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Farmers' Experiences with the Giant African Snail Infestation: A Case Study in the Orange Grove Farming District, Trinidad West Indies

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Abstract

The giant African snail was confirmed to be present in Trinidad in October, 2008. The study presents a case study on the farmers' experiences with the giant African snail in Orange Grove, an active agricultural district in Trinidad which confirmed the presence of the snail in 2016, eight years after it was confirmed on the island. A qualitative approach was undertaken for this investigation. A semi-structured survey instrument was administered to thirty (30) participants who were impacted by the presence of the snail in their crop production fields. A purposive and convenience sampling strategy was used to select the participants for the study. Additionally, prolonged engagement and persistent observation techniques were used to capture the farmers' experiences with the snail infestation in their crop fields for a period of ten (10) months. The information gathered from the study was analyzed using thematic analysis. The main themes derived from the analysis were "*crop production practices influence on the giant African snail infestation*", "*unmanaged and excessive weed growth*" and "*current approaches for controlling the giant African snail".* The study concluded that uncoordinated approaches for the management of the snail population and the lack of collective action among the members of the farming community could sustain the pest population in this farming area. Strategic planning and collective synchronized action among the farmers are crucial to containing, suppressing and eradicating the snail population within this crop farming area.

Keywords: Giant African Snail, Achatina (Lissachatina) fulica, pest, farmers' experiences, collective action

1. Introduction

The giant African snail, *Achatina (Lissachatina) fulica* (Bowdich) is a highly invasive terrestrial snail native to East Africa (Sarma, Munsi & Ananthram 2015; Raut & Barker, 2002). As a consequence of the destructive ecological characteristic of this pest, the Global Invasive Species Database has ranked it among the "100 Worst Alien Invasive Species" (Lowe, Brown, Boudjelas & Poorter, 2000) .This snail is of significant importance to tropical agricultural productivity (Raut & Barker, 2002) and also to human health since it is known to be a vector of the rat lungworm, *Angiostrongylus cantonensis*, which causes eosinophilic meningoencephalitis in humans (Provciv, Spratt & Carlisle, 2000; Alicata 1991).

The high invasion potential of the giant African snail (Teles, Fontes & Amaral, 2004), its polyphytophagous characteristic habit feeding on over 500 plant species (Raut & Barker, 2002 and Capinera, 2011) and its ability to reproduce rapidly under optimal field conditions and reach high densities and biomass in a very short time (Raut & Barker, 2002, Tiller 1982, Raut & Ghose, 1984) aggravates the management of this pest. Environmental conditions such as high humidity, moderate temperature and abundant rainfall favours the reproduction of *A. fulica* (Berry & Chan 1968, Lai, Funasaky & Higa, 1982, Raut & Barker 2002, Fisher & Colley 2005). Conversely, unfavourable environmental conditions triggers the giant African snail to aestivate (Rahman & Raut, 2010).

In 1984, *A. fulica* was established on the Caribbean island of Guadeloupe, by 1988 on Martinique, and subsequently on Barbados and Saint Lucia (Raut & Barker 2002). In October 2008, the Giant African Snail was discovered in the Republic of Trinidad and Tobago in one specific location in Trinidad. As of December, 2018, there have been thirty-nine (39) reported new areas of infestations within Trinidad in several agricultural and non-agricultural districts. It is likely given the current trend that new infestations will continue to emerge within Trinidad. Presently the snail has not been

reported in Tobago, however, the risk of invasion is high given the movement of agricultural produce, commercial goods and people on a regular basis.

The influence of the dry and rainy season periods in Trinidad and Tobago has affected the management strategies for the giant African snail. Noticeably, the snails are predominant in the rainy season July to December and very scarce in the dry season January to June. Vegetable crop production in Trinidad and Tobago is to a large extent rainfall dependent and the presence of the giant African snail possess a significant threat to farmer's livelihood, public health and to food security. In the dry season, the impact of the snail on crop production is negligible to non-existent given the ability of the snail to become inactive in the dry season. Given that Trinidad is the lead vegetable producer in the region (Ganpat, 2013), the presence of this pest could create a major threat to domestic food security.

