Sustainability **2009**, *1*, 1366-1387; doi:10.3390/su1041366

OPEN ACCESS

sustainability

ISSN 2071-1050

www.mdpi.com/journal/sustainability

Article

Negotiating Uncertainty: Jamaican Small Farmers' Adaptation and Coping Strategies, Before and After Hurricanes—A Case Study of Hurricane Dean

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Received: 29 October 2009 / Accepted: 10 December 2009 / Published: 16 December 2009

Abstract: In recent years, Jamaica has been seriously affected by a number of extreme meteorological events. The one discussed here, Hurricane Dean, passed along the south coast of the island in August 2007, damaging crops and disrupting livelihood activities for many small-scale farmers. This study is based on detailed ethnographic research in the southern coastal region of St. Elizabeth parish during the passage of Hurricane Dean, and explores the ways in which small farmers negotiate the stressors associated with hurricane events. The study employed a mix methods approach based on a survey of 282 farming households. The paper documents coping strategies employed by farmers in the immediate period of Hurricane Dean to reduce damage to their farming systems, and highlights the positive correlation between farmers' perceptions of hurricanes and degree of damage to local farming systems. In addition, through an analysis of socio-economic and environmental data, the paper provides an understanding of the determinants of adaptive capacity and strategy among farmers in the area. The study indicated that despite high levels of vulnerability, farmers have achieved successful coping and adaptation at the farm level.

Keywords: hurricanes; adaptive capacity; coping strategies; St. Elizabeth; food security

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1. Introduction

Between 2002 and 2007, Jamaica experienced a series of debilitating meteorological hazards which ravaged the small farming sector of the economy. The most extreme of these occurred between 2004 and 2007, beginning with the passage of Hurricanes Charley and Ivan in 2004. This was followed by a seven month drought, which began in late 2004 and extended well into 2005. This extended dry spell spawned several costly bush fires. The 2005 season brought more devastation with the passage of Tropical Storm Wilma and Hurricanes Dennis and Emily. While 2003 and 2006 were comparatively quiet, the ubiquitous vulnerability to meteorological hazards was again emphasized when Hurricane Dean struck the island followed by flood events which were triggered by two weeks of continuous rainfall associated with the passage of tropical Storm Noel. These events severely disrupted livelihood activities for many small farmers in the country.

Extreme events are nothing new to Jamaica and Jamaican farmers. Small resource-poor farmers in rural areas are often plagued with many interrelated and complex problems that they have to negotiate on a daily basis in order to survive. The literature on the subject generally points to small farmers as being very adaptive and resilient. Indeed, some scholars go as far as to describe farmers as professional specialists at survival and as such, a relatively large number of contemporary studies on small farmers focus on phenomenological aspects of the system.

This paper adds to this focus by documenting the adaptive strategies of farmers in the immediate period of Hurricane Dean. It highlights the positive correlation between farmers' perceptions of hurricanes and degree of damage to farming systems. Also, through an analysis of socio-economic and environmental data, the paper provides an understanding of the determinants of adaptive capacity and coping strategies among farmers in the area. The cognitive processes underlying the decision-making and behavior of farmers in relation to adaptive capacity and resilience, is also highlighted. It is important to note that while resilience explains the ability of an organization, ecological system, household or nation to recover quickly from a disaster [1] , it is useful to assess the concept within the context of dynamic responses to disturbances and future modifications of adaptive capacities that accompany the recovery process [2].

Adaptation studies enable the identification and development of community-specific adaptive measures and practices. It has been argued that the "aim [of community-specific adaptation studies] is not to score adaptation or measure relative vulnerabilities, nor quantify the impacts or estimated effects of assumed adaptation. Rather, the focus is to document the ways in which systems or communities experience changing conditions and the processes of decision-making in this system that may accommodate adaptations or provide means of improving adaptive capacity" [3]. Similarly, this paper does not assume the behavior and experiences of farmers during the climatic event; rather it provides a 'bottom-up' approach to identifying these experiences empirically and by so doing, employs the knowledge used by community members to negotiate the pertinent climatic conditions.

