Growers' fertilizer application behavior and their willingness to pay for the fertilizer: a study in coconut triangle of Sri Lanka

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ABSTRACT

Sri Lankan small−scale coconut growers do not have the proper habit of applying fertilizer for their coconut palms due to their norms, beliefs, and attitudes. Therefore, the objectives of the study were to identify the factors that determine growers' fertilizer application, ranking them, and assess the growers' willingness to pay for a 50 kg bag of adult palm mixture. The data were collected from 366 coconut growers in the main three coconut growing districts in Sri Lanka, and the stratified random sampling method was used. Statistics such as binary logistic regression, linear regression, Pearson correlation, and contingency valuation method were utilized to analyze the data. The results showed that three types of beliefs were contributed to the fertilizer application behavior: behavioral beliefs [yield increase (β = 0.335; p = 0.006), coconut palm grow vigorously (β = 0.182; p = 0.040), income increase (β = 0.029; p = 0.010), and gives sustainable yield over the years (β = 0.027; p = 0.000)], normative beliefs [Coconut Development Officer (β = 0.074; p = 0.003) and fertilizer shopkeeper (β = 0.003; p = 0.020)], and control beliefs [price of the fertilizer (β = 0.643; p = 0.006), technical knowledge on fertilizer (β = 0.204; p = 0.001), labor scarcity (β = 0.179; p = 0.020), and having no interest (β = 0.071; p = 0.007)]. Furthermore, attitudes, subjective norms, and perceived behavioral control were also significantly affected the growers' fertilizer application. The growers' willingness to pay for a 50 kg bag of adult palm mixture was 1,672.08 LKR (1 USD = 195 LKR). Therefore, apart from the price of the fertilizer, policymakers should pay attention to the growers' technical knowledge, the issue of labor scarcity, and different agricultural extension approaches.

Keywords: Attitude, contingency valuation method, intention, perceived behavioral control, subjective norm, theory of planned behavior

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INTRODUCTION

Since the last two decades, the coconut growers in Sri Lanka have been facing many problems, which have ultimately resulted in declining production, and profits from their estates. Further, the low productivity is the basic character of the smal-scale resource poor rural growers in Sri Lanka. The accelerated soil degradation is majorly due to the non-sustainable farming practices, and it is the major contributory factor for the low yield (Herath, 2016). Sri Lankan small-scale coconut growers do not have the proper habit of applying fertilizer, even though, it is a very important agronomic practice to obtain a sustainable yield from the coconut palms. According to Herath (2016), awareness of the coconut growers on adult palm mixture (APM), and young palm mixture (YPM) was very poor. Moreover, the study was indicated that the knowledge of fertilizer mixtures was at a very unsatisfactory level, and it was one of the most important aspects of coconut cultivation that had not disseminated properly among coconut growers (Herath, 2016).

Several research has been carried out to study growers' technology adoption process, but generalization of those findings is still a challenge for the researchers due to some reasons, for example, contrasts in growers' characteristics, their background, and the referring technology. Rose *et al*. (2018) attempted to create a list of growers' adoption factors using the data from several past studies. According to them, availability of labor, access to credit, market access, risk management ability, land ownership, size of the farm, and education were some of the factors which are important for the adoption process of growers. The adoption factors identified by Rose *et al*. (2018) were proved by several recently conducted studies. In addition, they have added some new factors to the list according to the study sample and referring technology. There are variations in the way each factor influences the adoption decision while some factors are still debatable.

Coconut growers' fertilizer application depends on various adoption factors, and they will be varying according to their socioeconomic conditions, beliefs, and attitudes (Herath, 2012). The fertilizer price is one of the main factors that determine growers' fertilizer application behavior. However, due to individual growers' unique fertilizer application behavior, several other factors could influence the fertilizer application behavior other than fertilizer price. A study conducted by Long (2013) revealed that despite the major role of economic motivation, growers, in general, have multiple objectives (economic and non-economic) in decision−making (Mukhopadhyay *et al*., 2020). Multiple objectives may also indicate the growers' different approaches in dealing with their situations, for example, heuristics, and intuition (Long, 2013). Further, any procedure used to evaluate why growers behave the manner they perform would be encountered the various number of inter-related factors, for example, personal factors (age, gender, experience, attitudes, and beliefs), business factors (farm size, cash flow, staff numbers, succession plans, and profitability), family, peer and advisory network, feeling in control of decision-making, relative advantage (incentives/rewards), market or compliance−based rewards (Rose *et al.,* 2018). Therefore, it is important to investigate how growers' different choice stimuli direct to a specific decision or behavior to understand growers' actual behavior in fertilizer application. The theory of planned behavior (TPB) presented by Ajzen (2002) has given a valuable framework to study associations between growers' decision variables and behavior.

