

The impacts and visions of the green fertilizer technologies (GFT)

Adoption behaviour among Malaysian paddy farmers

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Abstract

Purpose – With the increased stress on sustainability and food security, in addition, the need towards halting environmental deprivation has focused attention on green fertilizer technology (GFT), which is the means of improving the situation causing the rising environmental concern. It also gives efficient use of farm resources which can help to protect crops. Moreover, the adoption of GFT is one aspect to answer the problem in regards to the sustainable environment. In the year 1980, an initiative took place to simplify the adoption decision in the developing countries. Regardless of the low adoption rate elsewhere, comparable exertions in the current year have originated in developing countries. Accepting those primary factors that influence the adoption of GFT is very important. The paper aims to discuss these issues.

Design/methodology/approach – This study re-examines these factors and draws policy implications from that review for future actions. This research study re-examines them, based on other studies examining the inadequate adoption of GFT in developing countries, by generalising their conclusions to clarify why farmers have or have not made the decision to adopt GFT. The ability to address that awareness enables the theory of planned behaviour (TPB) model to predict the farmer's intention of acceptability of the GFT. By following a socio-psychological approach, by using TPB, the researchers have found out the paddy farmers' adoption decision towards GFT. The researchers later discuss the implications for promoting the adoption of GFT, which delivers suggestions for the upcoming research study.

Findings – The idea of this research study is to seek farmers' understanding about environmental attitudes in connection with conservation behaviour. The overall aim of this paper is to conceptualise the framework created by amending the environmental concern amongst paddy farmers towards GFT.

Originality/value – This research study will allow more academic consideration and may direct future research on the empirical findings on the environmental concern through the proposed conceptual framework amongst paddy farmers in Malaysia.

Keywords Adoption, Consumer behaviour, Intention, Environmental concern, TPB, GFT, Personal norm

Paper type Literature review

1. Introduction

The Green Revolution has radically boosted the paddy yield both in Latin America as well as Asia, and shows a strong indication of the prospective of farming technologies in enhancing the public's lifestyles particularly in the evolving world (Pray, 1981). Certainly, it has turned

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out to be the foundation of provision for the Green Revolution in Asia by some charitable groups and foundations. Prosperous agronomic transformation worldwide has been mainly ascribed towards the enhancement of farm technologies like water conservation, and improved soil, seeds, and fertilizers (Adnan, Nordin, Rahman, and Noor, 2017; Johnston and Kilby, 1975; Kherallah and Kirsten, 2002; Mellor, 1976). The adoption of the stated technologies offers chances for increasing both the agricultural incomes and productivity (Feder *et al.*, 1985). In the setting of emerging countries, the impact of improved technologies towards the farming productivity is properly recognised (Sunding and Zilberman, 2001). Hence, these improved technologies help to reduce the environmental pollution. The world-wide apprehension about deteriorating environmental conditions requires ecological nutritional goods that contribute towards a sustainable environment (Kumar *et al.*, 2016). Although the current nutrition manufacture scheme faces the contest of increasing food making to feed the world population, it is deprived of negotiating the environment (Jennings *et al.*, 2016). With the overall cultivation practices, food production, and its impact on the environment, it is indispensable that farmers should adopt efficient innovations that intensify productivity and reduce environmental damage (Jennings *et al.*, 2016). One of the most recent empirically proven technologies that is considered vital for efficient production is “green fertilizer technology” (GFT) (Kottegoda *et al.*, 2011). With its innovation, production, and profitability graph showing a major proliferation, and with its efficient usage, it has helped in reducing environmental damages. GFT is easy to use and is widely available to paddy farmers and agriculturalists in Malaysia (Chiew and Shimada, 2013). The adoption of GFT also gives crop protection (Adnan, Nordin, Rahman, and Noor, 2017). Even though the innovation of GFT gets promoted and indorsed by governmental extension agencies, an extensive research suggests that the adoption amongst farmers is stumpy (Adnan, Nordin, Rahman, and Noor, 2017; de Lauwere *et al.*, 2012). Assuming the existing low-adoption rate, it is beneficial to discover whether these farmers essentially have an intent to adopt GFT (Adnan, Nordin, Rahman, and Noor, 2017; Saleh, 2013). A brief knowledge and a thorough understanding of the factors which determine the intention to utilise GFT might help policy makers design policy initiatives to improve the feasibility of the adoption rates for this modernisation (Chua and Oh, 2011; Martey *et al.*, 2014). Consequently, this paper has two research questions.

RQ1. How durable is the intention of agriculturalists and farmers in Malaysia to use GFT?

RQ2. What are the factors that determine their intentions and target to utilise this innovation?

Over a period of time, researchers and scientists have shown a significant interest towards investigating agricultural technology adoption and its factors effecting the environment (Adesina and Baidu-Forson, 1995; Chua and Oh, 2011). A vast number of studies on the adoption decision in the agriculture industry have been carried out throughout the world (Reimer *et al.*, 2012). In the environment of developed countries, several technologies have been tested and examined, which have helped in shaping the various factors affecting the adoption decision (Borges, 2015; Läpple and Kelley, 2013). Conversely, in developing countries, the construction of the agriculture decision process in the acceptance of innovation is unproductively understood (Sambodo, 2007; Tey, 2013). Along with that, within developing countries, most of the studies on the adoption of innovations in agriculture are usually based on a random utility framework (Borges *et al.*, 2014). Most of the research and studies focus on explaining how characteristics of the innovation and observable socioeconomic characteristics influence farmers’ and agriculturalists’ decisions (Borges *et al.*, 2014). Such socioeconomic features take account of age, gender, enlightenment, and educational level and farm size (Reimer *et al.*, 2012). These studies generally analyse only authentic adoption behaviour, rather than the intention to adopt GFT. Another study suggests that there was a slight understanding of the psychological paradigms

