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Participatory Trial Using SMS to Share Shrimp Health Information amongst Smallholder Shrimp Farmers in Sri Lanka

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Abstract

Shrimp farming plays an important role in generating livelihoods for coastal communities in the North Western Province of Sri Lanka. Despite ongoing efforts by public and private-sector technicians, smallholder farmers' livelihoods are constantly threatened by shrimp disease. During earlier work, we documented that shrimp farmers were weakly connected to knowledge networks and that most farmers only acquired knowledge through in-person visits with technicians. We hypothesized that short message service (SMS) might serve as a practical means of increasing shrimp-farmers' access to knowledge. We used a participatory approach to design a pilot study to use SMS messaging to mobilize knowledge about best management practices to prevent shrimp disease. We carried out an SMS trial with 60 farmers during one production cycle. Technicians performed water-quality analysis of common water bodies and collected information about shrimp health in real-time. They used this knowledge to compose SMS messages to distribute to participant farmers. At trial end, farmers reported that there was increased engagement in cooperative activity to reduce shrimp disease risks. After analysis of outcomes, decision makers engaged in a scale-up project to increase the number of shrimp farmers participating in the SMS programme and expand the programme to other aquaculture sectors.

Introduction

In Sri Lanka, a country recovering from civil war and natural disaster, shrimp farming is an important source of income for smallholder coastal farmers, particularly in the North Western (NWP) and Eastern (EP) Provinces. Since the end of the civil war in 2009 and recovery from the 2004 tsunami, the government in Sri Lanka has undertaken a number of steps to control devastating shrimp disease outbreaks including; creating administrative zones and subzones,

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organizing farmers into decision-making collectives known as a 'shrimp farmer societies'; regulating stocking time and density; and developing better management practices (BMPs). However, similar to challenges reported for uptake of agricultural extension in other developing countries (Tripp 2006), adoption of BMPs by shrimp farmers in the NWP has been limited and poor farm management continues to lead to disease outbreaks, most notably those caused by white spot syndrome virus (WSSV). Poor management also negatively impacts shared community resources and ecosystem health in coastal water bodies and surrounding lands (Munasinghe et al. 2010).

Reasons for failure of BMP uptake by shrimp farmers in Sri Lanka have not been previously documented. However, drivers of behavior change are well described in other settings and include a perception of a threat from the status quo, a perception that implementing the change is achievable, a social environment that is supportive of the new behavior, and a perception that the benefits outweigh the costs (Fishbein and Yzer 2003). Reasons for poor uptake of agricultural practices have also been thoroughly explored (Anderson and Feder 2007), and include farmer demographics, social-network structure, access to resources (financial, infrastructure, technology), cultural appropriateness of information and knowledge translation strategies, adequacy of institutions, and make-up of value chains. Within Asia, improving shrimp-farmer access to knowledge has been associated with improvements in production practices. In Thailand, increasing knowledge, and strengthening knowledge networks throughout the shrimp production system were associated with increased uptake of management practices by farmers (Pongthanapanich and Roth 2006). In India, farmer education and social participation, as well as strong extension support networks were associated with uptake of management practices (Kumaran et al. 2008).

This study evolved from long-term research in Sri Lanka into the causes and impacts of disease on smallholder shrimp farms. We previously reviewed the global literature to understand how smallholder aquaculture was linked to human wellbeing (Burns et al. 2014). Within Sri Lanka, we previously documented that farm disease status was linked to sustainability of farming practices and to farmer access to knowledge, and that most farmers only acquired expert-knowledge passively, mainly through in-person farm visits from technicians employed by input-supply companies (Westers 2012). Based on the research team's knowledge of the local situation and the work of others (Cecchini and Scott 2003; Donner 2008), we hypothesized that use of short message service (SMS) might serve as a practical means of increasing smallholder shrimp-farmers connection to knowledge networks and improving knowledge about BMPs. Short message service, or text messaging, uses standardized communications protocols to allow people to send and receive short text communications on mobile phones or other mobile technological devices. We could not find previous studies about using mobile technologies such as SMS as a tool for knowledge sharing in aquaculture in developing countries. In fisheries, SMS has been used to a limited extent, mainly to share pricing information and link buyers and sellers(Anonymous 2010; Sreekumar 2011). In agriculture, SMS has been used more extensively, including in Sri Lanka (Da Silva and Ratnadiwakara 2008), where access to mobile services is high and is generally available at low cost (International Telecommunications Union 2012). The potential benefits of SMS for agricultural extension in developing countries have been reviewed (Aker 2011), with some trials showing positive outcomes when used alone or in combination with traditional extension techniques such as farmer field schools and face-to-face farm visits. Mobile technology has the longest track-record as a tool to support behavior change for human health, and it has been validated in this context in developing countries(Cole-Lewis and Kershaw 2010; Fjeldsoe et al. 2009).