Ajzen and Fishbein (1980) initially developed reasoned action theory and proposed that human action depends directly on an individual's intention. In this model, the intention is also generally influenced by individual attitudes and subjective norms (SN). Ajzen (1991) further introduced the variable of perceived behavioral control (PBC) to complete previous behavioral frameworks and developed the TPB model (Zhou *et al*., 2016). In the model, intention implies individual readiness to perform a given behavior (Ajzen, 2002) and is recognized as the motivation which is necessary for engagement in a particular behavior. The intention is the most substantial predictor of behavior (Clayton, 2004), and is assumed to be an immediate antecedent of that behavior (Ajzen, 2002). According to the TPB model (Figure 1), an individual's intention to perform a behavior is a function of that individual's attitude toward the behavior, SN, and PBC (Ajzen, 1991).

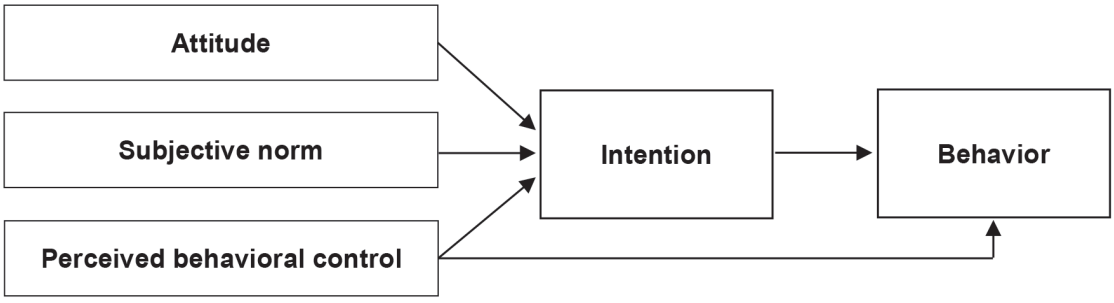

Figure 1 Graphical illustration of the theory of planned behavior
Source: Ajzen (1985)

Attitude is an individual's positive or negative evaluation of the performance of a particular behavior (Ajzen and Fishbein, 1980). A person, who believes that valuable positive outcomes would result from performing the behavior, will have a positive attitude toward such behavior. According to the TPB model, it must be said that the more favorable attitude toward a behavior, the more possibility that the individual will perform that certain behavior (Ajzen, 1991). In general, a strong relationship between attitude and intention or behavior has been reported in the literature (Gao *et al*., 2017; Li *et al*., 2018). Various studies have highlighted the importance of attitude in predicting growers' fertilizer application behavior (Savari and Gharechaee, 2020).

The SN is a social pressure exerted on an individual to engage in a particular behavior (Ajzen and Fishbein, 1980). Individuals intend to perform a behavior when they feel that the people who are important to them confirm that behavior (Shin and Hancer, 2016). The majority of studies applying the TPB model reported the SN as the key factor affecting intention (Dang *et al*., 2014; Chen, 2016; Arunrat *et al*., 2017). This is particularly true in the case of fertilizer application behaviors (Daxini *et al*., 2018; Savari and Gharechaee, 2020).

The definition of PBC is an individual's perceived ease or difficulty of a particular behavior performance (Ajzen and Fishbein, 1980). This component emphasizes the extent to which that an individual perceives a behavior to be under his/her volitional control (Fielding *et al*., 2005). Behavioral control is related to beliefs about the presence of factors that may further or hinder the performance of behavior (Ajzen, 2002). Empirical evidence for the effect of PBC on intention has been provided by several studies (Seaman and Eves, 2010; Shapiro *et al*., 2011; Mullan *et al*., 2013). Further, Savari and Gharechaee (2020) used the TPB model in the context of agriculture to predict Iranian growers' intention for safe use of chemical fertilizers, indicating that PBC was a reliable determinant of intention or behavior. Therefore, attitude, SN, and PBC could be a significant determinant of the coconut growers' decision-making behavior in fertilizer application.