underlying a farmer's decision (Borges, 2015). Indeed, Reimer *et al.* (2012) observed a rising interest in socio-psychological methods to study adoption decisions and factors. This recent interest has been prompted by a growing dissatisfaction with the random utility models of adoption behaviour. For example, a recent meta-analysis (Borges *et al.*, 2014) suggests that the variables utilised in the random utility models of adoption behaviour were habitually insignificant. The above findings were also supported by the research of Knowler and Bradshaw (2007) and Prokopy *et al.* (2008) even though these concluding studies were not restricted to random utility models. Both analyses also found that the variables used to explain the farmer's adoption decisions, such as socioeconomic characteristics, are inclined to be insignificant.

This research has dual purpose. First, to classify the effect of attitude, subjective norm (SN), and perceived behavioural control (PBC) on the intention of agronomists towards the usage of better GFT. Second, to know the role of agronomists' opinions as drivers of their attitude, SN, and PBC.

2. Contribution of this study

This research also covers the adoption of agricultural innovations by means of psychological ideas from the theory of planned behaviour (TPB) to discover the aspects that effect agronomists' decisions to use GFT. Furthermore, as far as the researchers know, it is the initial research that practices the TPB in the framework of Malaysian paddy farmers. Hansson claimed that research centred on the TPB offers the added awareness into the agronomists' behaviour. So, this research is predicted to offer strategy developers with an understanding of the core psychological aspects that effect the usage of upgraded GFT. These visions can be used to regulate present strategies and to advance new strategy initiatives to encourage the implementation and usage of this practice by agronomists. The remaining part of this research consists of five core sections. The "Literature review" section gives the comprehensive research directly related to the extended TPB. Based on this review research, the conceptual framework as well as hypotheses are suggested in the "Theoretical framework" and "Research hypotheses" segments.

3. Literature review

3.1 Adoption of agricultural innovations technologies

The adoption of agriculture innovation technology changes has already been recognised as a critical element of the financial growth and productivity (Ohkawa *et al.*, 2015; Ruttan, 2000). The rapid adoption of new agriculture-related technologies has a positive impact on growth in agronomic productivity and guaranteed food security (Bruegel, 2011). The adoption of innovations in terms of green technology has also transformed the way farm households consider the employment choices (Bruegel, 2011). Particularly, labour-saving technologies have permitted farm household adherents to increase their income by pursuing off-farm services. However, innovation is a new idea or practice by an individual (Rogers, 2010). It can be labelled as the application of knowledge for the real world. According to Ohkawa *et al.* (2015), "agricultural innovation is considered as an important and necessary component in the development of agricultural activities. Innovation may be new varieties of seeds, or new types of pesticides or fertilizers for adoption which results in the enhancement of the yield of the crop for an upcoming scenario." For instance, in the context of farming, adoption of technology allows paddy farmers to become more efficient or to do something that was not possible before, which can increase the farm's productivity. To benefit from technology, it needs to be successfully linked with the country's overall development objectives and applied to solve socio-economic problems (Singha and Mishra, 2015). It is not necessary for all the profitable technologies to be adopted since barriers to practice new technologies and

the unavailability of a market for environmental attributes associated new technology can limit their effectiveness. In this research study, the researchers are highlighting the adoption of GFT.

3.2 GFT innovation

Agriculture industries play an important role in the Malaysian economic development and supplying many job opportunities for the society. To enhance the agriculture production and to get optimum plant growth, nutrients such as fertilizers must be accessible in sufficient and balanced amounts. Nevertheless, the traditional method of agricultural farming in which chemical-based fertilizers are heavily used has contributed to the increased global warming and greenhouse effect. Additionally, the increasing soil destruction and immense use of biochemical fertilizers, particularly in rice cultivation, resulted in the Malaysian Government introducing the “National Green Technology Policy” (NGTP) in 2009. The NGTP put emphasis on boosting and implementing the green technology in agriculture (GFT).

GFT is an environmentally friendly technology which has been developed and used in such a way that it does not disturb the environment and conserve natural resource (Lema and Lema, 2012). It is also known as clean technology and environmental technology. Moreover, GFT is a system that uses innovative methods to create an environmentally friendly product. GFT refers to the equipment or system and product which ensure environmental sustainability, reduce the greenhouse gas emissions, and promote a healthy environment and food. As per the Ministry of Energy, Green Technology and Water (2009), there are four supports that are provided by the National Green Technology. These are energy, environmental economic development, and above all society (improve the life quality of a person). GFT refers to new seeds and fertilizers put into the agriculture industry (FAO, 2012). In this particular research discipline, the adoption of GFT improves the paddy farmer’s life style as well helps them to improve their production level. The green technology policy refers to the development and application of products, equipment, and systems used to conserve the natural environment and resources which minimises and reduces the negative impact of human activities (Hashim and Ho, 2011). The continual application of traditional fertilizers in Malaysian paddy production has been creating an adverse environmental impact with negative social consequences (Alam *et al.*, 2012). The development of an eco-friendly fertilizer is, hence, timely and appropriate. GFT in the form of control release fertilizer (Kottegoda *et al.*, 2011) has numerous advantages. These advantages are increment of fertilizer efficiency and crop yield; reduction of nutrients losses through leaching, runoff, volatilisation, and de-nitrification; savings of time, cost, and labour in reducing the frequency required for fertilizer application compared to the conventional method; synchronising the release of all macro- and micro-nutrients in the soil necessary for crop plantation; risk elimination of nutrient deficiency or scorching. The mentioned benefits certainly mark the way towards adoption of GFT amongst paddy farmers.