Our purpose was to use a participatory approach to both design and evaluate a trial to determine the feasibility of using SMS for knowledge-sharing within aquaculture in Sri Lanka. We were guided by three interrelated questions: Can SMS improve the experience of smallholder shrimp farmers with respect to connectivity to knowledge sources and/or knowledge providers? Will farmers respond to and/or share information received through SMS and with whom will they do so? Are farmers acting upon and implementing information received through SMS?

Materials and Methods

The trial was designed in conjunction with a combined provincial government-university-industry BMP initiative to develop and distribute BMP guides to farmers to help address locally relevant risk factors for disease outbreaks and production losses such as pond and water conditions, stock stress, health management and biosecurity.

Table 1. Eighteen better management practices recommended for shrimp farmers in Sri Lanka.

1.	Following crop calendar
2.	Drying pond bottom
3.	Checking of pH, Salinity, Alkalinity
4.	Purchase of good quality feeds
5.	Use of bird lines to prevent entering of birds
6.	Use of PCR to screen larvae for disease
7.	Feed monitoring using check trays
8.	Monitoring growth
9.	Monitoring of hatcheries by representative of farm associations/ farmers
10.	Screening of water through filter when filling the water
11.	Checking of Ammonia and Dissolved Oxygen
12.	Use of reservoir to treat incoming water to the pond
13.	Disposal of sediments away from the farm
14.	Use of crab nets to prevent entering of crabs
15.	Use of Probiotics
16.	Use of Chlorine/Chemicals to treat water before use for stocking
17.	Fertilizing the pond
18.	Use of foot bath and vehicle bath

Stakeholders in developing the BMP guide and SMS trial included faculty in the Department of Aquaculture and Fisheries at Wayamba University, staff in the Ministry of Fisheries NWP, and the Sri Lankan Aquaculture Development Association (SLADA; the industry organization representing aquaculture input-supply companies in Sri Lanka). Draft

BMPs (Table 1) were rolled-out in participatory community-meetings during which farmers were invited to contribute perspectives about how best to improve health management, minimize environmental impact, and increase productivity.

Through SLADA, members of the Aquaculture Technologists Society (ATS) were recruited to participate in the trial. The ATS is a professional organization made up of technologists employed by various input-supply companies to provide technical advice to clients. ATS members held university diplomas in aquaculture and had practical experience working directly with farmers in the region. Based on the BMPs, the research team collaborated with the ATS, university and government aquaculture experts, and a Sri Lankan private technology company to design a knowledge sharing strategy that used SMS to send information to farmers. This group determined that messages should provide information that would be (a) important in addressing risk factors and poor practices, (b) timely, so that information could be rapidly acted upon, (c) actionable, in that many farmers would have the capacity to respond, (d) easily deliverable over basic mobile phones, and (e) easily shared by farmers with each other. The five broad topics for messages were water analysis, disease prevalence, outbreak location, technical advice, and weather conditions. The specific content of each SMS was determined collaboratively in real-time by ATS members. Frequency of messaging varied depending on circumstances. Water quality was tested once per week at points where water was pumped in and out of shrimp ponds by a large number of farmers, and water quality SMS were generated from each test. Additional information, alerts, and advisories were sent out in real time by the technical advisory team as new information became available to them through their professional networks and interactions with farmers.

Open-forum meetings were held in 15 rural communities between research team members, ATS members, university aquaculture specialists and community members to provide orientation for the BMP manual, and discuss shrimp farming sustainability and ongoing WSSV disease. During the meetings, farmers received literature about BMPs. Communities that historically had high levels of shrimp disease were purposefully selected. From these meetings, a convenience sample of 75 farmers was selected for participation in the trial. The convenience sampling was determined by a number of factors relevant to the pilot trial:

(a) The farmer had to be in a production cycle through the course of the trial. The temporal and geographical staggering of the stocking of shrimp farms is determined each year by means of a crop calendar that stipulates which zones and sub-zones are permitted to stock ponds with post-larvae during specified periods. The majority of farms in NWP stocked sometime after February and with a 4-month production cycle, harvesting taking place sometime between May and July.
(b) Farmer societies were the most convenient and culturally acceptable way to approach participants for the trial. By agreement with the farmer societies, consent from shrimp farm society leaders was necessary to enroll members as participants in the trial. This also provided a means through which the role of the farmer societies in knowledge dissemination and farmer uptake of BMPs.

