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Lendel K. Narine
Utah State University Extension

Amy Harder
University of Florida

Grady T. Roberts
University of Florida

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Lendel K. Narine
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The Ministry Extension struggled to provide adequate services to Trinidadian farmers because of a reliance on top-down methods. Information Communication Technologies (ICTs) have been touted as an effective and efficient way to serve farmers in the Caribbean. This study sought to describe the factors affecting Ministry Extension officers' decisions to adopt text messaging via Short Messaging Service (SMS) to communicate with farmers. The Diffusion of Innovation theory (Rogers, 2003) guided this study, and data were collected from a census of Extension officers in the Ministry Extension service. Results showed most Extension officers used voice calls and SMS to communicate with farmers. Many Extension officers who did not use ICTs were willing to use multimedia messaging, SMS, electronic mail (email), voice calls, and social media to interact with farmers. Extension officers were accustomed to using text messaging, saw the benefit of using SMS to communicate with farmers, and were confident in their ability to use SMS for farmer interactions. However, results indicated a lacking policy environment for SMS use, and limited support existed from peers and supervisors to use SMS to interact with farmers. Findings showed most Extension officers perceived farmers can use mobile telephones to make calls, send text messages, and use multimedia messaging. This implies Extension officers were aware of the potential for using a variety of ICTs to engage with farmers. However, internal policies and administrative support are critical to their adoption of ICTs for farmer interactions in Extension.

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Introduction

The National Food Production Plan (2012 – 2015) of the Ministry of Agriculture Land and Fisheries in Trinidad and Tobago indicated a need to improve the competitiveness of domestic producers. The national plan prioritized national food security and the need to increase domestic production, reduce the food import bill, and create productive employment opportunities in the agricultural sector. The national plan guides the mandate of the Extension Division of the Ministry of Agriculture Land and Fisheries in Trinidad, henceforth referred to as Ministry Extension. The Ministry Extension is the dominant provider of extension in Trinidad (Ganpat, 2013). Therefore, the mobilization of the national plan depends on the effectiveness and efficiency of Ministry Extension.

Extension has county offices in all regions of the country (Ganpat, 2013). Extension officers in county offices provide administrative services to farmers, farm visits, and farmers' training programs. However, with an Extension-to-farmer ratio of 1:600 and reliance on top-down extension methods and traditional information dissemination techniques, the Ministry Extension struggles to provide adequate services to Trinidadian farmers (Ganpat, Webster, & Narine, 2014; Ram, Ganpat, & Narine, 2017; Seepersad, 2003). The adoption of modern extension approaches is essential to addressing the needs of Trinidad's farmers (Ganpat, Narine, & Harder, 2017; Ganpat, Ragbir, & de Freitas, 2010; Renwick, 2010).

The use of Information Communication Technologies (ICTs) has been touted as an effective and efficient way to serve farmers in the Caribbean (Ganpat & de Freitas, 2010). McNamara, Belden, Kelly, Pehu, and Donovan (2017) defined ICTs as "any device, tool, or application that permits the exchange or collection of data through interaction or transmission" (p. 3). ICTs include traditional devices such as radio, and modern technologies such as satellite imaging and smartphones. Wright et al. (2016) found extension officers' adoption of Short Messaging Service (SMS) in Kenya resulted in an increase of service quality and timeliness. According to the World Bank (2017), adoption of ICTs can reduce the overall cost of extension service delivery. Nonetheless, Ministry Extension officers in Trinidad mainly communicate with farmers via traditional farm visits (Ganpat & de Freitas, 2010), and one-way mass media such as radio and television are used to disseminate farming information (Ganpat et al., 2010; Strong, Ganpat, Harder, Irby, & Lindner, 2014).

Farmers' needs are not met if Extension farm visits are infrequent which is a common occurrence in the Caribbean (Ganpat et al., 2017). Strong et al. (2014) found many Ministry Extension officers used modern ICTs in their daily work routines for communicating with supervisors and enhancing their personal knowledge. However, no evidence of Extension officers' willingness to use modern ICTs to communicate with farmers has been reported. This study refers to modern ICTs as a technology cluster and is related to the use of mobile telephones for calls, SMS, Multimedia Messaging Service (MMS), social media, Skype, and email. Rogers (2003) stated a technology cluster is "one or more distinguishable elements of technology" that are perceived to be closely interrelated (p. 14). The World Bank (2017) indicated SMS is available on older mobile devices, making it accessible to any individual with a mobile telephone. Therefore, this study prioritizes Extension officers' perceptions of SMS as an innovation to communicate with farmers.