3.3 Benefit of the adoption of GFT

A main goal of paddy farmers using GFT is to increase productivity and profitability (Pypers *et al.*, 2012), whereas this is only probable by the help of more cost-effective use of the farm efforts. GFT can help a farmer to achieve the desired goal, such as increase productivity, keep pace with scientific awareness amongst paddy farmers and achieving environmental sustainability. Paddy farmers need to have specific information about the adoption of GFT which gives them the potential to increase paddy production, and it also helps farmers to get profit through a sustainable means (Alam *et al.*, 2013). The concept of profitability is founded on the based assumption that the clear reserves are completed from the adoption of GFT amongst farmers (Adnan, Nordin, and Noor, 2017; Chauhan *et al.*, 2012).

With the increasing availability of GFT, investment costs in these technologies have decreased over time (Chiew and Shimada, 2013). Nevertheless, the prices have remained relatively higher though as incentives or subsidies have not generally been provided to enhance the affordability of GFT (Saleh, 2013). Because of this, the adoption decision of GFT is difficult to accomplish. Grounded on the above issues, the researchers have observed that the benefits and cost of using GFT is complex, whereas the given difficulty has re-enforced the need to re-examine a number of individual evaluations which have considered the factors influencing farmers to make the decision to adopt GFT. This is meaningful as it should also facilitate a better understanding amongst policy makers (Chiew and Shimada, 2013). Besides that, is the fact that GFT is comparatively higher than traditional chemical fertilizer. However, the adoption of GFT has a number of benefits which are highlighted in Figure 1.

3.4 Theories to adopt GFT amongst paddy farmers

The research study regarding the theories on the adoption decision of green technology is measured to be one of the most established areas in the modern agricultural development (Mariano *et al.*, 2012). Reasonably, over a period of time, a number of theoretical models have been modified practically as well as combined from multiple disciplines like marketing, sociology, and social psychology in order to provide an understanding as well as forecast the validated determinants of adoption. Therefore, choosing different variables and theories of attention with the warranted theoretical perspective is considered to be an interesting task (Venkatesh *et al.*, 2003). In order to establish an extended model within the existing study, the scholar has intentionally studied various models and their variables in the following subsections and has implemented an approach to select a number of variables that produced a number of substantial results in previous literature. Specially, the TPB was used frequently by many researchers, though the TPB-based models have been in constant use to give a well understanding of farmer’s adoption behaviour and decisions in various areas of agronomy and farming which is highlighted in Table I.

Moreover, Martinez-García *et al.* (2013) used a prior version of the TPB, the theory of reasoned action (TRA), to study farmers’ decisions to use GFT. Nevertheless, the TRA model provided a less comprehensive explanation of the farmers’ intentions, as it does not consider the role of PBC (Meijer *et al.*, 2015; Yamano *et al.*, 2015). The TPB, applied in this core study, has not previously been practiced to analyse the usability of GFT. The detailed study of the TPB model will be performed in the next section.

3.5 TPB

The TPB assumes that human behaviour originates from individuals’ intentions to perform a specific behaviour (Ajzen, 1991). Whereas the behavioural intention and the behaviour are widely defined in the TPB (Ajzen, 1991), which is an extension model of the TRA (Ajzen, 2011, 2015; Ajzen and Fishbein, 1975), intention to act is the immediate determinant of behaviour (Niu and Zhou, 2015). In this study, the adoption of a farmer is defined as