(c) Farm zonal leaders requested to be included as participants to understand the trial and incorporate learning into their zones. Therefore each of the five zonal leaders was included in the trial.

Process of initiating the trial

Mobile phones were purchased in Sri Lanka for distribution to participant farmers. The selection of the mobile phones was based on several criteria: low cost, SMS receiving capability and adequate memory. It was crucial to the trial that the phones be representative of the type that would be owned by the small holder farmers at the lower income levels to ensure there would be no barrier to access. The mobile phone model chosen was the Bird K103 Multimedia phone.

Of the 75 trial participants, 60 received mobile phones from the trial (SMS group) and 15 did not. A workshop was held in March, 2012 to distribute mobile phones and provide phone orientation for the 60 participant farmers who would receive information via SMS

Generation and distribution of messages

Message sending was initiated on April 2, 2012 and ended on July 31, 2012. This 4-month period of SMS delivery was designed to cover the full production cycle. A total of 180 SMS messages were sent over the 4-month period. All messages were sent to all 60 phone recipients. Messages were sent in phonetic Sinhala using roman language characters interspersed with English 'technical terms' commonly in use among shrimp farmers which is the common means of using SMS in Sri Lanka and widely understood. Examples of messages are provided in Table 2.

Table 2. Sample SMS messages sent to participating farmers.

1. Gill disease now a common problem observed in present cycle: Brown gills due to dead phytoplankton; Orange gills disease due to acid sulphate soil; Red gills due to low DO, Black gills due to very poor pond bottom
2. Udappuwa area reporting yesterday a sudden mortality of stock over 4 months old. Suspect WSSV infection.
3. Sixteen ponds infected with WSSV within 3 days at Muthupanthiya.
4. Udappuwa and Andimunae lagoon areas are developing dark brown algae (dinoflagellate) bloom. Its effect [is] to increase pH & [causes] blocked gills, when you intake the water please be careful.
5. Udappuwa farmers are facing DO drop problem and poor water quality in lagoon. Contact technical staff.
6. Chilaw lagoon recorded low water pH this week. Please pay attention especially for Thoduwawa, Iranawila and Ambakandawila shrimp farmers. Hydrogen sulfide is more toxic at low water pH to shrimp.

Data collection

At the end of the trial, in-person questionnaires were administered to trial participants. Questions were multiple choice and collected information on farm characteristics, farmer perception of disease during the study production cycle as compared to previous cycles, impact of SMS on farming practices, impact of participation on farmer communications, and farmers' perceptions of the value of participating in the trial. For each question, farmers were asked to rank responses from one (not important/not helpful) to five (very important/very helpful). The Stuart Maxwell Chi-square test was used to examine the number of farmers using different communication methods (in-person, mobile voice, SMS) before and after the trial for both the SMS and control groups. The Pearson Chi-square with exact p-values was used to examine if, for farmers using in-person communication at the start of the trial, there was a difference in the communication method used by the SMS and control groups at the end of the trial.

Results

Participant farmer characteristics

Participants' farm characteristics are presented in Table 3.

Table 3. Characteristics of farms owned by the 75 farmers participating in the trial.

Farm Characteristic	SMS group	Control
Number of farmers	59	15
Number of female farmers	5 (8%)	1 (7%)
Number of ponds (median, 1^{st} - 3^{rd} quartiles)	4 (3 - 8)	3 (2 - 6)
Total pond area (acres, median, 1^{st} - 3^{rd} quartiles)	5 (3 - 10)	4.5 (2.5 - 8)
Employees- Full-time paid	30 (51%)	0
Employees- Part-time paid	32 (54%)	15 (100%)
Family workers- unpaid	35 (59%)	5 (33%)
Have a stock tank	21 (36%)	1 (7%)
Have pond-side electricity	41(69%)	5 (33%)
Have aerators	51 (86%)	14 (93%)
Shrimp weight at harvest (grams, median, 1^{st} - 3^{rd} quartiles)	17.5 (12-23)	20 (11-25)
% of shrimp surviving to harvest (median, 1^{st} - 3^{rd} quartiles)	75 (65-80)	70 (60-80)

Farmer perception of disease during the study production cycle

Farmers reported that shrimp disease was a very important problem (median 5, q1-q3 5-5). Sixty-two percent of farmers (45/73) reported that they were affected by disease in the study production cycle, and 57% of farmers (42/73) reported that they harvested early because of disease. Farmers that were affected by disease reported that it had a very significant impact on income from shrimp production (median 5, q1-q3 5-5) and estimated that they lost 25-50% of potential income due to disease (q1-q3 10% -75%). Farmers' perceptions of the level of disease within their farming subzone and on their own farms for the study production cycle are presented in Table 4.