The Giant African snail was discovered in 2016 in the Orange Grove farming (10°37′25″ N 61°21′11″ W) district located approximately 32 km from Diego Martin the area where it was first discovered. The Orange Grove area is flat and comprises several hundred vegetable farmers each cultivating on approximately two-acre plots which are adjoining to each other in a large open space away from residential settlement. A network of surface drainage canals spans the entire area. There are several abandoned high weed density areas which provide favorable microhabitats for the snails to refuge.

Although *Achatina (Lissachatina) fulica* (Bowdich), is well adapted and distributed around the world (Thiengo, Faraco, Salgado, Cowie, & Fernandez, 2007) the current study attempts to capture, as a case study, the farmers' experiences with the presence and impact of the giant African snail on their vegetable crop farming activities within the Orange Grove farming district in Trinidad. Additionally, the study provides baseline information for the management of other farming districts in the Trinidad and the wider Caribbean which have been impacted by the giant African snail.

2. Methodology

The study employed a qualitative approach to capture the farmers' experiences with the impact of the presence of giant African snail in the Orange Grove farming district in Trinidad, West Indies. In this manner, the study took a constructionist perspective to understanding and interpretation of the unique realities of the participants in their explanations of the effects of this pest to their vegetable crop production activities -for a real understanding to emerge from the information gathered. Moreover, this facilitated an in-depth exploration of the experiences of the farmers and the uncovering of the meaning that the experiences have for them: the subjective interpretation (Gergen, 1999). Prolonged engagement and persistent observation were employed to ensure the rigor and trustworthiness of the research. In prolonged engagement the researcher spends time in the setting under investigation to prevent distortions of data based on unfamiliarity with the context and culture of the setting (Miller and Keys, 2001). According to Lincoln and Guba (1985), for persistent observation the researcher should "identify those characteristics and elements in the situation that are most relevant to the problem or issue being pursued and focusing on them in detail." (p.304). Prior to the formal investigation the researcher spent ten (10) months in the Orange Grove district interacting with the farmers who were impacted by the snails. Thirty (30) active vegetable crop farmers were selected using a purposive and convenience sampling approach to participate in the study conducted in September 2018. Since the participants were familiar with the researcher's presence in the area, they were comfortable sharing their experiences.

The interview instrument was developed based on prior informal discussions with farmers in the area and with technical staff from the Ministry of Food Production, Land and Fisheries who were involved with the management of the giant African snail. In addition, the instrument was influenced by the existing literature on the giant African snail and also by the author's in-depth observations. The instrument was designed to capture the farmers' experiences with the giant African snail infestation and its influences on their crop cultivation practices. The interviews were conducted on site in the farmers' fields. In some instances, when the farmer was unable to participate in the face-to-face interview, a telephone interview was scheduled at the farmer's convenience. Each participant was interviewed and the responses were written into the survey instrument. The duration of the interviews ranged between 30 to 45 minutes.

The confidentiality and identity for all participants in the study were protected in the data interpretation and analysis process, and in the reporting of the findings. All participants had the opportunity to ask questions about the study, and they were informed that they had right to decline to answer any questions or withdraw from the interview at any time. A moral and ethical effort was made to ensure the protection of the human subjects who participated in the research (Naimi, 2007).

A thematic analysis was applied to this study to search for themes that emerged from the textual data derived from all interviews. The procedure for the thematic analysis for the information gathered followed the step-by-step procedure outlined by Braun and Clarke (2006). According to Rice and Ezzy (1999), the identification of themes involves a process of "reading and re-reading the data corpus". The emerged themes are essential for describing the phenomenon being investigated (Daly, Kellehear, & Gliksman, 1997). QSR NVivo12 software was used to manage and organize the

data since it is not in itself an interpretive device (King 2004). In reporting the emerging themes supportive illustrative verbatim statements, written in italics and surrounded by double quotation marks, were used. The statements were used to deepen the understanding of the emerged themes by providing evidence from the participants' voices. Although each theme is presented and expanded on separately, the themes are not mutually exclusive. The complexity of the topic and broad nature of the current research created themes which were interlinked.