Theoretical Framework & Review of Literature

This study sought to determine Extension officers' adoption of text messaging to communicate with farmers in Trinidad and was guided by Rogers' (2003) Diffusion of Innovations theory. Rogers noted the diffusion process involves the innovation, an individual with knowledge of the innovation, another individual without knowledge of the innovation, and the communication channels connecting these individuals. According to Rogers, the underlying nature of an innovation is adoption uncertainty, and diffusion is an uncertainty-reduction process. The innovation itself is of importance to this study. Rogers identified five characteristics of an innovation, in order of predictive power, these are relative advantage, compatibility, complexity, trialability, and observability.

Relative advantage refers to "the degree to which an innovation is perceived as better than the idea it supersedes" (Rogers, 2003, p. 229). Rogers and Shoemaker (1971) noted relative advantage encompasses economic benefits and psychological factors such as social prestige, convenience, and satisfaction. Tornatzky and Klein (1982) stated relative advantage is dependent on the contextual setting, making it a highly subjective factor regarding an innovation's adoption. The perception of Relative advantage is positively related to the adoption of the innovation (Rogers, 2003).

Compatibility is the "degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers, 2003, p. 240). Compatibility depends on the characteristics of the social system with respect to sociocultural values, beliefs, and adopters' needs (Rogers & Shoemaker, 1971). It is a subjective factor of adoption as it depends on the social context (Tornatzky & Klein, 1982). Perceptions of Compatibility are expected to have a positive relationship with the adoption of an innovation (Rogers, 2003).

Complexity is another attribute of an innovation. In contrast to relative advantage and compatibility, complexity is expected to have a negative relationship with the rate of adoption (Rogers, 2003). Complexity is "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 2003, p. 257). Rogers said an innovation can be defined on a complexity-simplicity continuum; an innovation tending toward simplicity is more easily adopted. Tornatzky and Klein (1982) argued complexity is theoretically less dependent on the subjective characteristics of a social system. Rogers indicated relative advantage and compatibility are expected to have a stronger relationship with adoption compared to complexity. However, Moonsammy, Narine, Harder, and Rodriguez (2017) found complexity was the most important innovation characteristic affecting Grenadian farmers' adoption of drip irrigation systems.

Trialability and observability are expected to have comparatively weaker effects on overall adoption compared to relative advantage, compatibility, and complexity (Rogers, 2003). Rogers and Shoemaker (1971) defined trialability as "the degree to which an innovation may be experimented with on a limited basis" (p. 155). Rogers noted trialability can reduce uncertainty and is expected to positively affect adoption. Trialability also allows for re-invention based on the innovation's appropriateness to the social setting and the adopters' needs. A high degree of trialability suggests users can modify or re-invent the technology to fit their needs within a specific context (Rogers, 2003).

The last attribute of an innovation, observability, was defined as "the degree to which the results of an innovation are visible to others" (Rogers, 2003, p. 258). Rogers noted it may be easier to visually observe innovations with a predominately hardware component because it has a physical or material presence. For example, individuals can easily observe the use of mobile telephones by others in their communities. In contrast, SMS is a software component of the mobile device; a person can own a mobile telephone and not use SMS. Hence, an Extension officer's use of SMS to communicate with farmers is not easily observed by others. Perceptions of Observability are expected to have a positive relationship with an innovation's rate of adoption (Rogers, 2003).

Innovations are more likely to be adopted when they are compatible with the existing system (Rogers, 2003). ICT infrastructure in the Caribbean is well-developed and supports widespread access through extensive mobile networks (Ganpat & de Freitas, 2010; Ganpat, et al., 2014; Renwick, 2010; Strong et al., 2014). Ramjattan (2016) found a general deficiency in content appropriate for delivery through ICTs in Trinidad, indicating agricultural factsheets and booklets were mostly available in hard copy format.

Although compatibility exists with respect to infrastructure, cultural compatibility with existing norms is uncertain. ICTs may have lower compatibility with the social system of Extension in Trinidad**.** In this regard, Extension officers enjoy farm visits because it provides them with an opportunity to spend time away from the office (W. Ganpat, personal communication, February 1, 2018). In addition, Extension officers are compensated for the traveling cost incurred through farm visits. Extension officers may prefer the outdoor aspect of their jobs because it gives them greater flexibility in their work schedules. Officers' adoption of mobile ICTs may reduce the need for farm visits, resulting in increased office time, less flexibility in work hours, and decreased benefits from travel reimbursements. Therefore, Extension officers may be concerned about the unintended consequences of adopting modern ICTs. However, these postulations have not been researched. Strong et al. (2014) stated extension officers in the Caribbean regularly used ICTs for personal reasons, chief of which was for personal communication. Extension officers had adequate literacy to use ICTs for interacting with others, but Ganpat, Ramjattan, and Strong (2016) found officers perceived a low level of institutional support from superiors and a lack of enabling policies to use modern extension methods. As such, Caribbean extension officers' intentions to use the technology to contact farmers was ranked lowest compared to other uses of ICTs (Strong et al., 2014).