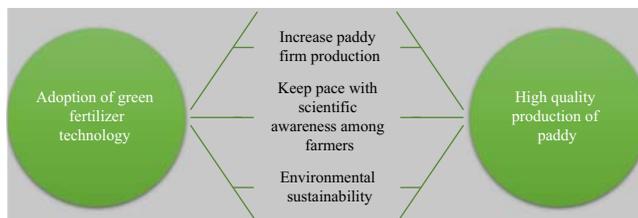


Figure 1.
Benefits of the
adoption of GFT

Technology	Research	Findings
Conservation	Beedell and Rehman (2000)	Farmers who are the members of Farming and Wildlife Advisory Group would have more environmental awareness. They are more prejudiced by conservation-associated concerns and less influenced by farm management concerns
Entrepreneurship	Bergevoet <i>et al.</i> (2004)	Substantial association amongst behaviour (farm magnitude as articulated by a farm's milk allocation) and area, and the intentions of the farmers. This association is even robust when declarations on attitudes, social norms, and perceived behavioural control are encompassed
Soil conservation	Wauters <i>et al.</i> (2010)	The farming communities do not observe any significant social pressure towards being involved or not in the conservation of soil. Moreover, the correlation (positive) between the intention and subjective norm suggests an impact of societal pressure clusters, possibly facilitated through the factor of attitude
Specialisation or variation	Hansson <i>et al.</i> (2012)	The aim of farmers in order to use enhanced natural grassland was influenced by the evaluation of the farmers towards enhanced natural grassland, which are attitude, perceptions towards societal pressure to use particular innovation (subjective norm), and perceptions towards their self-capability (PBC)
Land use practices	Poppenborg and Koellner (2013)	Decisions to plant perennial crops are most often accompanied by positive attitudes towards ecosystem services, whereas no differences were found between organic and conventional farming
Animal welfare practices	de Lauwere <i>et al.</i> (2012)	TPB was useful for understanding the farmers' choices with regard to the change to group housing, and that it provides indications for possible interventions to support farmers who have not yet changed to group housing
Dairy cow	Bruijnijis <i>et al.</i> (2013)	This study involved the animal welfare; especially the facility of good maintenance for the cows was appreciated as significant but was not connected to the purpose to advance dairy cow well-being. The cost-effectiveness of procedures appeared to be more significant
Organic farming	Läpple and Kelley (2013)	The results indicate that the impact of economic incentives and technical barriers varies, whilst social acceptance of organic farming constrains adoption
Improved natural grassland	Borges <i>et al.</i> (2014)	This study analysed the groups of farmers who originated from Brazil and the factor effecting the adoption decision of improved natural grassland. The subjective norm can be used as frequencies to distribute information about technology
Pro-environmental agricultural practices	Price and Leviston (2014)	The outcome of this research study dealt with the skill and abilities of farmers based on environmental constraints and biospheric values, and an intellect of presence that can be articulated to regulate one's purpose, which are substantial predecessors to pro-environmental practices
Water preservation practices	Yazdanpanah <i>et al.</i> (2014)	Researchers found two important elements for intention and behaviour of water conservation; they were the perception of risk and normative inclinations. Furthermore, linkages and the importance of the measurements were found to be dissimilar amongst the sub-groups of farming communities, particularly between advanced and traditional water management approaches
Rice variety technology	Yamano <i>et al.</i> (2015)	This paper identified that the results demonstrated that farmers who established high self-perception were inclined towards the adoption of new agriculture technologies.

(continued)

Table I.
TPB model on
agriculture studies

Technology	Research	Findings
Agroforestry practices technology	Meijer <i>et al.</i> (2015)	Numerous farmers measured home wants, such as procurement of food and agriculture contribution, as to what would reduce poverty whilst planting trees
Pest management technology	Ma <i>et al.</i>	The adoption of IPM has a positively significant effect on the apple yield; it also has a large impact on the net earnings in agricultural revenue
Conservation practices	Werner <i>et al.</i> (2017)	Uses of TPB, in order to understand how the farmers overcome barriers with regards to applying conservation practices.
Water saving measures	Pino <i>et al.</i>	This paper is based on the how environmental relations and public form positively affect a farmer's intentions towards the adoption of water saving measures

Table I.

follows: a farmer anticipates using GFT, in at least part of the farm, within the next year. With this model, defined by the behavioural intention, the actual behaviour is determined. After that, the behavioural intention is controlled by its three elements: attitude toward the behaviour, SN, and PBC (Ajzen, 1991). Now, researchers have also utilised the TPB structure to discover eco-friendly paddy farmers' behaviour.

For example, TPB model demonstrate by Chen *et al.* (2010) and Pino *et al.* a researcher get the idea of consumers' behavioural intention towards waste recycling and define the consumers' recycling intention. In addition, researchers (Deng *et al.*, 2016; Macintosh and Lockshin, 1997; Sigurdardottir *et al.*, 2013; Werner *et al.*, 2017) utilised the TPB to predict the purposes of the farmers' awareness. Furthermore, the study of M.-F. Chen and Tung (2014) using the TPB model using most psychological factors, such as attitudes and norms, had a major effect on the acceptance of ecological technology in the environment. Likewise, from all these research studies, the researchers have come to conclude that the TPB model is an appropriate concept to predict eco-friendly communication and increase the overall explanatory power of the TPB by adding some variables like moral beliefs by Kautonen *et al.* (2015). For example, Beck and Ajzen (1991) and Chen and Tung (2014) specified that the TBP's explanatory power had been increased by the personal approaches of moral accountability or individual moral ethics when inspecting the intention of the individual to behave in an eco-friendly manner, and noted that one's moral norms is a possible way to find the behavioural intention. Therefore, Arvola *et al.* (2008) argues that UK farmers know of climate change and they want to adopt GFT in their farms by paying a significant amount, and fulfil their moral norms and responsibility towards the environment and increase their production. Hence, by these research studies, it has been concluded that the variable of personal moral norms plays a significant role in behavioural intention. Therefore, the TPB previously having three primary elements, i.e. attitude, SNs, and perceived behaviour, may be converted into the extended TPB model by adding personal norms in the TPB model. Chen and Tung (2014) and Jalilvand and Samiei (2012) mentioned that framers are now more concerned with the environment from the last decades due to the dreadful condition of the environment today. Many researches have defined the link between green concerns as well as definite eco-friendly behaviour, and have worried about the environmental issues in predicating that behaviour. For example, Kahn and Kahn (1995) observed that environmentalist farmers, those who are concerned for the future generation, usually use GFT more than non-environmentalist farmers. Kvakkestad *et al.* (2015) observed that environmental concern is a very important and dominant factor in the purchase of GFT and those farmers who have a high concern with the environment will be more willing to buy GFT as they show their concern towards the environment by means of their purchase. Dias *et al.* (2015), Evans and Gariepy (2015)

and Ma and Abdulai (2016) showed in their research that farmers who show concern towards the environment have a greater stated preference for organic fertilizer. However, Saunders *et al.* (2016) used the defined data and statistics on both the decision to adopt green fertilizer technologies, and the concerns of the environment to study farmers' preferences towards green fertilizer technologies, and found that farmers will pay more for sustainable agriculture as they are highly concerned with the environment. Laple and Kelley (2013) defined the role of environmental concern and considered it as an important element of the extended TPB model. This research study shows that by performing an all-inclusive study and to comprehend paddy farmers' intention towards adoption of GFT, individual ethical norm and environmental concern were included in the TPB model to change it into an extended TPB model. This research established the appropriateness of the extended TPB model and confirmed that the extended TPB model had a good explanatory power in predicting paddy farmers' intention to adopt GFT.

