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Assessment of Farmers' Knowledge and Attitudes Towards the Commercialisation of Tailor-made Fertilisers in Thailand

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ABSTRACT

In Thailand, chemical fertilisers provide nutrients that are essential for increasing agricultural productivity but they are expensive, often representing 25% of the crop production cost. Tailor-made fertiliser technology is a new fertiliser application technology that is being promoted to help farmers reduce fertiliser costs. This study aims to investigate and clarify sugarcane farmers' knowledge and attitudes towards tailor-made-fertiliser. This study also attempts to provide a better understanding of the effect of farm size on farmers' beliefs and attitudes towards tailor-made-fertiliser. Moreover, the findings suggest that further extension of tailor-made-fertiliser practices should include training services for smallholders to improve their knowledge of relevant practices.

Key words: Tailor-made fertilisers, farmers' knowledge, farmers' attitude, different-sized farms

INTRODUCTION

In Thailand, chemical fertiliser has played an essential role in increasing agricultural productivity and the reduction of land for agricultural use and the deterioration of the soil quality in cultivated land have resulted in a steady increase in its use. However, Thailand relies on imports for 85% of its chemical fertiliser consumption (Phelinas, 2001). To meet the increasing domestic demand, imports of chemical fertilisers into Thailand increased by an average of 11.11% per year from 2008 to 2012, from 3.80 million tons in 2008 to 5.58 million tons in 2012 (OAE, 2012). As demand has outpaced supply, fertiliser prices have increased dramatically, with fertilisers now representing 25% of the crop production cost (OAE, 2009). Based on the above data, the government has been attempting to implement strategies to reduce the amount spent on fertiliser to lower crop production costs. Several such strategies have been proposed, including encouraging farmers to apply fertiliser as efficiently as possible to reduce the cost of production and to increase yield. Tailor-made fertiliser (TMF) technology is an appropriate technique for the efficient use of fertiliser. TMF refers to a concept of fertilisation based on providing crops with only the specific nutrient management they require. The advantage of TMF technology is that it would help farmers improve the efficiency of fertiliser use, which will help them reduce fertiliser costs. The application of TMF on a farm has been demonstrated by Attanandana *et al.* (2001), who reported that by applying TMF in rice fields, farmers can save an average 510 Thai baht per rai on production costs

and reduce the cost of imported fertiliser by at least 10,000 million Thai baht per year. Sriswasdi *et al.* (2008) concluded that TMF is much more preferable than the traditional approach to obtaining higher yields and reducing the cost of fertilisation. The government-supported TMF program subsidises fertiliser for farmers cultivating rice, cassava and corn in target areas. The government has also initiated efforts to educate farmers on the use and benefits of TMF and has advised farmers to analyse soil data to determine the specific nutrient requirements for their plants. With the potential of TMF technology, in addition to the government, the private sector is also actively involved in TMF marketing. Fertiliser companies are providing TMF for specific cultivation requirements to sell to farmers. However, TMF is new to the market and farmers still have the option of applying other types of fertiliser on their farm. Information about farmers' knowledge and attitudes towards TMF technology is essential for better understanding farmers' beliefs and attitudes towards the introduced soil fertility enhancement technologies (Enyong *et al.*, 1999). It has been noted that farmers differ from one another in personality, cognitive ability, attitudes and objectives and these differences are likely to be reflected in their management decisions (Austin *et al.*, 2001; Power *et al.*, 2013). Therefore, this study aims to provide a better understanding of farmers' beliefs and attitudes towards TMF. This study also seeks to investigate whether farm size has a significant effect on farmers' attitudes towards TMF. It is expected that farmers' knowledge and attitudes will vary significantly between farms of different sizes in Thailand. This study focuses on sugarcane cropping, which is a major economic crop and ranks third in chemical fertiliser use by crop in Thailand.