The effects of these recent meteorological events on domestic food production in Jamaica are well documented [4]. However, because farm-level adaptation is pivotal in translating climatic challenges and agricultural responses into changes in production, prices, food supply and welfare, this paper adds a different dimension to the existing analyses by providing a detailed understanding of what farmers do to buffer the impacts of a hurricane event. This is important because hurricanes are ubiquitous to the area and pose a constant threat to households, communities and societies that are dependent on agriculture for their livelihood. The knowledge of what farmers do in response to these events can aid in the expansion process of adaptation options and the improvement of resilience within the sector as a whole.

2. Contextualizing Coping and Adaptation Strategies

Based on the projected impacts of climate change, many scholars have agreed that the efficient and effective adaptation of those countries, communities, households and individuals deemed to be most vulnerable should be prioritized. There is an urgent need to understand the dynamism of coping and vulnerability in the context of developing future adaptation measures. In light of this, a growing body of scholarship has emerged in recent times with the thrust towards providing an understanding of peoples' adaptation to extreme events and climate change [5-7]. Yet only a small number of these studies focus on coping strategies as the 'blueprint' for future adaptation options.

A coping strategy may be defined as a temporary action undertaken in response to a known threat [8]. Adaptation, on the other hand, may be understood to be "an adjustment in the ecological, social or economic systems in response to observed or expected changes and their effects and impacts or take advantage of new opportunities" [9]. In relation to crop production, it has been posited that "coping strategies are risk spreading in nature and are designed to mitigate the negative impacts of poor seasons and usually fail to exploit the positive opportunities of average and better than average seasons. In addition, farmers often over-estimate the frequency of negative impacts of climate variability, and underestimate the positive opportunities" [10]. The authors suggested that in order to enhance the adaptive capacity of agricultural communities and stakeholders, their ability to cope with challenges and opportunities to current climate variability must first be understood.

Other researchers have cautioned, however, that coping strategies are not easily identified in rural areas where the diversification of income activities is a characteristic livelihood feature [11]. The coping strategies of some individuals represent the livelihood strategies of others. The use of qualitative information geared towards establishing an understanding of 'normal' behavior is recommended by the author to correctly interpret coping strategies. While acknowledging the importance of coping strategies in enhancing people's resilience to external stresses and shocks, the author pointed out that these strategies enable individuals to cope with a crisis and that care should be taken when reinforcing them, so as not to perpetuate a cycle of coping and subsistence. The goal of policy makers, should be focused on reducing people's need to have to 'cope' by implementing longer term measures geared towards strengthening productive capacity. These sentiments are no doubt valid but do not acknowledge that what might initially be a coping strategy could become an adaptation over time.

Coping strategies are devised by farmers to buffer short-term stresses and shocks within their farming systems and often exist alongside more long-term adaptive strategies. By definition adaptive strategies are more sustainable than coping strategies and are better suited to deal with longer-term changes [10]. The ability of farmers to cope with or adapt is fundamentally determined by their livelihood assets [12]. Generally, the more stable and diverse the asset base of farmers is the more equipped they will be to respond to atypical climatic conditions [10] and vice-versa. Coping strategies may be considered the 'blueprint' for future adaptation to increased climate variability and change. As opposed to many coping strategies, adaptation is often seen as 'a continuous stream of activities, actions, decisions and attitudes that inform decisions about all aspects of life and that reflects existing social norms and processes' [13].

Some researchers have alluded to the place and context-specific nature of agricultural adaptations [5]. The importance of farm-level decision-making in the adaptation process is increasingly being acknowledged [5,14] and the human factor is playing a more dominant role in improving our understanding of the practice. Farm-level adaptation and decision-making is also important because exposure to extreme events such as hurricanes often lie outside the coping range (the conditions that a system can deal with, accommodate, adapt to, and recover from) [15] of a system. Coping ranges are not static [3] and are sensitive to economic, social and political changes over time.