3.6 Conceptual framework and hypothetical relationship

According to Davis *et al.* (1989), the observation in the TPB model shows that behavioural intention and actual behaviour have similar factors, although behavioural intention is usually more powerfully forecasted than the actual behaviour. Moreover, Ajzen (1991) observed behavioural intention as an immediate determinant of actual behaviour; and, when a suitable measure of intention is attained, this will result in the most accurate prediction of behaviour. This indicates that the intention towards adoption may be more strongly connected to the determinants than the actual adoption. Schuitema *et al.* (2013) also defined that the measurement of the level of the actual adoption is slightly difficult to achieve. In the meanwhile, the adoption of GFT is in the beginning mode in Malaysia and a large number of farmers are making the decision as to whether to adopt GFT or not. Therefore, Mastrangelo *et al.* (2014) noted that the element of attitude present in the extended TPB directs the complete evaluation of the specific behaviour in the perspective of the farmer's intention towards the adoption of GFT, and attitude is the term that is defined as a positive or negative assessment of the adoption behaviour. As Kabaci (2014) observed, in many studies, attitude is an important variable (anterior) of behavioural intention. For example, Martey *et al.* (2014) surveyed a national base to find out the farmers' intention towards the adoption of GFT, and they found that farmers having positive attitudes towards environmental concerns are more willing to adopt GFT. However, Ajzen (1991) stated that the consumers who have more positive attitudes, their intention will be stronger to perform a certain behaviour. He further defined that SNs are when an individual receives social pressure from groups of people or other people that are important in his/her life and wish him/her to act in a specific manner. Additionally, Bockarjova and Steg (2014) and Chen and Tung (2014) observed that it has been proved in past research studies that SNs affect behavioural intention in a positive manner. However, they further elaborate that when people consider that they should perform a specific behaviour, they will have more intention to perform that way due to a higher degree of social pressure (Chen and Tung, 2014). In the TPB, PBC is the last predictor of intention (Ajzen, 1991). Moreover, Ajzen (1991) also defined PBC as the degree of ease or difficulty perceived by an individual with respect to conducting a certain behaviour. In the recent scenario, the PBC consists of the perception of technology, price, availability or knowledge to use the GFT, and the capability to perform the adoption behaviour. As per de Lauwere *et al.* (2012), the more the ability a farmer has to control these elements, the more behavioural intention will be developed. Ajzen (1991) defined that the personal moral norm, i.e., an extended element defined in the TPB, indicates that people's sense of performing a specific moral behaviour makes his/her findings depend on his/her responsibility or principle. There is quite a bit of difference between personal moral norm and SN, where SNs cover external social pressure, personal moral norms can be differentiated by the internalised moral rules or values (Kautonen *et al.*, 2015). Internalisation is

the main feature of personal moral norm. In this research, the researchers have explained the personal moral norm through which a farmer will decide either to adopt GFT or not, based on his/her personal responsibility or moral principle rather than social pressure or social norms. Rezvani *et al.* (2015) stated that if the farmer has a higher degree of personal moral norm, than he/she will be more willing to adopt GFT. Based on thorough literature review mentioned above, the hypotheses are proposed as follows:

- H1. Paddy farmer's attitude will have a significant effect on the farmer's intention to adopt GFT.
- H2. Paddy farmer's SN will have a significant effect on the farmer's intention to adopt GFT.
- H3. Paddy farmer's PBC will have a significant effect on the farmer's intention to adopt GFT.
- H4. Paddy farmer's personal moral norm will have a significant effect on the farmer's intention to adopt GFT.

3.7 Extended TPB model based on environmental concern

According to some works (Adnan, Nordin, Rahman, and Noor, 2017; Al-Debei *et al.*, 2013; Rahbar and Abdul Wahid, 2011), the researchers state that environmental concern is the term that defines the consideration and awareness of environmental issues. Therefore, Richardson (2013) defined an important factor related to environmental concern as the help for an individual to deviate from his/her present behaviour to a more environmentally friendly behaviour. Moreover, Ajzen (1991) mentioned in his research that environmental concerns do not impact directly on a specific environmental behaviour, rather, it is by some different variables, indirectly. Pagiaslis and Krontalis (2014) have performed a meta-analysis and found the correlation between environmental concern and environmentally friendly behaviour, and noted that the reading between 0.23 and 0.35 is called to average correlation coefficient of environmental concern and behaviour.

This result shows that the concern regarding the environment does not depend on behaviour, which is confirmed by a study of Blok *et al.* (2015). Dienes (2015) proposed that environmental issues put forth an impact on a person's behavioural intention by beliefs, attitudes, and norms. Thus, this paper covered that measuring adoption intention is more applicable than the actual adoption. So, it can be concluded that environmental concern is an indirect factor of behavioural intention, and a frontal factor of the elements of the extended TPB model. With the help of these studies, the researchers have assumed that paddy farmers' attitudes, SNs and personal moral norms, and perceived behaviour will be used to control the adoption of GFT and will be affected positively. The research framework is illustrated in Figure 2. Depending on the analysis made above, the hypotheses are suggested as follows:

- H5. Paddy farmer's environmental concern will have a significant effect on the farmer's attitude towards adopting GFT.
- H6. Paddy farmer's environmental concern will have a significant effect on the farmer's SN towards adopting GFT.
- H7. Paddy farmer's environmental concern will have a significant effect on the farmer's PBC towards adopting GFT.
- H8. Paddy farmer's environmental concern will have a significant effect on the farmer's personal moral norm towards adopting GFT.