Table 4. Farmer perception of the level of shrimp disease during the trial production cycle as compared to previous production cycles.

	Zone	Subzone	Own farm
None	3 (4%)	5 (7%)	28 (38%)
Less than previous cycles	12 (16%)	22 (31%)	17 (23%)
The same as previous cycles	13 (17%)	5 (7%)	2 (3%)
More than previous cycles	45 (62%)	39 (55%)	26 (36%)
Could not say	2 (3%)	4 (5%)	2 (3%)

Impact of SMS on farming practices

As a result of participating in the trial, farmers in both groups altered a median of seven practices, however, for the SMS group the interquartile range was seven to nine practices, while in the control group, it was six to seven, which was statistically significant (p=.01). ‘Engaging in cooperative activities to limit disease transmission’ was the practice most farmers (74) did differently from previous cycles, followed by ‘limiting water exchange based on knowledge about outside water quality’ (72) and ‘increasing measures to reduce disease spread onto their farm’ (72), ‘checking water quality more than previously’ (65), ‘adjusting harvest time’ (64), ‘checking shrimp for health more often’ (63) and ‘adjusting aeration in ponds’ (61). ‘Obtaining PCR testing for disease’ was done by 57% (42/74) of farmers. Reasons given for not obtaining PCR testing included expense (24), not thinking it would be helpful (9) and not knowing how to do it (3). Only 36% (27/74) of farmers treated water before pumping it into ponds. The two most common reasons for not doing this were not having a holding area for treated water (32) and expense (20).

Outcomes of trial on farmer communications

Participants ‘strategies for obtaining information about shrimp disease outbreaks changed from primarily in-person before the trial to primarily SMS at trial end. Of the 53 farmers in the SMS group using in-person communication as the major method to receive information before the trial, at trial end, 46 switched to SMS and seven switched to cell-phone voice. Of the 15 controls using in-person communication to receive information before the trial, at trial end, seven continued to use in-person communication, two switched to SMS and six switched to cell-phone voice. For both the SMS group (p<.0.01) and control group (p= 0.02), these were statistically significant changes. There was also a significant difference (p<0.01) between the SMS and control group at trial end, as more participants in the SMS group switched to obtaining information primarily through SMS. Most farmers reported that they received information ‘too late’ in previous cycles (71/73, 97%), but ‘in time’ in the trial cycle (65/73, 89%). This change in timeliness of information was significant for both the SMS group (p=0.00) and control group (p=0.02). For the 60 farmers in the SMS group, all reported that they shared information and sought technical advice in response to SMS messages often, while most informed government agencies (47/59), participated in coordinated responses (47/59) with other farmers, and organized or attended meetings in response to the messages (50/59).

Farmer perception of value of participation

All farmers reported that they had a better understanding of disease transmission as a result of participating in the trial. All strongly agreed that the information was useful, and that participating in the trial made them feel more connected to other farmers. Both farmers in the SMS group and those in the control group reported that the way they received information was useful to them. All farmers in the SMS group (n=59) strongly agreed that receiving a phone was useful to them.

ATS member outcomes

Technician members of the ATS took over major responsibilities associated with gathering information, creating messages and responding to farmer requests willingly and capably. They reported that the trial increased inter-technician knowledge sharing even between technicians working for competing input-suppliers. They perceived that the trial increased their ability to share technical knowledge with farmers dramatically. However, they were concerned about the increased work load if the number of farmers participating in the SMS system expanded.

Discussion

This pilot study demonstrated that SMS was both a feasible and acceptable methods for transmitting BMP information to Sri Lankan shrimp farmers and the results suggest that this method was able to inspire changes in practice and a more collective approach to disease management. The trial saw historical competitors in the technical team working collaboratively, witnessed a shift in knowledge seeking behavior amongst both exposed and control farmers towards greater use of SMS, and collected evidence that because of participation in the trial, farmers most often changed behaviors that would benefit the group as well as the individual.