With respect to complexity, Strong et al. (2014) explained officers may need specialized training on using ICTs. Samuel et al. (2014) found extension professionals in the Caribbean Community (CARICOM) perceived they had low competence for using ICTs. Communicating with farmers via ICTs may require a different skillset compared to those needed for interactions with colleagues (Strong et al., 2014). Campo, Robinson, Isaac, and Ganpat (2017) reported that a lack of professional training on ICTs was a challenge to the use of such Trinidad.

For relative advantage, Donovan (2017) noted SMS allows extension officers to send personalized information to farmers. Compared to the farm visit approach, this method is cheaper and reduces travel cost (World Bank, 2017). However, Samuel et al. (2014) found extension professionals in

CARICOM did not believe ICTs were of very high importance. This implied that Extension professionals are likely to perceive ICTs may not have much relative advantage over traditional methods.

Rogers (2003) found observability positively affected adoption of an innovation. Rogers indicated software innovations are less observable and may have a slower rate of adoption. This study focused on Extension officers' use of SMS to interact with farmers, i.e. a software innovation. In this regard, observability of SMS is lower compared to innovations with an observable hardware aspect. However, Ntemana and Olatokun (2012) reported observability had the highest impact on teachers' adoption of ICTs in Lesotho. Further, Schillewaert and Ahearne (2015) indicated ICTs were more likely to be adopted if peers accepted the technology. Therefore, observability may be linked to Extension officers' perceptions of the social acceptance of ICTs within their professional or work-related social system, i.e. Ministry Extension.

Socio-demographic factors such as age, gender, experience, and education can also affect ICT adoption (Haji, Pezeshki, & Chizari, 2014; Tata & McNamara, 2016). Purnomo and Lee (2010) indicated younger extension officers and those with more formal education were more likely to have positive attitudes toward an ICT program in Indonesia. Women tend to value opportunities to help others (Konrad, Ritchie, Lieb, & Corrigall, 2000), and studies have shown that they are more likely to use ICTs to meet farmers' information needs (Hadi & Yi-Hsuan, 2010). Ramjattan (2016) similarly reported female Extension officers, officers with diplomas, and those with greater professional experience used ICTs more than other extension personnel in Trinidad.

The Telecommunication Development Sector [ITU-D] (2018) indicated ICT infrastructure is well-developed and active mobile users in Trinidad increased by 21% from 2016 to 2017. Further, Extension officers have adequate levels of ICT literacy, and national policies support ICT use in agriculture (Ganpat et al., 2016; Strong et al., 2017). However, factors influencing Ministry Extension officers' decisions of whether to adopt SMS to communicate with farmers were unclear. Utilizing the Diffusion of Innovations theory (Rogers, 2003) will allow an assessment of the importance of these factors on Extension officers' adoption of SMS to communicate with farmers.

Purpose

This study sought to describe Extension officers' uses of modern ICTs and assess their perceptions of using the Short Messaging Service (SMS) to communicate with farmers. Four objectives supported achieving the study's purpose:

1. Describe Extension officers' uses of modern ICTs to interact with farmers;
2. Describe Extension officers' perceptions regarding the attributes of SMS as an innovation for interacting with farmers;
3. Compare Extension officer perceptions of SMS attributes based on adopter category;
4. Compare personal characteristics of Extension officers based on adopter category;
5. Describe Extension officers' perceptions towards farmers' abilities to use modern ICTs.

Methods

This study followed a causal comparative design (Ary, Jacobs, Sorensen, & Razavieh, 2009) and relied on data from

Extension officers of the Ministry Extension of Trinidad. The target population of this study was Extension officers of the Ministry of Agriculture, Land and Fisheries (MALF) in Trinidad. According to Roberts, Ganpat, Albert, Narine, and Sudeen (2016), approximately 12 frontline Extension officers work in each of the eight counties of Trinidad. Trinidad has an estimated population of 96 frontline Extension officers (W. Ganpat, Dean, Faculty of Food and Agriculture, The University of the West Indies, personal communication, March 11, 2018; J. Ramjattan, Extension officer, MALF, personal communication, March 13, 2018). This study sought to achieve a census of Ministry Extension officers. The survey response rate was 97% with 94 Extension officers responding (n = 94).

Diffusion of Innovation theory guided development of a researcher-made questionnaire to gather data for the study. The Tailored Design Method (Dillman, Smyth, & Christian, 2014) informed item design to ensure content, construct, and face validity. Questions were not double-barrelled and had an exhaustive list of mutually exclusive answer options. For Likert-type items, options on a five-point scale were evenly spaced with a clear mid-point. Further, items were grouped together by constructs to avoid unequal comparisons across different constructs. These measures also increased face validity and ensured consistency in item flow.