3. Results

3.1 Demographics

All the farmers selected for this study were vegetable crop producers who were currently impacted by the damage caused to their crops by the giant African snail. The population sampled at the Orange Groove farming district comprised of twenty-seven (27) males (90%) and three (3) females (10%). The majority of the participants (78%) sampled were over the age of thirty-one (31) with three (3) participants representing 10% of the sampled population being over the age of sixty (60). The population sampled comprised 21 (70%) who were farming in the area for over eleven (11) years. Some 90% of the participants interviewed practiced multi-cropping, cultivating various crops in one location within the area.

3.2 Thematic Analysis

The results of the thematic analysis were structured in terms of the main themes which emerged from the information obtained from the formal and informal interviews conducted among farmers who were impacted by the giant African snail. The emerging themes identified from the analysis of the data corpus are: **'*Crop production practices influence on the giant African snail infestation*', '*Unmanaged and excessive weed growth*'**, and **'*Current Approaches for controlling the giant African snail*'**. Although each theme is presented and expanded on separately, the themes are not mutually exclusive such that some themes were interlinked. The illustrative extracts were included to provide a sample of some of the participant responses to provide additional support to reinforce the themes identified.

3.2.1 Theme 1 - '***Crop production practices influence on the giant African snail infestation****'*

The farmers indicated that there are several crop production related issues which are influencing the persistence of the giant African snail population in the Orange Grove farming area, Trinidad. It was suggested that the independent and uncoordinated cultivation of crops among the over three hundred (300) farmers is negatively impacting the control of the snail population. The farmers in Orange Grove all produce crops at different times such that while one farmer is completing a crop cycle, the adjacent farmers may either be establishing a new crop or was at the peak harvest stage in a crop production cycle. The farmers expressed that they do not invest in crop sanitation or snail control practices nearing the end of the crop production cycle since the cost of the bait to control the snail is relatively expensive. As such, unharvested produce, other crop related waste and excessive weed growth are commonly found in the fields after the main crop was harvested. The unharvested produce, other crop related waste and weeds which remain in the farmer's field come to be a rich source of food stock and safe refuge for the snails to strive and reproduce during the period of neglect after the peak harvest.

Given that some farmers in the area may use the same workforce and the same machinery for land preparation there exist a high probability that the snails could have been spread to other places within this farming area. Field border sanitation and weed control was proving to be very difficult and costly for the farmers to control and as such any financial investment was considered a burden to their income. It was the general view among the participants that protecting the crop was first priority and if there was no crop in the field then the priority to control the snail population was reduced.

Several farmers have pointed to the network of earthen drainage and irrigation canals in the area as being an additional favorable site for the giant African snail. Managing the drains in terms of weed growth and debris removal was also proving to be very difficult given the swift resurgence of the weeds and debris accumulation during the rainy season (July to December). The water retention in the drains and the high water table in the Orange Grove area were suggested by some farmers as one of the main factors contributing to the high population density of this pest in the area. As a consequence of the snail's presence the farmers were unable to use mulches and top-dressing approaches for manure placement in their field.

Almost all (98%) of the participants indicated that the giant African snail was causing considerable damage to their crops and emphasized that the crops were previously successfully grown before the snails. In some instances, farmers expressed that they had to change the crop to other crops which were least favored or minimally affected by the snail.

Theme 1 Supportive Illustrative quotations

"*Everyone planting at different times, so when I controlling the snail in my field, the farmer next to me is not doing*

anything." [Male, 57]

"*I keep my field clean, the farmer next to me field is overgrown with weeds or in fallow and I cannot tell him what to do, I can only try to prevent the snail from coming into my field.*" [Male, 49]

"*After the crop is harvested, I usually take a break for a bit in the rainy season but in the dry season I usually don't plant as much unless I can get water.*" [Male, 53]

"*The drainage canals in the field and in the whole area have the snail, how are we dealing with that?"* [Female, 52]

"*I had to discard over 200 lbs of baigan (melongene) as a result of these snails biting it."* [Male, 62]

"*Anywhere it has some place for them to hide, even in the manure, you finding them there."* [Female, 52]

"*After years of growing lettuce and cabbage I had to stop and switch to planting caraille* [bitter gourd] *or tomatoes since they seem not to affect these plants as much once the plant had grown beyond the seedling stage."* [Male, 48]