LITERATURE REVIEW

Farmers' knowledge of agricultural practices: Azman *et al.* (2013) noted that knowledge can be referred to as organised or processed information or data and is crucial in any innovation process. Knowledge is often created by a combination of education and experience and farmers use knowledge to arrive at decisions that influence agricultural management practices (Mangan and Mangan, 1998; Brosius *et al.*, 1986; Grossman, 2003). Calvo-Iglesias *et al.* (2006) added that an understanding of farmers' knowledge is useful for understanding changes that occur in the landscape at a local level, especially the terms of changes in land-use and cultural practices. If agricultural change agents do not understand the knowledge and priorities of producers, improved management will be difficult, if not impossible, to realise (Morales and Perfecto, 2000; Grossman, 2003).

Farmers' attitudes towards new agricultural practices: Attitudes can be strong predictors of behaviours or the acceptance of ideas (Ajzen, 1991; Dietz *et al.*, 2005; Arbuckle *et al.*, 2013). Policy-makers have recognised that the way in which farmers adjust to changes in agricultural policy depends partially on the latter group's attitudes and mind-sets (Gorton *et al.*, 2008). When providing new technology to farmers, understanding their perceptions and attitudes can shed light on why farmers adopt technologies beyond their economic benefits and which industry researchers should focus on to encourage the adoption of these technologies (Adrian *et al.*, 2005). Many historians have argued that the evaluation of farmers' knowledge and perceptions is essential for the development of management strategies that match farmers' aspirations and are thus likely to be adopted (Chitere and Omolo, 1993; Rubia *et al.*, 1996; Tanzubil and Yakubu, 1997; Nyeko *et al.*, 2002). Yang *et al.* (2005) added that the evaluation of farmers' knowledge, perception and practices regarding a new technology is essential for the development of strategies to sustain

the new technology. Elsewhere, Dawoe *et al.* (2012) have argued that farmers' knowledge and perceptions of soils, as well as local indicators of soil quality, are important for the development of technologies and management interventions.

Previous research: Numerous studies have attempted to investigate farmers' knowledge and attitude towards new agriculture technology. Nyeko *et al.* (2002) investigated farmers' knowledge and perceptions of pest problems in agroforestry in Kabale district, Uganda, to provide the information necessary to promote the development of appropriate technologies and strategies to improve local systems of plant protection. Garforth *et al.* (2006) studied farmers' attitudes towards techniques for improving oestrus detection in dairy herds in southwest England to identify the causes of the low implementation rate of this technology and to improve the design of future knowledge transfer activities in this field. Odeyinka *et al.* (2007) investigated crop farmers' perceptions of Moringa oleifera in Nigeria to improve strategies to popularise this plant among Nigerian farmers. Brown and Khamphoukeo (2007) studied farmers' rodent management knowledge, attitudes and practices in the upland and lowland farming systems of the Lao People's Democratic Republic to better understand rodent management problems, which are a serious constraint for poor farmers in these farming systems. Litsinger *et al.* (2009) studied how farmers' knowledge, attitudes and practices were elicited in the development of integrated pest management programs for rice in Asia. Stuart *et al.* (2011) studied farmer's knowledge, attitudes and practices related to rodent pests and their management in the lowlands of the Sierra Madre Biodiversity Corridor, Philippines, to understand the attitudes of farmers towards community actions for rodent management. Bruijnis *et al.* (2013) studied dairy farmers' attitudes and intentions towards improving dairy cow foot health to improve the approaches used to address foot disorders in dairy cattle.

Several studies have attempted to investigate farmers' knowledge and attitudes towards new agriculture schemes. Gorton *et al.* (2008) studied farmers' attitudes toward agricultural policy and farming futures in the context of the 2003 Common Agricultural Policy (CAP) reform to provide a better understanding of farmers' attitudes and behavioural intentions and, consequently, to generate insights into likely responses to a policy change. Xu *et al.* (2011) studied the attitudes of farmers toward the New Rural Cooperative Medical Scheme in Northwest China one year after its introduction to guide policy-makers on how to improve the current national policy. Siebert *et al.* (2010) studied the attitudes of farmers towards a policy approach that combines the instrument of set-aside farmland with agri-environmental measures under CAP to achieve environmental goals. The study aimed to determine what types of problems might arise for farmers in the course of implementing this concept as an agri-environmental measure.