A panel of experts with specializations in extension education and questionnaire design reviewed the survey instrument for content and construct validity. Their major recommendations were the addition of items to several constructs, and rewording questions for readability. Next, a pilot study was conducted with a small portion of the population (n = 5) to ensure the instrument's face validity. Cronbach alphas were determined post-hoc for internal consistency with data from the census: Compatibility = .71, Complexity = .82, Relative Advantage = .84, Observability = .86, and Trialability = .85. All constructs had an acceptable internal consistency (Field, 2013). The final questionnaire was administered to the target population via face-to-face interviews in May of 2018 by a trained interviewer. The interviewer was an Extension officer assigned to the Plant Pathology Unit of MALF and a doctoral student of The University of the West Indies.

Guided by Rogers (2003) Diffusion of Innovations theory, this study assessed Extension officers' perceptions of the attributes of text messaging (SMS) as an innovation. The five attributes of text messaging were operationalized in a series of Likert-type items on a five-point scale (Relative advantage = 4 items, Complexity = 4 items, Compatibility = 5 items, Trialability = 4 items, and Observability = 3 items). Response categories for each item were 1 = *Strongly disagree*, 2 = *disagree*, 3 = *Neither agree nor disagree*, 4 = *Agree*, and 5 = *Strongly agree.* A respondent's agreement to an item corresponded to his or her perception of the favorability of the innovation's attribute. As such, the overall construct mean for each innovation attribute was interpreted in regard to Extension officers' perceived favorability as indicated by the real limits of the scale anchors: 1.00 – 1.49 = *very low favorability*, 1.50 – 2.49 = *somewhat low favorability*, 2.50 – 3.49 = *moderate favorability*, 3.50 – 4.49 = *somewhat high favorability*, and 4.50 – 5.0 = *very high favorability*.

The questionnaire also included items about Extension officers' uses of modern ICTs. Respondents were asked to indicate via a series of Yes/No questions if they used social media, SMS, Multimedia Messaging Service (MMS), voice calls, Skype, and email to communicate with

farmers. If their response to any item was "*No*", a follow-up Yes/No question inquired about their willingness to use the ICT service for farmer interactions.

Another section of the questionnaire examined Extension officers' perceptions toward farmers' abilities to use and willingness to learn about modern ICTs. ICTs examined were using a mobile telephone for calls, social media, SMS, Multimedia Messaging Service (MMS), Skype, and browsing the Internet for agricultural information. The response categories for these questions were *Yes*, *No*, or *Maybe*. The final section of the questionnaire asked Extension officers to indicate their educational levels, years of professional experience, gender, and age.

Given the use of a census, results of this study were presented as descriptive statistics and crosstabulations. Crosstabulations were used to describe the relationships between Extension officers' perceptions of the attributes of SMS and their adoption of SMS to communicate with farmers.

Census

Roughly one-half the population of Extension officers were male (51%, $n = 48$), 38 years of age, and had about 12 years of professional experience. Many officers who responded had earned a diploma (46%, $n = 41$), 25% ($n = 22$) achieved a bachelor's degree, 17% ($n = 15$) earned an associate degree, and a few held a postgraduate degree (12%, $n = 11$). Almost all Extension officers owned a smartphone (96%, $n = 87$) and used mobile Internet (96%, $n = 87$). Many officers also used SMS (95%, $n = 85$) and MMS (85%, $n = 77$). In addition, about 85% ($n = 79$) of respondents stated they used the Internet several times a day.

Results

Objective 1: Extension Officers' Uses of Modern ICTs to Interact with Farmers

Table 1 provides a descriptive summary of the ICTs that Extension officers used to communicate with farmers. Most officers (88%) contacted farmers through voice calls, and about 64% used SMS. Fewer Extension officers used email (40%), social media (34%), and MMS (34%) to communicate with farmers. Only 6% of officers used video calling to communicate with farmers.

Table 1
Extension Officers' Use of ICTs to Communicate with Farmers

Rank	ICT use	%, (*n*)	
		Yes	No
1	Mobile telephones (voice calls)	88 (83)	12 (11)
2	Short Message Service (text without pictures or video)	64 (60)	36 (34)
3	Email	40 (38)	60 (56)
4	Social Media (e.g. Facebook)	34 (32)	66 (62)
4	Multimedia Messaging Service (text with pictures, videos)	34 (32)	66 (62)
6	Video calling (e.g. Skype)	6 (6)	94 (88)

If a respondent did not use the ICT listed in Table 1, a follow-up question was asked about his or her willingness to use the innovation. Table 2 shows Extension officers' willingness to use ICTs to interact with farmers. A majority stated they were

willing to use MMS (81%), SMS (79%), email (73%), mobile telephones for voice calls (64%), and social media (58%) to communicate with farmers. However, only 43% of Extension officers were willing to use video calling to interact with farmers for that purpose.