Adaptation can also be ineffectual and unsustainable, thus making a situation worse for a farmer and his/her neighbours. For example, while the spraying of crops with fungicide and insecticide after the hurricane often prevents an outbreak of plant diseases, it may often lead to environmentally unsustainable practices. The sustainability of adaptation is dependent on the heterogeneity of adaptive capacity across different stakeholders [13]. However, these and other attempts reflect the willingness and intent of farmers to do whatever they can to protect their farms including the homestead. Successful adaptation depends on how that 'action meets the objectives of adaptation, and how it affects the ability of others to meet their adaptation goals' [13]. Effective adaptation should be 'robust to uncertainty' and flexible (*i.e.*, ability to change in response to altered circumstance) [13].

The idea by some scholars that adaptation to future climate will be determined by current individual, community and institutional behaviour partly in response to current climate [16] is supported here. Employing local knowledge, defined as "dynamic and complex bodies of know-how, practices and skills that are developed and sustained by peoples/communities with shared histories and experiences" [17] available to them, as well as other strategies, small-scale farmers in southern St. Elizabeth have demonstrated a determination to confront new and unfamiliar circumstances. The vulnerability of small-scale food producers operating in marginal economic, political and environmental conditions as well as the differences in coping strategies are important signposts for future adaptation policies.

3. Trends in Caribbean Hurricane Activity

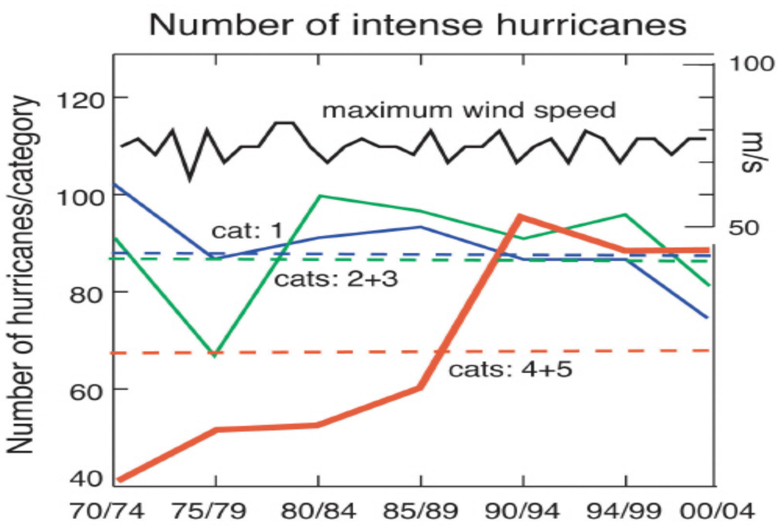
Hurricanes are the most prevalent meteorological hazards that occur in the Caribbean [18,19]. The global hurricane belt includes all tropical oceans between latitudes 40 degrees south to 40 degrees north except the southern Atlantic. However, some researchers suggest that 'all portions of Latin America (including Central America and South America) south of 10 °N had a less than 1% chance of a hurricane strike per year. The annual likelihood of hurricane activity increased farther from the equator to a maximum of >20% northeast of The Bahamas' [20] It has been noted that because of its geographical conditions, the Caribbean region is prone to such natural events of severe intensity [21].

Such susceptibility to natural events is not uniform throughout the region and some countries are more vulnerable than others. The Greater Antilles (Cuba, Haiti and Jamaica) have been identified as the most disaster prone group in the Caribbean and along with Pacific islands with unstable economies and weak political and institutional development, are heavy losers to repeated natural shocks [22]. This finding is supported by other research which found that the northern Caribbean including Jamaica, Cuba, Hispaniola, Puerto Rico, The Bahamas, Turks and Caicos Islands and the Cayman Islands, has high inter-annual variability of hurricane occurrence with a mean strike rate of 1 per year; while the southern Caribbean experiences a much lower strike rate of 0.4 hurricane strike per year [23].