3.2.2 Theme 2 - ***'Unmanaged and excessive weed growth'***

Excessive weed growth and the inability to keep up with weed management were stated by the farmers as a main issue contributing to the overwhelming giant African snail population. The farmers have expressed that it was too expensive to manage the weeds in the surrounding areas which were not having a direct impact on their respective crops. The farmers, however, have recognized that there is a relationship between the excessive weeds in the area and the snail population. Most of the farmers in the Orange Grove farming district cultivated their crops in the rainy season when the weed populations throughout the area are even more aggressive. The stools of some weeds like elephant grass (*Pennisetum purpureum*) and isolated banana (*Musa sp*) stools were noted by the farmers interviewed as main refuge and breeding areas for the giant African snail in this district. Some of the farmers expressed their difficulty with eliminating the elephant grass more so in the areas outside their field such as along the road-ways and in abandoned fields. It was mentioned by some farmers that they burned the weeds when the fields were fallow to destroy the snails and any eggs which may be present.

The farmers have indicated that limited attention was given to weed control in the areas where it does affect the crop cycle directly since it is costly and time consuming. Several farmers have noticed that some weeds were sources of food for the snail especially when there was no crop in the field. It was mentioned that spraying the weeds alone was not enough since you needed to remove the dead weeds since this too can eventually become a refuge for the snails.

Theme 2 Supportive Illustrative quotations

"Everywhere it has grass and the snails are living in it, especially in the root of the elephant grass and others weeds which have thick bases." [Female, 43]

"Burning the field is good for the dry season but in the rainy season when we grow more crops it is difficult." [Male, 38]

"I only focus on controlling the weeds in my crop." [Male, 58]

"The snails are making me spend more money and time in weed control outside my field and it still not helping to reduce the population since other farmers are not making the effort to do it." [Male, 49]

3.2.3 Theme 3 - '***Current Approaches for controlling the giant African snail'***

The farmers have indicated that they rely heavily on pesticides in the form of bait for controlling the snail populations in and around their fields mainly during crop production. The application of metaldehyde bait is the main form of control for controlling the giant African snail in Orange Grove. Iron phosphate, once available was also used along with various baiting concoctions prepared by some farmers. The farmers baiting concoction was made from either one of or a combination of chopped pumpkin, shredded cabbage or papaya leaves saturated with Thiovin ® (thiodicarb) and beer. In some cases, the commercial bait was included into the mixture which would then be placed in small piles in areas where the snail population was most dense. The farmers expressed that they did find that there was some effectiveness with the baiting concoctions but it was time consuming to prepare and its effectiveness was impacted by rainfall when compared to the commercial bait product. The farmers revealed that the high frequency for the commercial bait applications was related to the high population density of the snails in the area and also the numerous areas which exist for the snails to refuge and reproduce. It was revealed among the farmers that baiting while the crop was in cycle was effective and hence only baited to protect the crop. They found that it was not beneficial to them to bait when the field was in fallow given the cost of the bait and the relatively high snail population density in the area.

Some farmers stated that they burned their fields after harvesting their crop in an attempt to eliminate the snail population from their fields. The farmers indicated that burning the crop residue and weeds in their field gave the next crop a head start before the snail can once again re-infest the field. Additionally, the practice of burning fields at the end

of one crop production cycle would reduce the amount of bait which would be needed during the early stages in the following crop production cycle. However, the success of this was dependent on if this practice was also adopted by surrounding farmers. The farmers mentioned that the network of drainage and irrigation canals provided a safe place for the snails and protected them from being burned.

In some crops like ochro, melongene and corn the snails can be found on the stems of the plant. The farmers removed the snails on their crops by hand-picking, however, given the high snail population it became a routine task which they found time consuming. The farmers found that baiting like hand-picking required the collection of the dead or live snails respectively followed by incineration within designated areas in their fields. The stench from dead snails left in the fields after baiting applications was unbearable to the farmers and field workers and as such incineration and burial was essential to prevent this from occurring.