Table 2
Extension Officers' Willingness to Use ICTs to Communicate with Farmers

Rank	ICT use	*n*	%	
			Yes	No
1	Multimedia Messaging Service (text with pictures, videos)	62	81	19
2	Short Message Service (text without pictures or video)	34	79	21
3	E-mail	56	73	27
4	Mobile telephones (voice calls)	11	64	36
5	Social Media (e.g. Facebook)	62	58	42
6	Video calling (e.g. Skype)	88	43	57

Objective 2: Extension Officers' Perceptions regarding the Attributes of SMS as an Innovation for Interacting with Farmers

Table 3 shows Extension officers' perceptions toward items related to the complexity of SMS. Results indicated Extension officers tended to agree SMS had favorable complexity ($M = 4.02$, $SD = .61$). Many Extension officers agreed they had the technical skills to use SMS (92%), they could use SMS to communicate with farmers (94%), SMS could be easily used to communicate with farmers (84%) and using SMS to communicate with farmers is easy (70%).

Table 3
Extension Officers' Perceptions toward the Favorability of Complexity

Items	%				
	SD	D	N	A	SA
I have the technical skills needed to use SMS.	1	1	6	54	38
I am fully capable of using SMS to communicate with farmers.	1	2	3	64	30
I think SMS can easily be used to communicate with farmers.	1	10	5	66	18
Using SMS to communicate with farmers is easy.	1	16	13	50	20
Complexity (Mean, *SD*)	4.02 (.61)				

Note: SD: *Strongly Disagree*, D: *Disagree*, N: *Neither Agree or Disagree*, A: *Agree*, SA: *Strongly Agree*.

Table 4 shows items related to the relative advantage of SMS. Results indicated Extension officers tended to agree SMS had favorable relative advantage ($M = 3.78$, $SD = .79$). Most Extension officers agreed SMS can play an important role in serving farmers (80%), meeting farmers' needs (75%), improving their relationship with farmers (72%), helping farmers improve their practices (73%), and addressing farmers' problems faster (68%).

Table 4
Extension Officers' Perceptions toward the Favorability of Relative Advantage

Items	%				
	SD	D	N	A	SA
SMS can play an important role in effectively serving farmers	0	10	10	55	25
If I use SMS to communicate with farmers, I can better meet their needs.	2	7	16	60	15
I can improve my relationship with farmers if I use SMS to provide Extension services.	2	10	16	54	18
I believe it is possible to help farmers improve their practices by using SMS.	2	10	15	57	16
If I use SMS to communicate with farmers, I can address their problems faster.	3	17	12	49	19
Relative Advantage (Mean, *SD*)	3.78 (.79)				

Note: SD: *Strongly Disagree*, D: *Disagree*, N: *Neither Agree or Disagree*, A: *Agree*, SA: *Strongly Agree*.

Table 5 displays respondents' perceptions toward items related to the trialability of SMS. Results showed Extension officers tended to agree SMS had favorable trialability ($M = 3.69$, $SD = .78$). Most officers agreed they would use SMS to communicate with farmers if given the opportunity (85%), and that many opportunities existed to use SMS to communicate with farmers (72%).

Table 5
Extension Officers' Perceptions toward the Favorability of Trialability

Items	%				
	SD	D	N	A	SA
If I get the chance to use SMS to communicate with farmers, I will give it a try.	1	6	8	67	18
There are many opportunities to use SMS when communicating with farmers.	4	10	14	56	16
I was able to try out using SMS to communicate with farmers.	6	19	9	55	11
Trialability (Mean, *SD*)	3.69 (.78)				

Note: SD: *Strongly Disagree*, D: *Disagree*, N: *Neither Agree or Disagree*, A: *Agree*, SA: *Strongly Agree*.

Table 6 reflects items related to the observability of SMS. Officers perceived SMS had less favorable observability ($M = 3.27$, $SD = .97$) compared to the characteristics of complexity, relative advantage, and trialability. A majority agreed Extension officers used SMS to communicate with farmers (51%), and farmers used SMS to communicate with officers (53%). However, fewer Extension officers agreed SMS was a common form of communication between Extension officers and farmers (45%).