This trial was successful in engaging researchers, university staff, regional government staff, aquaculture technologists, and farmer society leaders and farmers. SLADA, farmers and the ATS technologists were highly engaged in the project. ATS technologists took ownership over water quality analysis and deciding which data to send out to farmers, increasing the probability of local sustainability. Farmers in the SMS group relied heavily on the SMS messages for information, and switched in a dramatic fashion from receiving knowledge through face-to-face communication to receiving knowledge through SMS. This might indicate that farmers in this study are highly motivated to access knowledge about shrimp farming, and SMS overcomes some impediments to access and uptake of knowledge.

Although this pilot was not designed to ascribe casual relationships between the SMS interventions and farmer behaviors, theories of behavior change would support the hypothesis that the SMS approach is useful in this context. There are four main drivers of behavior change(Fishbein and Yzer 2003). First, the person needs to believe he or she is at risk. The pre-existing belief of all of the farmers that disease put their farm at risk was re-enforced by having a pre-trial workshop to review disease issues and BMPs.

This form of social priming may in part explain the behavior changes in the control group as it would have reminded them of the existing disease BMPs.

Second, the person must believe that s/he is able to undertake and complete the proposed action. The trial used BMPs that had been developed in conjunction with industry, and messaging focused on actions that were plausibly within the control of the farmer. Farmers reported that outcomes, such as access to knowledge and cooperative activity with other farmers to reduce disease risk, were markedly improved by participating in the trial. Both SMS group and control group farmers perceived that they had more timely access to knowledge than in previous cycles. This may have increased their sense of being able to successfully change their practices. When farmers did not change their practices, it was most often because they did not have the money or equipment necessary to make changes such as testing juvenile shrimp for WSSV prior to stocking or treating pond water. The challenge of self-efficacy was seen in the work of Munasinghe et al. (2010) where the authors hypothesized that inequities in farmer wealth was an impediment to properly implementing the required disease BMPs. Future messaging would need to ensure that recommendations provided were achievable across the diversity of resources across farms in the region.

Third, the person needs to believe that other people important to him or her (like peers, family or others) believe s/he should adopt the proposed change. Past work has shown a social norm of incomplete or inadequate implementation of BMPs in this community (Munasinghe et al. 2010). A lack of control over external factors such as the actions of neighbors or sensitivity of farms to impacts from other farms can serve as further disincentives (Rohitha 2008). The fact that the most commonly changed behaviors were ‘cooperative activities to limit disease transmission’ and ‘alter water exchange based on knowledge about outside water quality’ might reflect the value of this trial is helping farmers overcome their perceived lack of control over external factors, and suggests valuable targets for future messaging. Perhaps more important to the success of this trial was the inclusion of the farmer society and society leaders who, through support of this programme, established that adoption of BMPs and participation in this trial was important to the group. Farmers were required to be members in farmer societies. Farm society leaders encouraged certain BMPs among their members, but their effectiveness in influencing practices was limited by the function of the farmer society itself and the often small number of practices that were mandatory for farmer society membership. The SMS built on the social ‘permission’ from the farmer societies for farmer participation and helped overcome the limited capacities for the farmer societies to be agents of change by increasing connection of the farmer with experts and information.

Finally, a person would need to believe that benefits of making the behavior change by adopting BMPs or changing practices outweigh the costs. This aspect of the pilot was only qualitatively assessed and relied on self-reporting by the farmers. Those data do show significant behaviour changes which imply that the farmers judged the benefits to outweigh the costs. Although, both farmers receiving SMS and those receiving only literature about BMPs changed practices as a result of participating in the trial, those receiving SMS changed significantly more practices, indicating that SMS has some additional value in changing farmer behaviour. The sustainability of such changes across subsequent production cycles will need to be assessed.

The results of this trial provided sufficient evidence to funders (private sector and NGO), government and industry representatives to implement a scale-up of the trial to include more shrimp farmers, as well as to develop a similar system for two other aquaculture sectors, culture-based fisheries and oyster farming.

Conclusion

SMS showed promise as a means of increasing knowledge sharing between technical experts and smallholder shrimp farmers faced with ongoing disease outbreaks. Participant farmers and technical experts felt the trial improved knowledge availability and farmer success. The process of developing and implementing the trial served to strengthen communication networks between expert stakeholders from different institutions. It is difficult to attribute SMS as the major causal factor responsible for the increased connectivity as compared to the impact of the participatory process used to build and implement the SMS trial. It is likely that both the SMS and participatory activities provided some benefits to farmers, but the improved outcomes for expert networks were primarily a result of the SMS trial acting as a driver for more interaction and collaboration. Ongoing efforts from researchers will still be necessary to support collaboration between stakeholders from university and government in the hopes of making the collaboration network more sustainable.

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