The farmers have expressed that although the Ministry of Agriculture, Land and Fisheries supported them with occasional bait applications in the area they found that the intervention by the Ministry was insufficient. The farmers expressed that given the severity of the infestation they were unable to rely on the Ministry's support and resorted to managing the pest on their own in order to protect their crop. The farmers indicated that the overall cost to control the snail population was elevating their cost of production and they were unable to transfer this cost to the consumers given the national market price stability for locally grown vegetables. The farmers were of the view that the Ministry of Agriculture, Land and Fisheries could be more aggressive and could assist them with developing a strategic eradication plan for the snails in the Orange Grove area.

The farmers indicated that the snails were difficult to control in the dry season because of their inactivity and that baiting to control the giant African snail was mainly done in the rainy season. It was also stated that the resurgence of the pest in the rainy season was overwhelming. The farmers felt that some plan of action should be devised with the support of the Ministry for establishing a rainy season and dry season action plan for the control of the growing snail population.

Theme 3 Supportive illustrative quotations

"*The snails affect us most in the rainy season and when we apply the bait it gets washed away during periods of heavy rainfall...although it works much of it is wasted*" [Male, 60]

"Snail poison is costly and to use it when there is no crop in the field is a waste of money, we need to protect the crop since that is what is important" [Male, 56]

"My focus is on the crop, to protect it from the snails, I cannot afford to bait the snails when I do not have a crop" [Male 49]

"The snails in here [Orange Grove] by the millions and I as a farmer by myself cannot handle it alone, I have to keep applying bait all the time, we need help to deal with this" [Male, 58]

"We have to keep putting bait, spraying Thiovin ® and making all sorts of recipes to deal with the snails……it working but expensive and only seem to be short term since dem [the snails] *only keep coming back all the time"* [Male 39]

"The Ministry needs to supply us with free bait and help more, come out in the night and bait" [Male 39]

"The dead snails smell up the place and making working in the field very difficult" [Male, 48]

"The main time for controlling the snails is when they come out in the rainy season…… you cannot find them in the dry season…..they hide all over" [Female, 43]

4. Discussion and Conclusion

The reality of any major successes for the control of the giant African snail in the Orange Grove farming district is impacted by the current practices engaged by the farmers. The oscillations in pest management related to controlling the snail to only during the period within a crop production cycle fosters the perpetuation of the snail's presence in this farming community. A precision based collective crop protection approach could enable a more sustainable approach for the effective control of the giant African snail in any infested crop producing area. The application of bait as a single strategy is ineffective to the holistic control of this pest. The baiting frequency and timing is also critical and must be coupled with the aggressive monitoring of the refuge places. Additionally, habitat modifications techniques such as destroying or aggressively controlling the areas where the snail seeks refuge or lay eggs is crucial to the overall control approaches.

The giant African snail is known to be more active in the rainy season and during this period their rate of reproduction is at its highest. It is imperative to reduce the number of reproductive adults entering the dry season to effectively suppress the population expansion on a yearly basis. During the dry season there should also be a control strategy in effect. Although, the snails are aestivating (hibernating) in the dry season, regular monitoring and destruction of the refuge sites should be

incorporated into an action plan for the dry season. In essence, the control of the giant African snail should not only take priority in the rainy season but there should be dry season strategies aimed at controlling the pest as well.

The approach to control should consider several factors which include crop type, stage within the crop production cycle, overall assessment of field sanitation to include the type and density of weed biodiversity present within and exterior to production plots and most importantly farmer-to-farmer collective action. The farmer-to-farmer collective action should aim to coordinate baiting and cultural control practices specifically directed to reducing the high snail population within this vegetable crop farming area. Collective action in pest control management is not new. Since 1990, the concept of collective action has played a role in the development of participatory approaches to integrated pest management in order to improve local-level management and learning processes, often through farmer field schools (Van Huis & Meerman 1997, Norton et al. 1999, Van den Berg 2004, Van den Berg & Jiggins 2007).

The presence and spread of the giant African snail in the Orange Grove farming district requires continuous effort with sustained collective action to ensure the effective control of the pest. According to Toleubayev, Jansen & Van Huis (2007), "the inability to organize collective action for pest control can lead to severe problems". The failure of collective action within the Orange Grove area has contributed to the giant African snail population explosion and continued presence in many of the farmer's plots. Figure 1 presents a hypothetical model which requires the farmers to firstly assess their farming practices within the context of snail's agroecological requirements before implementing a strategy aimed at the containment of the infestation for eradication interventions. The government through its agricultural extension support services should coordinate the intended action and provide technical support and training to ensure the success of the collective actions undertaken. The success of the collective action should be pegged to key indicators such as reduction in the number of the reproductive snails over time to juveniles and then to neonates. It should be noted that the size of the bait in relation to the mouth of the snail limited the consumption of the bait to mainly the adults and that baiting only would lead to a reduction in the adult size population of snails.