In the fertiliser context, farmers' local knowledge of soil fertility and management strategies plays a significant role in the fertility maintenance of farmlands (Dawoe *et al.,* 2012). Jia *et al.* (2013) added that knowledge training can help farmers reduce their N fertiliser use. An understanding of farmers' perceptions and attitudes towards the new technology being introduced is essential for a better understanding of the implementation behaviour of these farmers (Enyong *et al.*, 1999).

Numerous studies have attempted to investigate farmers' knowledge and attitudes towards fertilisers (Enyong *et al.*, 1999; Farouque and Takeya, 2007; Okoedo-Okojie and Aphunu, 2011; Cavane, 2011; Zhou *et al.*, 2010; Chouichom and Yamao, 2010). Among these studies, several have attempted to explain the attitudes of farmers belonging to different groups. Farouque and Takeya

(2007) assessed farmers' attitudes in different samples based on landholder (landless or holding marginal, small, medium-sized or large farms). Similarly, Alam *et al.* (2010) also assessed farmers' attitudes towards four different farm sizes according to landholder class (marginal, small, medium-sized and large farms). Cavane (2011) assessed farmers' attitudes in the highlands and lowlands of the Manica district, Mozambique. However, little research has explored farmers' knowledge of fertilisers. Zhou *et al.* (2010) studied farmers' knowledge of chemical fertilisers in northern China. Okoedo-Okojie and Aphunu (2011) recently studied farmers' knowledge of organic fertiliser use in the northern agricultural zone of Delta State, Nigeria.

Based on previous studies, it is widely accepted that information about farmers' knowledge and attitudes towards such agricultural practices will provide a better understanding of how to encourage farmers to implement cropping strategies and to improve their delivery approaches. In the context of Thailand, TMF technology is a new fertiliser application practice in the cropping system; however, no research has been conducted to determine farmers' knowledge and attitudes towards tailor-made fertilisers according to farm size. Therefore, this study investigated sugarcane farmers' knowledge and attitudes towards tailor-made fertiliser based on farm size in Thailand.

METRIALS AND METHODS

Thamaka district of Kanchanaburi province, located in western Thailand, was selected as the study area. Agricultural production is the primary industry of Thamaka and its crop production is dominated by rice and sugarcane, with 66,816 rai devoted to rice cultivation and 40,557.50 rai devoted to sugarcane. Sugarcane farmers in Thamaka still apply fertilizer to cultivated areas in the traditional way; as a result, the cost of fertiliser accounts for 14% of the total production costs. Thus, sugarcane farmers in this area would likely benefit from adopting TMF as a new fertiliser practice. A sample was selected randomly from sugarcane farmers who sell their products at the Thamaka sugar refinery during the normal trading season. The sugarcane farmers sampled were interviewed using a structured questionnaire. The wording and appropriateness of the statements and questions were checked by piloting the questionnaire with 30 sugarcane farmers. The developed instrument was then used for the actual data collection. The sample comprised 387 sugarcane farmers, representing 3% of the 12,918 sugarcane farmers in Thamaka district (according to the formula established by Yamane, 1967). Overall, the data collection required 3 months (January to March 2012) to complete.

The statistical parameters used to analyse the data included the frequency distribution, percentage and standard deviation. To determine farmers' knowledge of tailor-made fertiliser, 17 statements were presented, almost all of which were developed using the concept of tailor-made fertiliser and the NPK Test Kit (DoA, 2005) and were chosen by the researchers based on a literature review. Knowledge was measured by "true" or "false" statements, where each correct answer was scored as 1 and each incorrect answer was scored as 0. Cut-off points are used to convert the probabilities of ignition into dichotomous 0-1 data. The scores varied from 0-14 points and were classified into three levels: low (less than 60%), moderate (60-80%) and high (>80%). The cut-off points for attitudes were determined after taking the mean of all respondents (Al-Alaboud and Kurashi, 2006).