Conceptual framework to study paddy farmers intention towards the adoption green fertilizer technology

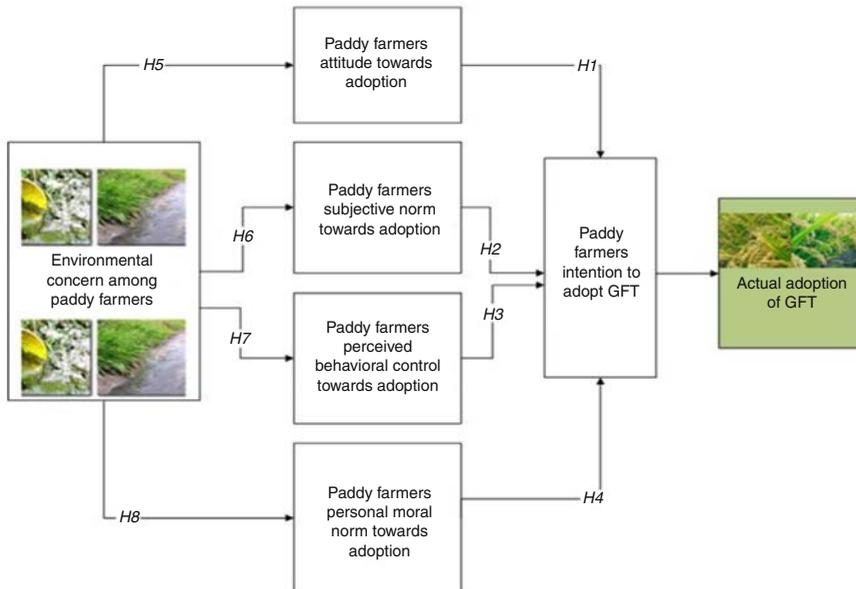


Figure 2. Conceptual framework

4. Discussion

This section contains the current studies and their outcomes in the domain of GFT adoption. There have been numerous significant key points during the course of this research in order to address the overall objective. Besides that, the outcomes derived from this research study will be advantageous to further understand the existing situation of environmental concern as well as the farmer’s personal norm. This study is grounded on the TPB model from different principals necessary for a fruitful introduction of the new GFT in the paddy industry of Malaysia. The aim of this research study is to provide a comprehensive understanding amongst paddy farmers that affects their adoption level towards the GFT, which helps them to raise their production of paddy. It contributes considerably to the investigation of the environmental concern and personal norm in a new context, and reduces the knowledge gap. The findings will provide an insight into enhancing the knowledge of new innovations in the Malaysian paddy farmers to increase paddy production, which is as of now considerably insufficient.

This research will significantly attempt to encourage better personal norms, environmental concern, and the quality of the relationship amongst stakeholders, especially paddy farmers in Malaysia. The outcomes of the research study will lead to the dissemination of more information that could provide more options in order to increase the overall production of paddy. Moreover, the farmers’ perception towards GFT may help improve their ways of dealing with farming-related issues and promote environmental concern at paddy granaries which will lead farmers to generate a positive perception, specifically the adoption and awareness of the GFT.

5. Key findings

The study examined the innovation process in the paddy industry. The role of environmental concern on the process is also part of the study’s objectives. The process,

however, requires several variables, such as environmental concern and the farmer's personal norm. The variables could measure the quality of awareness amongst the farmers. Although environmental concern, as mentioned by Rodger, is a way for information transfer, it is, however, broader than the definition. Environmental concern involves various aspects, for example, the psychology aspect, social cohesion aspect, and social interaction aspect. These elements are highly related to the TPB. Based on the findings discussed previously, the environmental concern practiced by the farmers could as well be explained by the two theories.

6. Data

The research study of this review paper recapitulates some things that have been ended and initiated from the previous research studies, although the researchers came to know that it involved a widespread instrument to examine and categorise the pool of pertinent searching skills. The majority of the studied articles were searched for by using Scopus® Science Direct and Thomson Reuter's database. The search was performed by means of the keywords "Adoption AND Personal Norm AND Farmers AND Environment"; it resulted in 280 research papers (journal article: 45.71 per cent, book chapter: 43.93 per cent, review: 2.1 per cent) starting from the year 2009 up to 2016. In Figure 3, the articles found for the above mentioned keywords are shown graphically. Around 51 per cent of the articles for the searched keywords have been available in the last three to four years, showing a great research thrust in the domain of the adoption of GFTs. Figure 4 illustrates the documents by year vs the number of publications.

The pie chart presented in Figure 4 shows the total number of searched research articles using the keywords in Scopus. The total number of journal articles was around 83.8 per cent, whereas the book chapter was nearly 6.3 per cent. Whilst searching, the researchers found that only 5 per cent of the review articles were published. Approximately, 4 per cent of the conference papers were there in the last seven years. Less than 2 per cent of the articles were in press.

