilizer at a cheaper price produced by other countries such as Indonesia and China. A study on the financial aspect could provide empirical data to indicate the likelihood of innovation adoption amongst farmers besides communications for persuasion.

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