Table 6
Extension Officers' Perceptions toward the Favorability of Observability

Items	%				
	SD	D	N	A	SA
Extension officers are using SMS to communicate with farmers.	7	13	21	50	9
Farmers are using SMS to communicate with Extension officers.	5	19	23	47	6
SMS is a common form of communication between Extension officers and farmers.	10	22	23	38	7
Observability (Mean, *SD*)	3.27 (.96)				

Note: SD: *Strongly Disagree*, D: *Disagree*, N: *Neither Agree or Disagree*, A: *Agree*, SA: *Strongly Agree*.

Table 7 shows Extension officers' perceptions toward items related to the compatibility of using SMS for farmer interactions. Extension officers tended to agree less on the favorability of compatibility associated with SMS (*M* = 3.10, *SD* = .90). Extension officers did not agree they were encouraged by their colleagues to use SMS (48%), farmers wanted to communicate with them via SMS (41%), their supervisors encouraged them to use SMS (45%), and Extension policies supported the use of SMS to communicate with farmers (38%).

Table 7
Extension Officers' Perceptions towards the Favorability of Compatibility

Items	%				
	SD	D	N	A	SA
I am encouraged by my colleagues to use SMS to communicate with farmers.	6	17	29	38	10
My farmer clientele wants me to use SMS to communicate with them.	4	22	33	34	7
My supervisor encourages me to use SMS to communicate with farmers.	11	23	21	40	5
Extension policy supports the use of SMS to communicate with farmers.	16	29	17	28	10
Compatibility (Mean, *SD*)	3.10 (.90)				

Objective 3: Compare Extension Officer Perceptions of SMS Attributes based on Adopter Category

Table 8 displays the differences between adopters and non-adopters based on Extension officers' perceptions of the attributes of SMS. Results indicated Extension officers who adopted SMS to communicate with farmers perceived all attributes were more favorable compared to the non-adopters. However, adopters and non-adopters agreed SMS had somewhat highly favorable complexity, relative advantage, and trialability. In contrast, both adopters and non-adopters perceived SMS had moderate compatibility (Adopters: *M* = 3.24, *SD* = .94; Non-adopters: *M* = 2.83, *SD* = .85) and observability (Adopters: *M* = 3.44, SD = .86; Non-adopters: *M* = 2.96, *SD* = 1.07).

Table 8
Extension Officers' Perceptions toward SMS Attributes by their Adoption Behavior

Construct	Construct Score: *M* (*SD*)	
	Adopters	Non-adopters
Compatibility	3.24 (.94)	2.83 (.85)
Complexity	4.09 (.57)	3.91 (.66)
Relative Advantage	3.80 (.71)	3.74 (.93)
Observability	3.44 (.86)	2.96 (1.07)
Trialability	3.80 (.72)	3.53 (.87)

Objective 4: Compare Personal Characteristics of Extension Officers based on Adopter Category

Table 9 shows the differences between adopters and non-adopters of SMS by Extension officers' selected personal and professional characteristics. Results indicated SMS adoption was higher among officers 18 to 30 years old (74%), those with diplomas or associate degrees (61%), and female (74%). SMS adoption was 15% higher for younger Extension officers compared to those older than 46 years, and 20% higher for female Extension officers.

Table 9
Extension Officers' Personal Characteristics and their Adoption of SMS

Characteristics	Level	*n*	SMS Adoption (%)	
			Yes	No
Age	18 to 30 (25th percentile)	23	74	26
	31 to 46 (50th percentile)	48	63	37
	> 46 (75th percentile)	22	59	41
Education	Diploma/Associate	56	64	36
	Degree/Postgraduate	33	61	39
Gender	Male	48	54	46
	Female	46	74	26

Objective 5: Extension Officers' Perceptions towards Farmers' Abilities to Use Modern ICTs.

Table 10 displays officers' perceptions of farmers' abilities to use ICTs. Most officers indicated that farmers were able to use mobile telephones for voice calls (96%), send SMS text messages (67%), receive pictures (64%), send pictures (61%), and receive videos from a mobile telephone (52%). However, less than one-half the number of Extension officers perceived farmers had the ability to use a mobile telephone or computer to browse the Internet for agricultural information, use social media, send videos from a mobile telephone, use email, or use the Internet for video calling.