To determine farmers' attitudes towards the "4Ps" marketing mix of tailor-made fertiliser, a five-point Likert rating scale was applied, where 1= not important and 5 = very important. The data for the five items of each marketing mix element were adapted from the work of Purnomo *et al.* (2010) and developed by the researchers based on farmers' buying fertiliser behaviour in

Thailand. To examine the difference in the means for the farmers' attitudes towards TMF. ANOVA was performed to examine the overall differences by farm size and the mean attitude score was compared using Scheffe's post hoc analysis.

EMPIRICAL RESULTS AND DISCUSSIONS

Demographic characteristics of the respondents: The demographic characteristics of the sample of farmers are given in Table 1. Sugarcane farmers were classified into four cultivated area holding categories according to farm size in hectares (ha): marginal (less than 1.5 ha), small (1.5 to 3.2 ha), medium-sized (3.2 to 8 ha) and large (more than 8 ha) (Kaenmanee *et al*., 1982). According to this classification, of the 387 respondents, 214 (55.30%) had large farms, 64 (16.54%) had medium-sized farms, 56 (14.47%) had small farms and 53 (13.70%) had marginal farms.

As seen in Table 1, men accounted for the clear majority of respondents in large (75.23%), medium-sized (60.94%) and small (62.50%) farms, while there was a relatively even distribution of men and women (52.83 and 47.17%, respectively) in marginal farms. The majority of respondents in large (42.52%) and medium-sized (53.13%) farms were 50-59 years of age, while the majority of respondents in marginal (41.51%) and small (44.64%) farms were 60-69 years of age. Regarding the distribution of schooling and education, over half of the respondents in small (69.64%) and medium-sized (54.69%) farms had not completed primary school education, which also represented the largest group among farmers of marginal (49.06%) and large (29.91%) farms. Over half the respondents in medium-sized (60.94%) and large (71.50%) farms had over 21 years of experience in sugarcane production, which also represented the largest group of respondents in marginal (39.62%) and small (42.86%) farms.

Table 1: Demographic characteristics of the respondents

	Farm size				
Demographic characteristics	Overall (%) (n = 387)	Marginal (%) (n = 53)	Small (%) (n = 56)	Medium (%) (n = 64)	Large (%) (n = 214)
Gender					
Male	63.67	52.83	62.50	60.94	75.23
Female	36.43	47.17	37.50	39.06	24.77
Age (year)					
20-29	1.30	-	-	-	2.34
30-39	9.60	13.21	8.93	3.13	10.75
40-49	18.30	26.42	19.64	10.94	18.22
50-59	38.80	18.87	26.79	53.13	42.52
60 and above	32.00	41.51	44.64	32.81	26.17
Edncation					
No formal education	4.65	3.77	-	-	7.48
Less than primary school	42.38	49.06	69.64	54.69	29.91
Primary school	19.12	5.66	14.29	17.19	24.30
Secondary school	12.40	24.53	5.36	7.81	14.02
High school	11.63	9.43	7.14	14.06	11.21
Bachelor's degree	9.82	7.55	3.57	6.25	13.08
Experience in sngarcane prodnction					
<10 years	10.34	33.96	16.07	6.25	4.21
10-20 years	28.42	26.42	41.07	32.81	24.30
>21 years	61.24	39.62	42.86	60.94	71.50

Table 2: Distribution of farmers' knowledge level of tailor made fertiliser

	Distribution of farmers by farm size (%)				
Knowledge level (% correct answered)	Overall	Marginal	Small	Medium	Large
Low (<60%)	20.16	22.64	10.71	6.25	8.88
Moderate (60-80%)	40.31	37.74	53.57	43.75	34.11
High (>80%)	39.53	39.62	35.71	50.00	57.01
Total	100.00	100.00	100.00	100.00	100.00