Analysis of the long-term climatic data has indicated two major trends within the region. Firstly, it has been shown that the climate of the Caribbean region is changing [24,25]. Specifically, the region has experienced a rise in surface air temperature that is in excess of the global average. Also, "the extreme inter-annual temperature range is decreasing; the number of very warm days and nights is increasing while the number of very cool days and nights are decreasing" [25]. They also found the maximum number of consecutive dry days to be decreasing and the number of heavy rainfall events to be increasing.

Research also indicates some relationship between the nature of hurricanes and Sea Surface Temperatures (SST) [25]. Specifically, 'an increase in sea surface temperature may affect the maximum speed of hurricanes but it is uncertain what effect it will have on average speeds or hurricane frequency, and there is no evidence that the area affected by hurricanes will increase' [26]. Changes in Sea Surface Temperature have been attributed to the El Nino event [27]. The El Nino event was also found to influence hurricane landfall activity in the region [28].

Figure 1. Number of hurricanes, categories and intensities.



Source: http://physicsworld.com/cws/article/news/24452/.

The years 1995–2007, witnessed an increase in the occurrence of these events. Between 1995 and 2000 the 'North Atlantic experienced the highest number of hurricanes in reliable record. In the last 6 years there has been a doubling of overall activity for the entire basin, a 2.5 fold increase in major hurricanes and a five-fold increase in hurricanes affecting the Caribbean' [29]. The Atlantic basin was especially active in 2003 with 16 tropical storms, 7 hurricanes and 3 major hurricanes. There is also evidence of an increase in the intensity of hurricanes, with an overall increase in the number of category 4 and 5 hurricanes since 1970 (Figure 1). This argument is strongly supported by research indicating that major storms in both the Atlantic and the Pacific since the 1970s have increased in duration and intensity by about 50 percent [30].

The aforementioned positive correlation between sea surface temperature and hurricane intensity is not convincing enough to some scientists who strongly believe that, natural cycles of ocean circulation are responsible for the amount and intensity of tropical cyclones in the Atlantic basin [31-33]. For example, there was no statistically significant correlation found between SSTs and average tropical cyclone intensity in either ocean basin during the 1950 to 2005 period [33]. However, 'Changes in both the mean and the variability of climate, whether naturally forced (e.g., cycles of ocean circulation), or due to human activities (global warming), pose a threat to crop production globally' [34]. The aim here is not to try to settle the debate as to what is causing these changes, but rather to submit an understanding of how local farmers are coping with these changes and the implications they have for food production and security.

Implications for Domestic Food Production

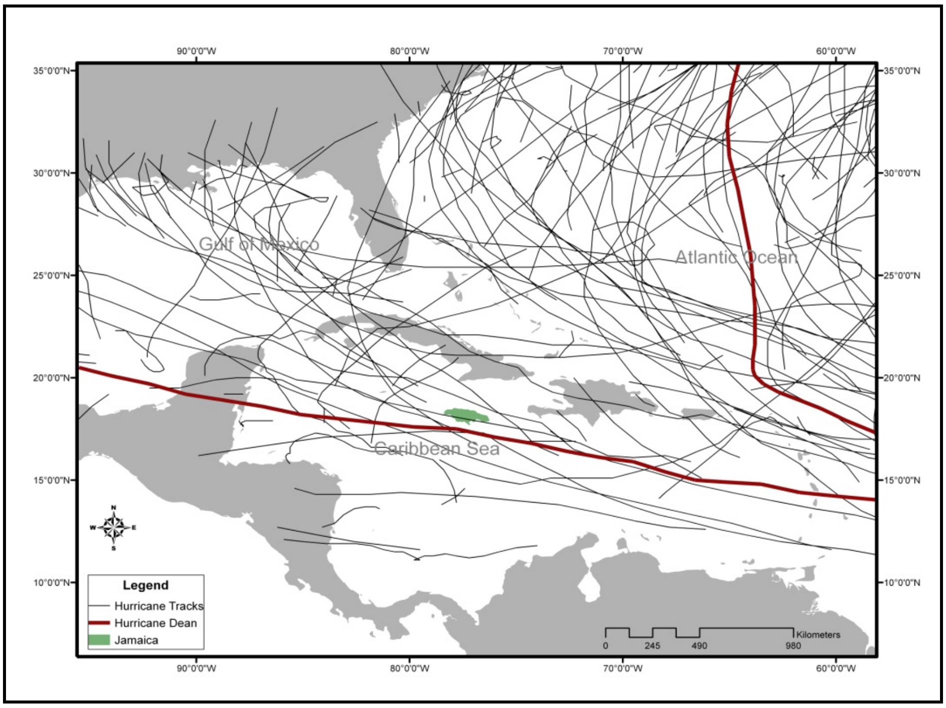
Jamaica is a small, open, commodity-export and tourism dependent economy. Despite this reliance on tourism, agriculture still remains central to the economy [35,36]. Agriculture, forestry and fishery provide around 20% of total employment, but make a relatively small contribution to GDP—accounting for 5.5% in 2006 [37]. Jamaica has two agricultural systems operating parallel to each other. Producing food as cash crops for export is the primary goal of large-scale farmers while small farmers produce mainly for the local market. Small farmers account for most domestic production and some exports, while having been historically confined to small plots on steep marginal land in the rugged interior [38,39] while the flat fertile lands are mainly for export crop production mainly sugar cane and bananas.