Table 10
Extension Officers' Perceptions of Farmers' Abilities to Use ICTs and Related Services

Rank	Tasks	% (*n*)		
		Yes	No	Maybe
1	Use mobile telephones to make calls	96 (90)	1 (1)	3 (3)
2	Send SMS text messages	67 (62)	4 (4)	29 (27)
3	Receive pictures from a mobile telephone	64 (60)	6 (6)	30 (28)
4	Send pictures from a mobile telephone	61 (57)	7 (7)	32 (30)
5	Receive videos from a mobile telephone	52 (48)	6 (6)	42 (39)
6	Use a mobile telephone to browse the Internet for agricultural information	49 (46)	8 (8)	43 (40)
7	Use a computer to browse the Internet for agricultural information	48 (45)	8 (7)	44 (41)
8	Use social media (e.g. Facebook)	46 (43)	7 (7)	47 (44)
8	Send videos from a mobile telephone	46 (43)	7 (7)	47 (44)
10	Receive emails	42 (39)	13 (12)	45 (41)
11	Send emails	41 (38)	15 (14)	44 (41)
12	Use the Internet for video calling (e.g. Skype)	29 (27)	17 (16)	54 (50)

Table 11 indicates most Extension officers perceived farmers were willing to learn about all the ICT services examined in this study. Many indicated that farmers were willing to learn about using mobile telephones to make voice calls (86%), send and receive pictures from a mobile telephone (71%), use a mobile telephone and computer to browse the Internet for agricultural information (70%), send and receive videos from a mobile telephone (67% and 66% respectively), and send SMS text messages (66%). Slightly fewer officers indicated that farmers were willing to learn about using social media, sending and receiving emails, and using the Internet for video calling.

Table 11
Farmers' Willingness to Learn to Use Modern ICTs and Related Services as Perceived by Extension Officers'

Rank	Tasks	% (*n*)		
		Yes	No	Maybe
1	Use mobile telephones to make calls	86 (80)	4 (4)	10 (9)
2	Send pictures from a mobile telephone	71 (66)	2 (2)	27 (25)
2	Receive pictures from a mobile telephone	71 (66)	2 (2)	27 (25)
4	Use a mobile telephone to browse the Internet for agricultural information	70 (65)	4 (4)	26 (24)
5	Use a computer to browse the Internet for agricultural information	67 (62)	2 (2)	31 (29)
5	Send videos from a mobile telephone	67 (62)	3 (3)	30 (28)
7	Receive videos from a mobile telephone	66 (61)	4 (4)	29 (27)
7	Send SMS text messages	66 (61)	8 (7)	26 (24)
9	Use social media (e.g. Facebook)	59 (55)	7 (6)	34 (32)

10	Receive emails	56 (52)	10 (9)	34 (31)
11	Send emails	55 (51)	10 (9)	35 (33)
12	Use the Internet for video calling (e.g. Skype)	50 (46)	8 (7)	42 (39)

Discussion, Conclusions & Recommendations

This study investigated Extension officers' adoption of SMS and related ICT services to interact with farmers in Trinidad. Strong et al. (2014) indicated officers regularly used modern ICTs for personal reasons. Results of this study showed most officers used voice calls and SMS to communicate with farmers. Furthermore, many Extension officers who were not using ICTs were willing to use multimedia messaging, SMS, email, voice calls, and social media to interact with farmers. Past studies indicated a reliance on top-down extension models in the Caribbean (Ganpat et al., 2017; Ganpat, Ragbir, & de Freitas, 2010; Renwick, 2010). Now, it appears Ministry Extension officers are generally willing to use several forms of modern ICTs, including SMS, to communicate with farmers.

Rogers (2003) discussed the role of relative advantage, compatibility, complexity, trialability, and observability in the innovation-decision process. Extension officers perceived SMS had favorable complexity, relative advantage, and trialability. This suggest Extension officers are accustomed to using ICTs. Although Extension officers used modern ICTs regularly for personal reasons, Strong et al. (2014) noted they may need specialized training in using ICTs for communicating with farmers. Favorable complexity implies officers were confident in their ability to use SMS for farmer interactions. Perceptions of favorable relative advantage and trialability suggest that Extension officers had positive experiences experimenting with SMS to communicate with farmers and saw benefits in using SMS over other methods.

Extension officers' perceived SMS had lower observability and compatibility. Rogers (2003) noted software innovations are less observable compared to hardware innovations and may have a slower rate of adoption. Similar to Schillewaert and Ahearne (2015), observability was linked to the social acceptance of using SMS to communicate with farmers. However, findings showed Ministry Extension officers were less likely to perceive their peers used SMS to communicate with farmers. Extension officers also perceived SMS was less compatible with their jobs. Results indicated limited support from peers and supervisors to use SMS to interact with farmers. Most perceived a lack of enabling policies existed to encourage SMS use. This may explain officers' low intentions to use ICTs to contact farmers, as described by Strong et al. (2014). Although mobile infrastructure exists (Ganpat & de Freitas, 2010), the lack of perceived peer and administrative support may be impeding Extension officers' adoption of SMS for communicating with farmers.