The growers' willingness to pay for 50 kg of APM fertilizer bag estimated by the contingent valuation method (CVM) has been employed over the past years for the economic estimations of natural resources. Further, it was also used as a tool for eliciting public aspiration to finance several suggested programs (Blaine *et al*., 2003). Lee and Han (2002) used CVM to estimate the use and preservation values of national parks in Korea. Moreover, CVM was utilized to assess growers' readiness to pay for extension services (Ajayi, 2006) and measure the willingness to pay for green electricity in Japan (Nomura and Akai, 2004). Therefore, the objectives of this study were to recognize the factors that determine growers' fertilizer application, rank the identified factors, and predict the growers' willingness to pay for a 50 kg bag of APM fertilizer.

MATERIALS AND METHODS

Measuring Variables in the Theory of Planned Behavior

Most of the previous research has been utilized the expectancy-value method to measure the TPB variables. It assumes that attitude towards a behavior depends on belief about the behavior, and its good or bad evaluation. There are three fundamental constituents for the expectancy-value method which include the belief of the behavior (b), value evaluated by the individual for the behavior (v), and attitude (a) (Viklund, 2002) as follows (equation 1):

$$a = \sum_{i=1}^{n} b_i v_i \quad \text{----- (1)}$$

Based on the concept, the relationship between behavior and intention was formulated in equation 2. Therefore, the model was expressed as equation 3.

$$B \approx I \propto AT + SN + PBC \quad \text{----- (2)}$$

$$B \approx I = \beta_1 \sum_{i=1}^{s} bb_i oe_i + \beta_2 \sum_{j=1}^{t} nb_j mc_j + \beta_3 \sum_{k=1}^{u} cb_k p_k \quad \text{----- (3)}$$

where B is behavior, I is an intention, AT is an attitude, SN is a subjective norm, PBC is perceived behavioral control, β is regression coefficient, bb is behavioral belief, oe is outcome evaluation, nb is normative belief, mc is motivation to comply, cb is control beliefs and p is power.

Development of the Questionnaire

The beliefs towards the expected behavior are very important to develop attitude, SN, and PBC in an individual. Furthermore, the salient beliefs play a significant role in foreseeing intention, thereby behavior. Those that first come to mind if ask a question from an individual for example, what do you think would be the advantages for you to perform a certain behavior? are called salient beliefs. According to Francis *et al*. (2004), salient beliefs can be identified by conducting a survey. Therefore, a survey was conducted in the coconut triangle (Kurunegala, Puttalum, and Gampaha districts) of Sri Lanka with randomly selected 35 coconut growers. The questionnaire was developed by the researchers for the current study which was comprised of the beliefs identified by the above preliminary survey which was contained six main categories, i.e., behavioral beliefs of fertilizer application, normative beliefs of fertilizer application, control beliefs of fertilizer application, outcome evaluation, motivation to comply, and power of control beliefs. Both open-ended and close-ended questions were included. The close−ended questions were based on the 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Further, for the negative items, the reverse coding system was followed. Moreover, the questionnaire was pretested to ensure both validity and reliability, All the Cronbach's alpha values for the questionnaire items were above 0.6. Therefore, according to Hair *et al*. (1998), all values were lined within the acceptable range, and higher reliability was reported.

Sampling Method and Study Location

According to Dillman (2007), to represent around 30,000 of the coconut growers in the coconut triangle, 365 respondents were sufficient, but 425 respondents were targeted to compensate for incomplete or unresponsive questionnaires. Therefore, the data were collected from 175, 150, and 100 growers who were selected using stratified random sampling technique from Kurunegala, Puttalm, and Gampaha districts respectively to represent the coconut cultivation extent.

Data Collection and Analysis

The effective response rate was 86.8, 82.6, and 90% with 152, 124, and 90 duly completed questionnaires returned from Kurunegala, Puttalm, and Gampaha districts, respectively. Finally, the total sample size was 366. The identified salient beliefs were categorized into three groups according to the TPB which consisted of behavioral, normative, and control beliefs. A regression analysis was done by using SPSS version 22.0 to access the contribution of identified salient beliefs towards the intention for

fertilizer application. Binary logistic regression was performed to estimate the relationship between fertilizer application behavior and explanatory variables (i.e., attitude, SN, and PBC). The explanatory variables were entered stepwise to explore the impact of each and all variables. The value of −2 log likelihood was considered for the goodness of fit.