Since the mid-1990s the sector has been hit by meteorological phenomena such as hurricanes, floods and droughts. Between 2002 and 2007 the agricultural sector was affected by approximately 12 extreme weather events; seven hurricanes, two dry spells and three extended periods of heavy rains. Total damage incurred to the sector has been estimated at US$285.7 million [4]. The cumulative effects of this increase in extreme events can be a push beyond the coping range of a system—resulting in an inability to adapt or recover [3,40].

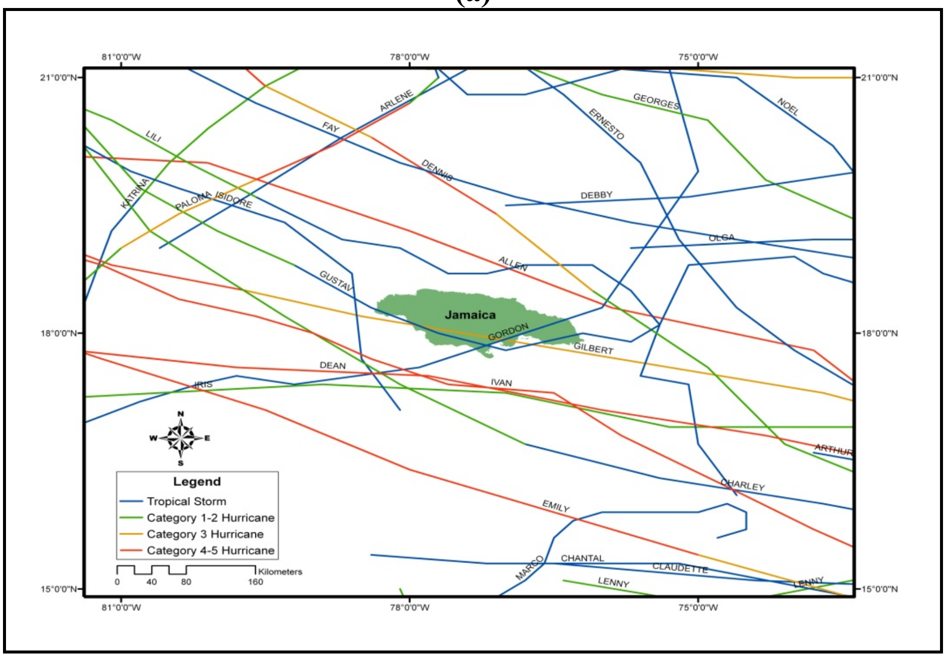
Extreme events often manifest themselves as *shocks* and *stresses* within the context of rural livelihood [41] and can seriously hamper food security. Food security is defined as the "physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" [42] at the household, community and national levels.