Table 3: Farmers' knowledge of tailor made fertiliser

	Correct answer by farm size (%)				
Parameters	Marginal	Small	Medium	Large	Overall
Qnalification of TMF	82.26	78.22	84.68	87.84	83.82
The TMF formula depends on the soil series	98.20	92.90	92.20	99.50	97.90
TMF contains NPK suitable for specific soil and plant conditions	79.20	80.40	85.90	91.60	87.60
TMF recommends a different fertiliser for each soil series	86.80	83.90	89.10	80.80	82.90
TMF contains an exact percentage of NPK, facilitating fertiliser nse	81.10	82.10	82.80	96.30	89.70
Farmers can choose their own material mix for the fertiliser	66.00	51.80	73.40	71.00	61.00
Prodnction of TMF	80.76	73.54	83.12	83.84	77.90
The producer should have knowledge of checking the soil set, soil sampling and soil analysis	86.80	85.50	92.20	90.70	92.00
The producer should obtain soil samples for plant mineral analysis before nsing TMF	84.90	78.60	95.30	86.90	88.40
Analysing soil samples reveals the essential mineral contents	90.60	91.10	85.90	90.70	89.40
Farmers are trained to analyse soil samples themselves	75.50	67.90	73.40	78.00	68.00
Farmers are trained to produce their own TMF	66.00	44.60	68.80	72.90	51.70
Application of TMF	68.40	69.63	79.70	87.98	80.83
TMF is sufficient to satisfy plant needs	86.80	82.10	87.50	92.10	89.40
When applying TMF, farmers should not burn rice straw or grass because rice straw can improve the soil structure (loosen soil) and increase soil K	56.60	73.20	79.70	86.40	79.80
TMF can reduce production costs	64.20	60.70	64.10	84.60	72.40
TMF can increase production yields	66.00	62.50	87.50	88.80	81.70

Farmers' knowledge of Tailor-made Fertiliser: The distribution of farmers' knowledge of tailor-made fertiliser (Table 2) indicated that, overall, nearly half of the respondents (40.31%) had a moderate level of knowledge, 39.53% had a high level of knowledge and 20.16% had a low level of knowledge. More than half the farmers of large farms (57.01%) had a high level of knowledge about TMF, as did half of the farmers of medium-sized farms (50%) and nearly half the farmers of marginal farms (39.62%). More than half of the farmers of small farms (53.57%) had a moderate level of knowledge about TMF. Interestingly, farmers of larger farms were more knowledgeable about TMF than farmers in smaller farms.

Table 3 shows the percentage of correct answers for each farm size regarding the qualification, production and application of TMF. The most widely known fact is the TMF qualification item, "The TMF formula depends on the soil series", while the least known fact is the TMF production item, "Farmers are trained to produce their own TMF". Overall, the respondents had a high level of knowledge (83.82%) about the qualification of TMF, with the knowledge level being high for

Table 4: Farmers' attitude towards marketing mix elements of tailor made fertiliser

Marketing mix elements	Farm size	Mean	SD	F-value	Significant difference*
Product	Marginal	3.09	0.332	25.119	Ma<M, Ma<L,
	Small	3.23	0.416		S<M, S<M
	Medium	3.47	0.485		
	Large	3.57	0.398		
Price	Marginal	3.23	0.493	10.712	Ma<M, S<L
	Small	3.36	0.551		
	Medium	3.42	0.563		
	Large	3.60	0.409		
Place	Marginal	3.05	0.519	18.894	Ma<M, Ma<L, S<L
	Small	3.26	0.674		
	Medium	3.45	0.510		
	Large	3.57	0.419		
Promotion	Marginal	3.13	0.541	17.655	Ma<M, Ma<L, S<L
	Small	3.37	0.679		
	Medium	3.46	0.478		
	Large	3.64	0.416		
Overall "4Ps"	Marginal	3.13	0.382	28.511	Ma<M, Ma<L,
	Small	3.30	0.476		S<L, M<L
	Medium	3.45	0.397		
	Large	3.59	0.307		

Ma: Marginal, S: Small, M: Medium-sized, L: Large, *all mean differences are significant at $p<0.01$ using Scheffe's *post hoc* testing procedure

marginal, medium-sized and large farms and moderate for small farms. The farmers of small farms had a low level of knowledge (51.8%) about the item of "Farmers can choose their own material mix for the fertiliser".