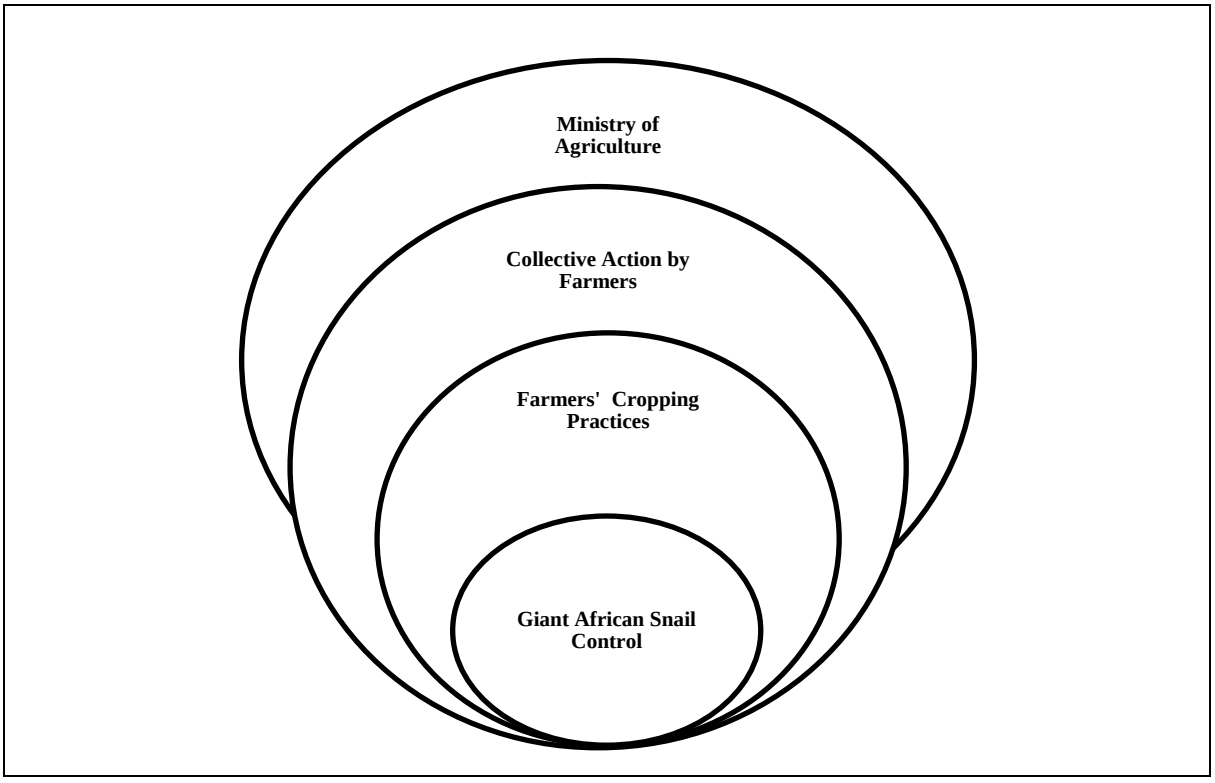

Figure 1. Model for the giant African snail control in the Orange Grove farming area

The implications of failing to coordinate the approach to control would only result in the infestation remaining persistent thereby increasing the overall cost of production attributed to bait purchases. Furthermore, given the negative effects of metaldehyde bait applications to the environment (Castle et al., 2017) all efforts should be made to curtail the prolonged use of this pesticide. The current approach for controlling the giant African snail would only lead to more and more metaldehyde being introduced into the environment and as such coordination of collective interventions would have a greater effect in the efficiency of its use. Given that the Orange Grove farming area in Trinidad is one of the main vegetable producing areas urgent intervention is required to coordinate the strategy for the control of the giant African snail.

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