Both in the year 2009 and 2010, 8 per cent of the total journal articles had been published. As for the year 2011 and 2012, the number of publications were increased from 6 per cent to 11 per cent. The graph shows a little rise in regards to published papers in 2013 and 2014 (16 per cent). However, there is a steep rise in the year 2015 (20 per cent). The use of the TPB for the farmer's decisions and adoption behaviour was formulated by a different number of research studies undertaken by the authors in the past few years

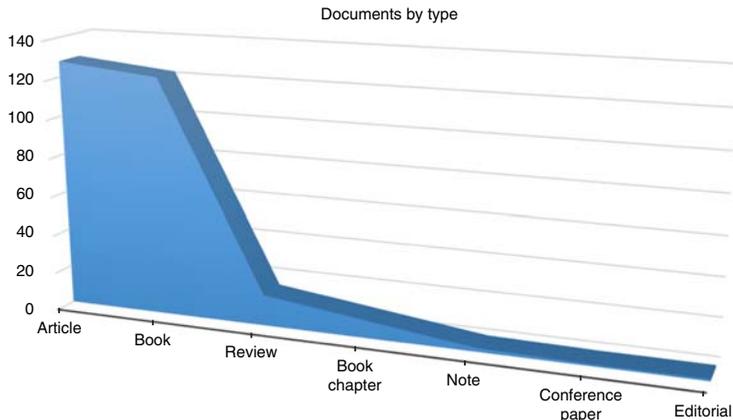


Figure 3.
Documents by type

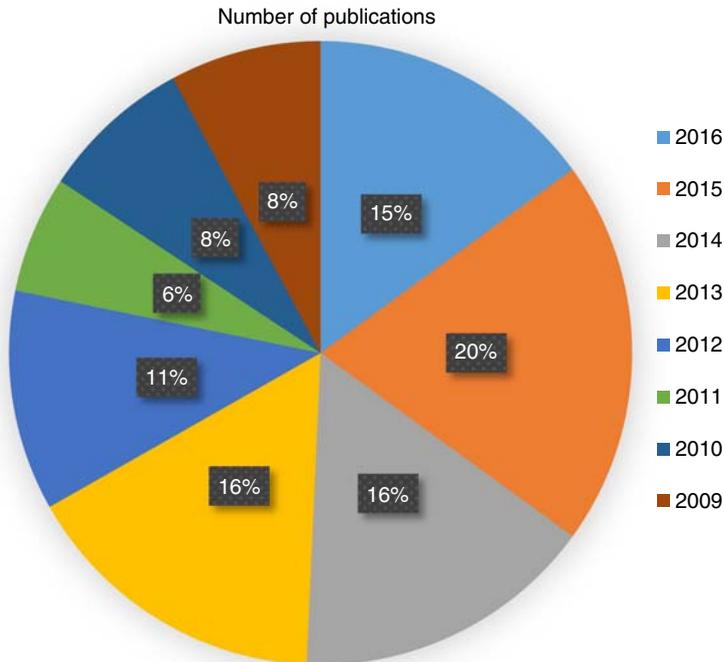


Figure 4.
Documents by year

which was shown in Figure 3. Bowles, S., Gintis, H., and Yazdanpanah, M. had a maximum number of four publications each. Moreover, Binder, C.R., Feola, G., Ostrom, E., and Delgadillo-Puga, C. had a maximum number of three publications each. A total number of author who has two publications was quite huge, with more than 40 scholars, which were indicated in the bar chart specified in Figure 3 in the adoption of GFT amongst farmers for the last few years. In the survey, the objective was to examine the factors that influenced farmers towards the adoption of GFT, and some explained why farmers are not adopting the innovation. Particularly, the researchers were more interested in the manifestation of the adoption and non-adoption that has taken place by the farmers. Henceforward, all those studies were based on forecasts, which measured the farmers' intention, attitude, and willingness to pay, to predict the future of that particular innovation. Subsequently, researchers restricted their review studies to the ten journals based on actual fact. Where they found that there were some studies that observed the adoption of innovation amongst farmers. As a combined set of these numbers of synopses, the researchers scrutinised 38 publications to find out the review result synthesis. Figure 5 shows the documents by author.

The secondary examination of this research paradigm has put emphasis on the identification of the core disciplines and research streams by discussing the mostly cited articles. The results show that the distribution of the GFT innovations has become a collective period in dissimilar technical societies, which has a notwithstanding base on a lack of formative work which emphasises the idea of the adoption of GFT innovations. Though approximately most of the cited articles have been taken into account for this research paper to get a better understanding of the farmer's adoption of GFT, some of them have a specific research focus, such as the impact of environmental risk associated with innovation (Lynne *et al.*, 1995), performance measurement of attitude (Adnan, Nordin, and