Shocks are climatic events that deviate significantly from normal or average conditions (e.g., hurricanes, floods and droughts) and *stresses* are more gradual changes in the climate (e.g., a few months of above or below normal rainfall) [43]. These shocks and stresses usually fluctuate over space and time and contribute significantly to patterns of household vulnerability [43]. Stresses and frequent shocks also pose a serious threat to the sustainability of domestic food production. As such, one basic concern here is food security. A 2002 study of the impact of climate variability on food security in Southwestern Cameroon concluded that 'increased year to year variation of climate and changing local factors can markedly affect income from agricultural production, cost to consumers, and food scarcity' [44].

Figure 2. (a) Atlantic hurricane tracks 1980–2008; (b) Hurricanes and Tropical Storms that affected Jamaica 1980–2008.



(a)



(b)

Note: The hurricane tracks in Figures 2a and 2b were obtained from NOAA Coastal Service Center (http://hurricanes.csc.noaa.gov/hurricanes/) and modified using ArcGIS computer software.

Whether or not it influences the nature of hurricanes (its frequency, intensity or duration), changes in climate variability will affect food production at all scales [34,45,46]. Within the context of a changing Caribbean climate, small farmers are, and will be increasingly, vulnerable to these external stresses and shocks [4]. Some crops could become marginalized, and might require increasing and careful use of irrigation systems as a result of decreases in water availability via increasing evapotranspiration [4] while others could surpass their critical temperature threshold [34] leading to a retardation in growth and productivity.

Already marginalized due to structural biases against them [39], Jamaican small farmers are especially susceptible to these natural events. However, the impact of hurricanes on agriculture is usually a function of the strength, frequency and duration of the event as well as the level of preparedness and damage reducing tactics of farmers-that is, his or her experience and socio-economic endowment. According to official data nine of Jamaica's fourteen parishes are over 70 percent rural and agriculture is the main source of livelihood for an estimated 65 percent of the people [47]. Hurricanes can therefore seriously increase the extent of rural poverty in Jamaica, increase vulnerability, and inflate food insecurity. With adaptation, however, "vulnerability can be reduced and there are numerous opportunities to be realized" [5]. It is against this background that the case of Hurricane Dean is discussed.

4. The Case of Hurricane Dean

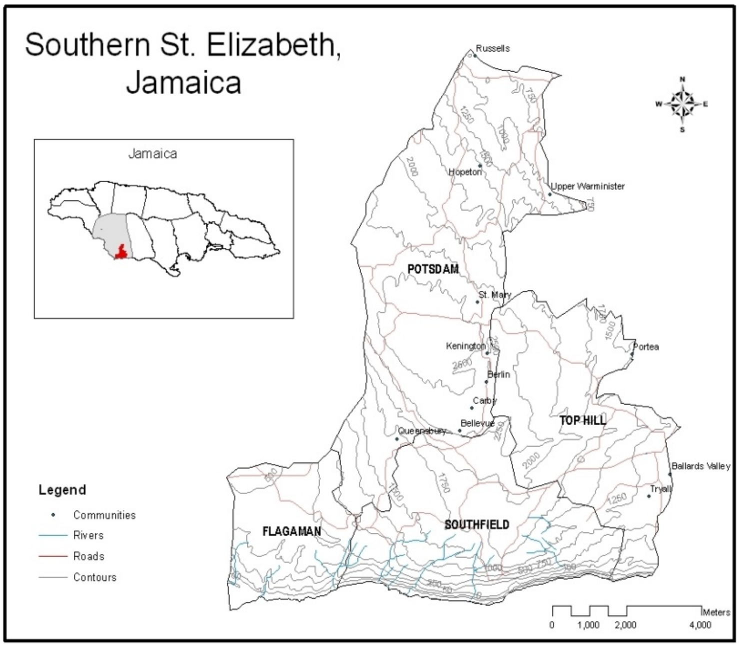
Hurricane Dean was the 9th most intense Atlantic hurricane ever recorded and the third most intense ever to make landfall. Dean was also the first Atlantic hurricane in 15 years to make landfall at Category 5 intensity (Hurricane Andrew in 1992 was the last storm to do so). The storm developed on August 13, 2007 and dissipated on August 23, leaving behind significant damages to some Caribbean and Central American countries. The storm passed Jamaica August 19 and wreaked havoc on the agricultural sector.