Consistent with Diffusion of Innovations theory (Rogers, 2003), Extension officers who had more positive perceptions toward the favorability of SMS's compatibility, complexity, relative advantage, observability, and trialability adopted it for farmer interactions. However, personal characteristics also influenced adoption. Similar to Hadi and Yi-Hsuan (2010), results indicated younger officers, those with diploma or associate degrees, and female Extension officers adopted SMS for farmer interactions at a higher rate compared to other officers. Arguably, younger officers may be more familiar with mobile technologies, and were more likely to use

such modern ICTs during their diploma or bachelor's degree program. Venkatesh and Morris (2000) found men's intention to use technology was affected by their attitudes toward new technology.

Konrad, Ritchie, Lieb, and Corrigall (2000) indicated women valued opportunities to help others, whereas men valued promotional opportunities related to salary increases. However, it is unlikely SMS use results in job advancement due to its perceived low level of support from supervisors. Therefore, males may opt to focus on other aspects of their jobs that yield promotional opportunities, while females use SMS for the intrinsic benefits of helping others, but further research is needed regarding this aspect of the phenomenon. Overall, results suggest the five attributes of an innovation are important in facilitating Extension officers' adoption of SMS to communicate with farmers.

Extension officers who had more positive perceptions toward the attributes of SMS were more willing to adopt SMS for farmer interactions. Findings showed relative advantage and trialability were most important to officers' willingness to adopt SMS. Extension officers are very likely to adopt SMS for farmer communications if they understood the benefits of using SMS for such interactions and could experiment with the technology, i.e. more opportunity for observability and trialability (Rogers, 2003). These findings emphasize the need for facilitating Extension policies to speed the adoption process by focusing on all attributes of the innovation (Rogers, 2003).

Ramjattan (2016) indicated a major barrier to ICT use in Extension was officers' perceptions that farmers had limited capacity to use modern ICTs. However, Internet usage and active mobile users in Trinidad and Tobago increased by 7% and 21%, respectively, from 2016 to 2017 (Telecommunication Development Sector, 2018). Therefore, it is likely Extension officers encountered a greater number of farmers who used mobile ICTs in 2018 compared to 2016. As a result, findings showed most Extension officers perceived that farmers could use mobile telephones to make calls, send text messages, and use multimedia messaging. In addition, most Extension officers indicated that farmers were willing to learn about all of the ICTs and related services examined in this study. Coupled with Extension officers' confidence in their ability to use ICTs, this suggests a potential exists for Extension to use a mix of ICT technologies to serve farmers in Trinidad (McNamara et al., 2017). Results support the notion that modern ICTs could be used as an alternative method to meet the information needs of the nation's farmers (Ganpat & de Freitas, 2010).

This study bears major implications for Extension administrators and frontline Extension officers in Trinidad and perhaps other Small Island Developing States with similar contexts. Extension is tasked with mobilizing the National Food Production Plan of the Ministry of Food Production, Land and Marine Affairs. However, Extension is faced with major financial and human constraints which severely limit its ability to meet farmers' information needs (Ganpat et al., 2015; Seepersad, 2003). With a high Extension officer-to-farmer ratio, it is critical for Extension to explore alternative approaches to serving farmers in Trinidad. Further, a potential exists for Extension to use multimedia messaging and other modern ICTs to meet farmers' needs. Extension officers can use SMS to respond to farmers' questions and keep them updated with relevant information in between scheduled farm visits, thereby increasing service timeliness (Wright et al., 2015). This may reduce the need for frequent farm visits, which eases the time constraints of

Extension officers and reduce travel costs incurred by Extension (World Bank, 2017).

A need exists to ensure favorable conditions exist for Extension officers' adoption of modern ICTs to communicate with farmers. Enabling policies and managerial support is needed to improve the compatibility (Rogers, 2003) of using ICTs for farmer interactions. Extension policies should address cost recovery measures to ensure Extension officers are compensated for using their personal devices to communicate with farmers. In addition, financial and human resources are needed to facilitate the conversion of hardcopy educational material to digital content for dissemination through electronic platforms. Extension administrators must be willing to promote ICT use and facilitate social acceptance of the technology. This can be achieved through ICT professional development to communicate the need for, and benefits of using, SMS for communicating with farmers. Extension officers must understand the advantages of using ICTs over traditional methods, and gain support from supervisors and peers to use ICTs for regular interactions with farmers. ICTs are already a critical part of Extension in Trinidad, but a supportive work environment, including changing its norms, is needed to ensure it is effectively adopted to communicate with farmers.

Additional research is needed to explore supervisory support for ICT use as an alternative communication method for Extension in Trinidad. Moreover, other studies could focus on the potential for providing Extension services via other modern ICTs such as smartphone applications and the Internet. Cost-benefit frameworks are needed to determine the net change in service cost, quality, and timeliness of ICT-based extension approaches compared to the traditional farm visit approach. These studies should inform policy measures to create a facilitative environment for ICT uptake in Trinidad's agricultural sector.

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