The contingent valuation method was utilized to analyze growers' willingness to pay. The price which growers are willing to pay for 50 kg of APM fertilizer bag was calculated by using lower bound mean (LBM) as presented in equation 4 (adapted from Blaine *et al*., (2003)). It is a conservative lower average willingness to pay because it does not capture the interpolations of that lie between those listed (Ajayi, 2006).

$$LBM = \mu_0(P_0) + \sum_{i=1}^{K} \mu(P_i - P_{1-i}) \quad \text{----- (4)}$$

where μ_0 is the cumulative percentage of respondents willing to pay the initial or smallest finite amount, P_0 is the smallest finite amount and K_0 is number of subsequent amount

RESULTS AND DISCUSSION

Socio-Economics Characters

The comparisons of socio−economic characteristics of coconut growers in Gampaha, Kurunegala, and Puttlam districts are given in Table 1. Means for age of the participants in Gampaha, Kurunegala, and Puttlam districts were 59.5 (SD 12.4), 58.2 (SD 13.5), and 55.2 (SD 14.0) years, respectively. The majority of coconut growers were male, and the highest educational background was recorded in Gampaha district. Comparing the data on time spent on farming, most of the coconut growers in Gampaha and Puttlam districts were part−time growers, while a majority of the growers in Kurunegala district were full−time growers. The highest average farm size was reported in Puttlam district which was 17.4 (SD 14.7) acres.

Reliability Analysis

The reliability analysis was performed to measure the internal consistency of the measured concept or constructs to ensure adequacy and reliability. The generally accepted lower limit of Cronbach's alpha value for reliability analysis is 0.7, but in the exploratory research, 0.6 is acceptable (Hair *et al*., 1998). Thus, in this study, a lower limit of Cronbach's alpha was considered at 0.6. All the Cronbach alpha values were lined within the acceptable range, and the results are given in Table 2.

Table 1 Socio-economic characteristics of coconut growers

Characteristics	Gampaha (N=90)		Kurunegala (N=152)		Puttlam (N=124)	
	Mean	SD	Mean	SD	Mean	SD
Age (years)	59.5	12.4	58.2	13.5	55.2	14.0
Education (No. of years)	12.2	1.7	12.0	1.9	11.2	1.5
Gender (M/F ratio) (male) (%)	90.4	−	87.0	−	80.6	−
Involvement in farming						
Full-time (%)	23.8	−	57.5	−	28.6	−
Part-time (%)	76.2	−	42.5	−	71.4	−
Farm size (acres)	4.3	3.1	14.1	9.9	17.4	14.7

Note: N = number of respondents, SD = standard deviation

Table 2 Cronbach alpha values and standard errors of the variables

No.	Variable	Cronbach alpha value	Standard error
1	Behavioral beliefs of fertilizer application	0.784	0.21
2	Normative beliefs of fertilizer application	0.856	0.22
3	Control beliefs of fertilizer application	0.711	0.30
4	Outcome evaluation	0.752	0.28
5	Motivation to comply	0.751	0.28
6	Power of control beliefs	0.672	0.34

Attitudes towards Fertilizer Application and Relationship with Socio-Economic Variables

The main factors that influence growers' fertilizer application could vary with their socio-economic characteristics, beliefs, and attitudes. According to the previous literature, growers' fertilizer application behavior may be governed by various decision stimuli, and they will be varying according to their beliefs and attitudes. Therefore, unique fertilizer application behavior could be observed in individual growers. Even though the price has a greater impact on growers' fertilizer application, several other factors are also important to determine the growers' fertilizer application behavior. Therefore, it is essential to explore how growers' different decision stimuli are varied with the decision or behavior. The correlation values between TPB constructs and several socio-economic characteristics of the coconut growers are given in Table 3.

Table 3 Pearson correlations between socio-economic characteristics and predictors of intention (N=366)

Variables	Education	Income	Farm size	Age
Attitude	0.307**	0.477**	0.435**	−0.191*
Subjective norms	ns	ns	ns	0.464**
Perceived behavioral control	ns	0.493**	0.354**	−0.260**

Note: * correlation is significant at the 0.05 level (2−tailed), ** correlation is significant at the 0.01 level (2−tailed), ns = not significant

Even though, farm size, farm income, and education had a positive significant correlation with attitude, while age had a negative correlation. When the growers received a good education, more information and knowledge could be accessed, allowed the grower to make wise decisions. Subsequently, if the growers are more socially active, their social networks would be wider, and their innovativeness will be improved. Hence, more educated growers may tend to develop favorable attitudes towards fertilizer application which similar to the results of the study by Abebe and Debebe (2019). Moreover, Kleebbua and Siriparp (2016) found a positive correlation between attitudes and education. Further, education level was also associated with the uptake of various behaviors across the set of reviewed papers (Gholamrezai and Sepahvand, 2017; Issa and Hamm, 2017; Mekonnen *et al*., 2017). Moreover, after noting that there was limited knowledge of the effectiveness of behavioral interventions, Helitzer *et al*. (2014) used an educational intervention to improve the

safe use of integrated pest management techniques amongst arable farmers in New Mexico, USA. Therefore, education had a positive significant impact on growers' fertilizer application behavior.