Overall, the respondents had a moderate level of knowledge about the production of TMF, which was high for marginal, medium-sized and large farms and moderate for small farms. The respondents overall had a relatively low level of knowledge (51.7%) about the item, "Farmers were trained to produce their own TMF", which was moderate for marginal, medium-sized and large farms and low for small farms.

Overall, respondents had a high level of knowledge (80.83%) about the application of TMF, which was high for large farms and moderate for marginal, small and medium-sized farms. It is interesting to note that the farmers of marginal farms had a low level of knowledge about the item "When applying TMF, farmers should not burn rice straw or grass because rice straw can improve the soil structure (loosen soil) and increase soil K".

Farmers' attitude towards the marketing mix element of Tailor Made Fertiliser: Farmers were asked to rate the importance of the role of TMF marketing mix factors in their decision-making (Table 4). It is important to ask questions about farming as a general context to assess its importance in the balance of decision-making (Guillem and Barnes, 2013). Farmer attitude toward the overall attributes of the "4Ps" marketing mix differed by farm size ($F = 28.511$, $p<0.01$). Furthermore, farmer attitudes toward each attribute of the "4Ps" marketing mix varied by farm size: product ($F = 25.119$, $p<0.01$), price ($F = 10.712$, $p<0.01$), place ($F = 18.894$, $p<0.01$) and promotion ($F = 17.655$, $p<0.01$). These findings show that farmers' attitudes differed by farm size.

Table 5: Comparison of farmers' attitudes towards marketing mix elements of tailor made fertiliser

	Farm size				
Farmers' attitudes towards marketing mix elements	Marginal	Small	Medium	Large	Significant difference*
Prodnct elements					
Stability of TMF product quality	3.30	3.39	3.61	3.71	Ma<M, Ma<L, S<L
Prodnct weight is the same as that indicated on the label	2.79	3.02	3.23	3.36	Ma<M, Ma<L, S<L
Prodnct formula is the same as that indicated on the label	3.08	3.41	3.61	3.65	Ma<S, Ma<M, Ma<L
Prodnct is well recognised by its packaging	3.02	3.20	3.47	3.38	Ma<M, Ma<L
Soil analysis service offered	3.25	3.14	3.42	3.73	Ma<L, S<L, M<L
Price elements					
The price of TMF is lower than that of other fertilisers	3.32	3.00	3.09	3.30	S<L
The price of TMF is commensurate with its quality	3.30	3.59	3.34	3.80	Ma<L, M<L
The price of TMF is reasonable considering the farmer's purchasing power	3.13	3.59	3.66	3.87	Ma<S, Ma<M, Ma<L
The discount program is very nseful for farmers	3.15	3.25	3.47	3.43	-
The price is stable	3.26	3.38	3.52	3.57	Ma<L
Place elements					
Quick services satisfy the buyers	3.25	3.32	3.55	3.61	Ma<L
Retailers are widespread	3.09	3.43	3.52	3.52	Ma<M, Ma<L
Dealer/retailer sells directly to the farmer	3.21	3.41	3.73	3.60	Ma<M, Ma<L
Continuons product availability	2.64	2.87	3.02	3.49	Ma<L, S<L, M<L
Timely delivery	3.06	3.25	3.42	3.64	Ma<M, Ma<L, S<L
Promotion elements					
Dealer/retailer is more aggressive in its promotion than competitors	2.75	3.38	3.23	3.50	Ma<S, Ma<M, Ma<L
Dealer/retailer responds to the farmer's complaints	3.30	3.52	3.50	3.67	Ma<L
Dealer/retailer promotion is interesting	3.15	3.34	3.36	3.48	Ma<L
Dealer/retailer has good collaborations with other related companies	3.26	3.18	3.48	3.67	Ma<L, S<L
Dealer/retailer cares about the farmers' needs	3.19	3.43	3.72	3.91	Ma<M, Ma<L, S<L