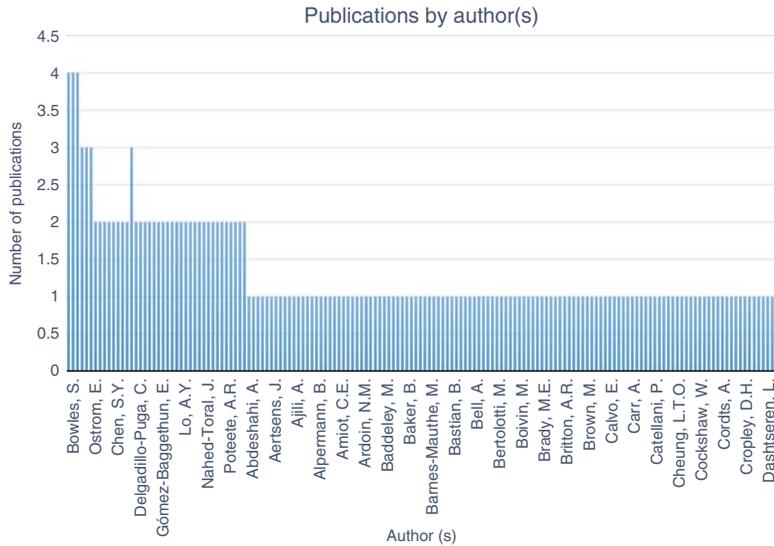


Figure 5.
Documents by author

Noor, 2017; Adnan, Nordin, Rahman, and Noor, 2017; Adnan, Nordin, and Redza, 2017; Wauters *et al.*, 2010; Willock *et al.*, 1999) or the impact of societal pressure (Bowman and Zilberman, 2013). All the articles are relevant for the interdisciplinary fields of the research in the domain of innovation studies. Based on the review of the most relevant cited articles, it has been possible to identify some interdisciplinary research streams within three disciplines (economics, sociology, and management), and two old-fashioned research fields (marketing and agent-based modelling) related to the adoption of agricultural innovation. Whereas this research has highlighted the core factors which are based on the TPB theory and with the integration of environmental concern, the researchers can come up with a new approach that can help farmers in their adoption of GFT.

7. Implications and limitations

To sum it all up, the rice and paddy industry of Malaysia has been given distinct attention by the Malaysian Government from pre-independence to post-independence times for numerous purposes in order to reduce poverty and for production-level improvement. The rice industry has substantially improved in Malaysia in the domain of yield and its overall production level by the help of timely governmental initiatives. The farmers in paddy farms are the ones who have benefited by both the economic development and incentives. Since subsidies and incentives were introduced, the status of living and the income of the paddy farmers were increased. These days, food security is the main focus in order to get sufficient food for the nation. Different types of incentives have been announced in order to make improvements and to strengthen rice industries around the country. Furthermore, the facility of these incentives is also to safeguard the paddy farmers as well as the industry in general. The government should take proper action for the increment of the production level of the rice industry by the year 2020 with the farmers' help, who can achieve a higher level of production with the GFT adoption.

8. Conclusions

In the agriculture sector, to increase Paddy production and achieve sustainability, adoption of GFT has been considered as the best alternative. The research for an

extended TPB model was used to find consumer intentions towards adoption of GFT. The researchers have also observed that the individual ethical norm of the paddy farmers is a progressive sign on their behaviour intention towards adoption. But in comparison with past researchers (Adnan, Nordin, and Redza, 2017; Arts *et al.*, 2011; Kaiser *et al.*, 2003; Long *et al.*, 2011), the addition of the personal moral norms has upgraded the explained variance which was less than the expected one. In this research, the impact of personal moral norms was lower than the measured values in the international studies. Thus, this is not applicable amongst Malaysian farmers. The main reason for this is that communism is leading on numerous sides of day-to-day life (Furnham and Telford, 2012), and societal stress shows a vital role in changing the behaviour of the farmers. The impact of the SN leads to individual moral norms, and the effect of concern regarding the environment on the components of the extended TPB structure, as well the intention towards adoption, is further explained.

It is defined that intention towards adoption is effected by environmental concern indirectly, and its effect is positively related to attitude, SN, PBC, and personal moral norm. The extended TPB model elements, in part, arbitrate the effects of paddy farmers' environmental concern on the intention towards the adoption of GFT. It is vital to highlight that adoption intention and environmental concern are not directly proportional to each other. In fact, the intention of adoption depends upon the impacts of eco-friendly concern and the four components of the extended TPB model. Furthermore, we must be aware that 50 per cent of those participating in the theoretical assessment declined due to less adoption of innovation GFT. The farmers were motivated more towards the adoption of GFT. This analysis of this research is not only useful in literature but also the finding will be effective for the policy makers and farmers. By this, the research concluded that paddy farmers' attitudes towards adopting GFT are positive, impacted by environmental concerns. In other words, if paddy farmers have more concern towards the environment, they will have more attraction towards adopting GFT. In general, with respect to the marketing angle, fertilizer suppliers launched the GFT as a means to enhance the popularity of the brand as well as because of the paddy farmers' environmental concern and emphasis on the awareness of eco-friendly environmental benefits towards the adoption of GFT. Paddy farmers give importance to social pressure or pressure inserted by other farmers or early adopter farmers, and this is one of the most significant factors of their intention towards adoption. By supporting the research, the researchers will stand a chance in developing this further with the theoretical frameworks of emotions in psychology, paddy farmer's behaviour, and ethics. Whereas there is a need for proper communication memoranda, instruction and strategies can generate explicit intellectual and emotive replies in paddy farmers, and therefore affect their choices and behaviours. Accepting the reasoning and emotional reactions can assist marketing authorities and lawful agencies in devising their communication, instruction, and strategies to possibly overcome more or less a few obstacles towards the adoption of GFT. The assessment of GFT by these participants and the initial adopters bears a vital impact on the farmer's adoption intention. Enough so, that the government sector and producers of GFT give high attention to enhancing the initial adopters' GFT evaluation. Hence, this paper tries to fill the gap by proposing a conceptual framework by tailoring the sustainability of environmental concern that leads towards the SN, attitude, personal norm, and perceived behaviour control which leads in the direction of the intention that is directed towards the actual adoption. The proposed conceptual framework has theorised the significant relationship amongst the variables towards the proper adoption of GFT as well as environmental sustainability, and opens a new path for future research to empirically prove the hypothetical relationship amongst these variables.

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