The application of fertilizer is a costly activity. Therefore, growers' income is a significant factor that is involved significantly in making farming decisions. Accordingly, growers' income is the main factor in fertilizer application decisions, and it is in line with the study of Zhou *et al*. (2010). Further, uptake of technology was associated with high−income farmers, and with those who were able to make the most of employee expertise (Aubert *et al*., 2012).

The size of a farm was also a crucial factor that developed favorable attitudes towards the fertilizer application because the size of a farm had a strong positive association with growers' income. Both Bergevoet *et al*. (2004) and Kiptot *et al*. (2006) observed that the cultivated land extent had a strong influence on attitudes. Moreover, Li *et al*. (2020) revealed that the farmers owning larger orchards are more likely to adopt agricultural technologies compared to ones owning smaller orchards. Other papers that found a link between farm size and adoption of management practices, included Campbell *et al*. (2011) and Nöremark *et al*. (2016). The latter paper finding that the biosecurity behavior of Swedish farmers was affected by herd size and number of employees (amongst many other factors). But, according to Zhou *et al*. (2010), the farm size negatively affected the application of the fertilizer. Interestingly, a negative correlation was found between age and attitude. It infers that the younger generation has prominent positive attitudes for fertilizer application, and it may be due to their higher education than their parents. Furthermore, they do new inventions and innovations, and willing to take risks. Consequently, these characteristics might be involved in the negative correlation between age and attitudes. Aubert *et al*. (2012) found that different ages of Canadian farmers held different attitudes towards the adoption of precision agriculture (older more likely to be resistant), whilst pre−determined level of innovativeness was also a key factor. Gebrehiwot and van der Veen (2015) found a negative correlation between increasing farmer age and adoption of risk management practices in Ethiopia.

The SN or social pressure is the other predictor which affects the intention. It was not correlated with all socio-economic characteristics except age. Further, the older workers were more strongly influenced by subjective norm for the adoption of the technology adoption (Morris and Venkatesh, 2000). Hence, it was a good indicator to prove the social pressure that could have a noteworthy effect on elderly growers. The growers' social bonds were built up with social maturity, and respect for each other than youngsters. Hence, they are willing to follow the correct advice given by the extension officer and peer growers. Hence, age has a greater influence on growers' intentions.

The final predictor, PBC had a positive correlation with farm extent and income but had a negative correlation with age. Meanwhile, PBC was not statistically significant with education. The PBC is the feeling that whether grower can overcome hindrances. Therefore, if the growers receive sufficient income, they can overcome the obstacles in fertilizer application. Then, the growers can purchase fertilizer, pay for farm labor and afford the risks. If the farmland is larger, the availabilities of resources, machinery, and other inputs are also high. Consequently, the quantum of resources available urges growers to overcome the barriers that they face in fertilizer application. Hence, if the farm size is larger, growers pay more attention to improve it. The results are compatible with the study of Daxini *et al*. (2018). In contrast to elderly growers, younger growers are progressively creative and attempt to overcome their farming obstructions. More often elderly growers think conventionally and unwilling to alter their farmlands. They wish to proceed with what they have used to practice for a long time. Therefore, age has a negative correlation with PBC.

Factors and their Contributions to Fertilizer Application Behavior

Behavioral beliefs

The regression analysis showed that intention to apply fertilizer significantly depended on behavioral beliefs in terms of yield increase,

coconut palm grows vigorously, income increase, and gives sustainable yield over the years (Table 4). Behavioral beliefs developed an attitude toward the fertilizer application. Therefore, the belief, fertilizer application will increase their yields was the top belief that led to developing a favorable attitude for fertilizer application, followed by coconut palm grows vigorously, income increase, and gives sustainable yield over the years.