Ma: Marginal, S: Small, M: Medium-sized, L: Large, *All mean differences are significant at $p<0.05$ nsing Scheffe's *post hoc* testing procedure

Scheffe's post hoc test indicated that there were significant differences ($p<0.01$) between each farm size; the overall marketing mix attributes of TMF were less important to smaller-farm farmers than larger-farm farmers. This seems to be consistent with reports by Purnomo *et al.* (2010), who found differences in customer attitude by farm size, with small farms having the lowest score, followed by medium-sized farms and then larger farms.

To obtain better insight into farmers' attitudes towards each of the "4Ps" elements, Table 5 shows the mean score and post hoc analysis for each statement by farm size. There were significant differences ($p<0.05$) in attitudes about the importance of each product element by farm size as well as attitudes about the importance of all product elements between farmers of marginal farms and other farms (small, medium-sized and large). There was a significant difference in attitudes about the importance of "Stability of TMF product quality", "Product weight is the same as that indicated on the label" and "Soil analysis service offered" between farmers of small and large farms. Similarly, a significant difference in attitudes was also found for the importance of "Soil analysis service offered" between farmers of medium-sized and large farms.

With regards to price element, no significant difference ($p<0.05$) was observed between farmers of different-sized farms for the statement "The discount program is very useful for farmers", whereas significant differences were observed between farmers of different-sized farms for the other four statements. The importance given to "The price of TMF is lower than that of other fertilisers" is significantly different between farmers of small and large farms. There was a significant difference between farmers of marginal farms and other farms in terms of attitudes about the importance of "The price of TMF is commensurate with its quality", "The price of TMF is reasonable considering the farmer's purchasing power" and "The price is stable". There was a significant difference in attitudes towards the importance of "The price of TMF is commensurate with its quality" between farmers of medium-sized and large farms.

Significant differences ($p<0.05$) were found in attitudes towards the importance of each place element by farm size. The attitudes about the importance of all promotion elements are significantly different between farmers of marginal farms and other farms. Moreover, a significant difference in attitudes towards the importance of "Continuous product availability" was observed between farmers of small and large farms and between medium-sized and large farms. There was a significant difference in attitudes towards the importance of "Timely delivery" between farmers of small and large farms.

Finally, a significant difference ($p<0.05$) was found in the attitudes towards the importance of each promotion element by farm size. The attitudes about the importance of all promotion elements were significantly different between farmers of marginal farms and other farms. In addition, farmer attitudes towards the importance of "Dealer/retailer has good collaborations with other related companies" and "Dealer/retailer cares about the farmers' needs" are significantly different between farmers of small and large farms.

CONCLUSION

Based on the questionnaire survey administered to a sample of sugarcane farmers in Thamaka district, Kanchanaburi Province, this study investigated farmers' knowledge of tailor-made fertilisers and attitudes towards a marketing mix of tailor-made fertiliser among four farm sizes. The results show that farmers' knowledge of and attitudes towards tailor-made fertiliser differed by farm size. Farmers of larger farms had higher levels of knowledge about tailor-made fertiliser than farmers of smaller farms. With regards to farmers' attitudes towards tailor-made fertiliser, the results show that farmers of larger farms perceived a higher importance of all marketing mix elements in terms of their decision-making to use tailor-made fertiliser than did farmers of smaller farms. This seems to be consistent with the results of previous studies (Farouque and Takeya, 2007; Alam *et al*., 2010; Purnomo *et al*., 2010) reporting different attitudes among farmers of different farm sizes and according to customer size segment. Knowledge enables farmers to understand how to apply good agriculture practices (Azman *et al*., 2013). This, in turn, suggests that further extension of tailor-made-fertiliser practices should include training services for smallholders to improve their knowledge of practices.

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