Table 4 Contribution of behavioral beliefs for the fertilizer application behavior

Behavioral beliefs	Beta value	Significance	Rank
Yield increase	0.335**	0.006	1
Income increase	0.029*	0.010	3
Coconut palm grow vigorously	0.182*	0.040	2
Gives sustainable yield over the years	0.027**	0.000	4
Reduces pest and disease damages	−0.270	ns	
Increase the yields of intercrops	0.532	ns	
Reduce immature nut falling	0.680	ns	
Increases the nut weight	0.254	ns	
Continuous application of fertilizer is required if the palm get adopted to the fertilizer	0.178	ns	
Increase the maintenance cost	0.272	ns	
Cause environmental pollution	−0.300	ns	
Cause diseases to human	−0.482	ns	
Increase the growth of weeds	0.133	ns	
Degrade the soil	−0.961	ns	
R^2 value		58%	
F−statistics		15.18 ($p < 0.000$)	

Note: *significant at $p < 0.05$, ** significant at $p < 0.01$, ns = not significant

Normative beliefs

When normative beliefs are considered, there were two statistically significant beliefs related to fertilizer application behavior. They were Coconut Development Officer (CDO) and fertilizer shopkeeper. Normative beliefs are important to develop subjective norm of the fertilizer application. Therefore, only CDO and fertilizer shopkeeper influence the developing intention of the grower to apply fertilizer (Table 5). According to Herath and Wijekoon (2013), CDO contact greatly influenced the motivation towards the adoption of organic farming. Further, family members and neighboring growers had a minor role in providing information in fertilizer application. Especially, Sri Lankan rural farm families are dominated by male growers, and normally they take farming decisions alone. In contrast, some studies stated that family members and neighboring growers were important persons in the process of farming decisions. Furthermore, Wimalagunasekara *et al*. (2012) confirmed the influence of neighbors and village colleagues in growers' decisions related to fertilizer recommendations in rubber cultivation. Similarly, in a Mexican study by Martínez-García *et al*. (2013) on factors influencing dairy farmers' decisions to adopt improved grassland management,

social pressure applied by the fathers of farmers was found to be a significant factor. An interesting study of wine growers in France by Kuhfuss *et al*. (2016) found that farmers would be more willing to enroll in a management scheme if they believed that a significant number of their peers would do the same. Generally, growers seek information from neighbors and other growers, when there are limited resources and access for the information in the village.

Table 5 Contribution of normative beliefs for the fertilizer application behavior

Normative beliefs	Beta value	Significance	Rank
Members of my family	0.440	ns	
Coconut Development Officer	0.074**	0.003	1
Neighboring grower	0.087	ns	
Other coconut growers	0.546	ns	
Fertilizer shopkeeper	0.003*	0.020	2
Coconut pluckers	−0.168	ns	
Coconut traders (buyers)	0.241	ns	
R^2 value		45.8%	
F−statistics		46.70 ($p < 0.005$)	

Note: *significant at $p < 0.05$, ** significant at $p < 0.01$, ns = not significant

In contrast, Solano *et al*. (2003) revealed that individual decision−making is the most common decision−making system among the farming community. They also stated that Costa Rican dairy farmers took decisions without anyone else's input. The linkages between grower and CDO, and grower and fertilizer shopkeeper are strengthening by growers' information−seeking behavior. Furthermore, Herath and Wijekoon (2013) found a significant role of field extension workers and government agencies as innovation sources for small−scale coconut growers in Sri Lanka. Elliot *et al*. (2011) illustrated that perceptions about lamb mortality were significantly influenced by advisors, and also the farming press and family, amongst their participants in Australia. Furthermore, Alarcon *et al*. (2014) used an English case study to explore the decision−making process used by pig farmers for disease control, finding that vets were most influential.

Control beliefs

As far as a control belief is concerned, it is an ability to cope with barriers. During the elicitation study, 14 barriers were identified which impeded the application of the fertilizer. The regression analysis results showed that the respondents' intention was affected by four factors (Table 6). Affordability (price of fertilizer) was the highly influenced factor followed by lack of technical knowledge, labor scarcity, and having no interest. These findings were supported by the following past studies. The analysis of Ding *et al*. (2011) showed that farmers who adopted the agricultural technologies had income approximately 15% higher than nonadopters. Moreover, the findings from another study supported that the diversification of household income was a positive influence on the uptake of modern technologies (Diiro, 2013).

Ugur and Mitra (2017) found that the impact of labor availability on technology adoption to be direct and positive. Some studies pointed

out that, members in the farm family are a source of supply farm labor to some extent. Neil and Lee (2001) stated that there was a strong and positive association between number of farm family members and technology adoption. Udimal *et al*. (2017) also found a link between family size and technology adoption among rice growers in Ghana. Further, Gockowski and Ndoumbe (2004) found a significant and positive adoption rate resulting from a large proportion of adult males in the farm family.

Table 6 Contribution of control beliefs for the fertilizer application behavior

Control beliefs	Beta value	Significance	Rank
Lack of technical knowledge	0.204**	0.001	2
Availability of fertilizer	0.194	ns	
Labor scarcity	0.179*	0.020	3
Affordability (price of fertilizer)	0.643**	0.006	1
Farm gate price for coconuts	0.179	ns	
High labor wages	0.064	ns	
No suitable time to apply fertilizer due to climate change (heavy rain and drought)	−0.410	ns	
No interest	0.071*	0.007	4
No nutrient deficiency symptoms	0.435	ns	
No trust in fertilizer mixtures	0.096	ns	
Less time to involve	0.034	ns	
No adequate money	0.078	ns	
No credit facilities	0.006	ns	
Fluctuation of coconut price	0.026	ns	
R^2 value		55.9%	
F Statistics		32.39 ($p < 0.005$)	

Note: *significant at $p < 0.05$, ** significant at $p < 0.01$, ns = not significant

Model Fit Values of Explanatory Variables for Application of Fertilizer

Table 7 shows the results of binary logistic regression, which indicates the relationship between fertilizer application behavior and explanatory variables (attitude, SN, and PBC). The outcomes indicated that the introduction of attitude was decreased the −2 log likelihood deviance by 33.132, (df = 1; $p < 0.001$). The attitude was contributed to 11.2% of the variance in the model (Nagelkerka R^2 0.112).

Table 7 Relationship between explanatory variables and fertilizer application behavior

Step	Explanatory variable	Chi−square value	Significance	Nagelkerke R^2
1	Attitude	33.132	0.001	0.112
2	Subjective norms	11.548	0.001	0.096
3	Perceived behavioral control	115.892	0.001	0.501

The variable SN only decreased the −2 log likelihood by 11.548 (df = 1; $p < 0.001$) and was a statistically significant factor for fertilizer application behavior. The model with attitude and SN together reduced −2 log likelihood by 44.68 (df = 2; $p < 0.001$). Therefore, the attitude had more explanatory power than SN. The attitude and SN together represented 20.87% of the variance in the model (Nagelkerka R^2 0.208). The PBC only reduced −2 log likelihood by 115.892 (df = 1; $p < 0.001$). Moreover, the introduction of all three variables to the model together decreased −2 log likelihood by 160.572 (df = 3; $p < 0.001$), and the model represented 70.9% of the variance in fertilizer application (Nagelkerka R^2 0.709). Therefore, three variables, i.e., attitude, SN, and PBC, had a significant influence on growers' fertilizer application behavior. The main responsible variable for the application of fertilizer was growers' PBC (72.2%), followed by attitude (20.6%) and SN (7.2%). The importance of TPB variables for the technology adoption was also reported by Rose *et al*. (2018) in their literature review.

Average Willingness to Pay

In the survey, growers were asked to mark the amount that they are ready to pay for 50 kg of APM fertilizer bag. The different prices were suggested by them, ranged from 1,300−2,500 LKR in irregular increments (Table 8). The LBM or growers' willingness to pay for 50 kg of APM fertilizer bag in the study area was 1,672.08 LKR (1 USD = 195 LKR).

Table 8 Willingness to pay for 50 kg of adult palm mixture fertilizer bag

Amount willing to pay (LKR)	Frequency	Percentage (%)	Cumulative percentage (%)
2,500	10	2.73	2.73
2,300	5	1.36	4.09
2,000	95	25.96	30.05
1,800	59	16.12	46.17
1,500	116	31.70	77.87
1,300	81	22.13	100.00
Total respondents	366		

When conducting knowledge exchange, whether verbally or in writing, key advisors should be identified in a given region. For example, related to coconut; CDOs. Building their support is crucial for influencing the behavior of their clients and these trusted individuals are often better able to tailor advice to individual growers. The Coconut Cultivation Board (CCB) could ensure that CDOs, receive advice meant for growers, particularly since growers may rarely read it themselves. There is a need to identify which groups in a given place exert the greatest social pressure on the subjects, thereby helping to shift social norms and attitudes (could be friends, advisors, or family). Furthermore, it is noticeable that the private sector too can involve in agricultural extension activities. Fertilizer companies could act as the key partners in the process of technology transfer to the growers. Therefore, policies could be formulated to motivate the private sector to expand their agricultural extension activities. When conducting farming seminars or demonstration events, inviting growers' families and advisors along to the same session is very important in order to stimulate peer−to−peer learning. Also ensure that other key decision−makers are there, which could include the landowners. Furthermore, keeping track of ongoing research on peer-to-peer learning by Coconut Research Institute (CRI) is vital. One of the deliverables involves the development of success factors for good peer−to−peer knowledge exchange, a key component of social change.

Where behavioral change was incentivized, there were signs of positive change, although perhaps not in the long−term. Therefore, first, the policymakers should find ways of rewarding good behavior in a sustained way, for example, the government can issue a 50 kg APM and YPM fertilizer bag to the cost of 1,672.08 LKR which was identified by the current study via CVM. Then it is a good reward for the fertilizer recommendation to adopted coconut growers, meanwhile, non-adopters could also be motivated due to the affordability of the price.

The Sri Lankan policymakers are another group that could use the outcomes of the study, especially in the Ministry of Plantation Industries in addressing the issues related to the lower level of fertilizer application by the coconut growers. One of the major strategies of the Ministry of Plantation Industries is to achieve higher coconut yield from the existing lands and uplift the financial status of the coconut growers in Sri Lanka. The statistical data and the information that will be provided by this study would be able to help them to improve existing policies and design new policies by targeting coconut growers in Sri Lanka to enhance their economic well-being levels, reduce the poverty and increase the coconut growers' contribution to the Sri Lankan economy.

The current study shows that several factors affected the growers' behavioral changes in the context of fertilizer application, for example, attitudes, SN, PBC, education, farm size, income, and age. Further, there has been no research done to integrate CVM to calculate the average willingness to pay for fertilizer by the growers in the context of agriculture. Therefore, this research is beneficial for academicians to improve their understanding of the factors affecting the growers' behavioral changes in fertilizer application, and the use of CVM to estimate the average willingness to pay.

Sri Lankan coconut growers are the target respondents of this study but only the sample selected for the study is comprised of the coconut growers in the coconut triangle which represents more than 80% of the coconut cultivation of Sri Lanka. It represents only four districts of Sri Lanka out of twenty-four. Thus, it has faced the limitation of location-feedbacks. Further, the list of growers was taken from the CCB of Sri Lanka, and it was used as the population for this study due to the lack of proper statistics about coconut growers. Sampling errors can occur when a stratified random sampling method is used to select a sample, but that sample does not reflect the general population or appropriate population concerned, known as sample bias or selection bias. Furthermore, to collect quantitative data, close-ended questionnaire was used and it might force respondents to select a particular response that did not represent their actual output. Some kind of bias could be occurred in the survey

because of the self-administered questionnaire. Therefore, there is a chance to select the correct answer or any other answer that reflects their preference rather than the real practice.

In the current study, the researchers used only four factors of the growers (education, income, farm size, and age) to study their effect on TPB variables (attitudes, SN, and PBC), but in future studies, more factors should be incorporated to study the technology adoption behaviors of the growers.

CONCLUSIONS

Understanding growers' behavior and perceptions towards fertilizer application are necessary for policymakers to formulate effective policies on fertilizer application for better yield and productivity at the growers' level. The highly contributed variable for fertilizer application was PBC, followed by attitudes and SN. There were 14 beliefs that were contributed to forming PBC but only four main beliefs were identified which included the price of fertilizer, technical knowledge on fertilizer, labor scarcity, and having no interest. Considering the attitude formation for fertilizer application, there were four beliefs, the application of fertilizer will increase the yield, income, vigorous growth of the coconut palm, and it gives sustainable yield over the years. Furthermore, CDO and fertilizer shop keeper also influenced the coconut growers to apply fertilizer.

A positive correlation was revealed between attitude towards fertilizer application, and growers' socio-economic characteristics, such as education, grower income, and farm size, but the growers' age correlated negatively. Only, age had a significant relationship with SN. For PBC, it had a positive correlation with income and farm size but had a significant negative correlation with age. Further, the growers' willingness to pay for a 50 kg bag of APM fertilizer was 1,672.08 LKR.

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