Estimates from the Planning Institute of Jamaica [PIOJ] suggest that the agricultural sector suffered J$9 billion of damage from Hurricane Dean, with major sub-sectors like banana J$4 billion, domestic agriculture J$1 billion and sugar J$2 billion, the worst hit [48]. The Office of Disaster Preparedness and Emergency Management (ODPEM) further estimated that 75% of the country's vegetable crops were destroyed and that 60% of housing for livestock was affected. In St. Elizabeth, one of the principal food producing regions in the country, the damage was estimated to be over J$90 million. Three years ago, the same parish incurred an estimated J$105 million loss due to Hurricane Ivan alone [49].

4.1. Methodology

A detailed ethnographic approach was combined with qualitative and quantitative data gathered from a wider survey of 282 farming households in four communities (Potsdam, Top Hill, Southfield and Flagaman) in southern St. Elizabeth to investigate the nature of farming in the area, impacts of recent climatic events and adaptive strategies as well as farmers' perceptions to these events. A questionnaire survey was administered to farmers within these four communities which form an altitudinal transect from the Potsdam region located at the top of the Santa Cruz Mountain to the low-lying Flagaman area (See Figure 3).

Figure 3. The study area.



St. Elizabeth parish is known as the bread basket of Jamaica mainly due to food production in the southern coastal area. The area is the main fruit and vegetable producing region in the country. Crops such as broccoli, yellow squash, melons, cabbage, tomato, sweet pepper, condiments and carrots feature prominently throughout the region. The modal farm size reported by farmers is 2 acres. The area is characterized by a low average annual rainfall (from 650 mm to 800 mm per annum) and insecure water supply yet the parish still manages to be a major source area for domestic food. Farming practices in the area developed as an adaptation to these challenging environmental and agro-climatic conditions. Farmers have reported that these conditions have changed significantly over the years. Specifically, farmers suggest that the rainy season is increasingly characterized by unpredictable shorter periods with torrential rainfall. For a system that is entirely dependent on the quality of the rainy season, these changes are obvious setbacks to crop production.

The sample was selected randomly at a 10 percent confidence interval from a self-generated sampling frame. The sampling frame was generated from sketch maps of each community which highlighted roads and counted and numbered all the houses (Table 1). A random number table was then used to select the houses until the required number for each community was reached.

Table 1. The study sample.

Community	No. of counted houses	Sample at 10% confidence interval
Potsdam	217	67
Top Hill	472	80
Southfield	316	58
Flagaman	461	77
TOTAL		282

The occurrence of Hurricane Dean during the period of this survey provided a unique opportunity to observe and investigate first hand, the behavior of farmers before and after the event. With the short warning about the arrival of the hurricane, a short questionnaire was created in the field to analyze (i) the awareness of farmers to the event, (ii) their perceptions and attitudes, (iii) source of information about the hazard and (iv), preparation for the hurricane with an emphasis on the damage-reducing strategies they put in place.

A total of 50 farmers were interviewed during the immediate period of the hurricane (two days before and two days after). It should be noted that 40 of these farmers were part of the broader study of 282 farmers. A convenience sampling technique was also employed for a further 10 farmers who were not part of the wider sample. All farmers that displayed or indicated that they planned to do something on their farms to reduce the impact of Hurricane Dean were also revisited after the event.

4.2. Pre-Hurricane Dean

Before the hurricane, farmers were asked about their awareness of the threat of Hurricane Dean, how seriously they took the threat and their plans to reduce or mitigate its impact on their farms. Two days before the hurricane struck, 27% of the farmers were unaware of the looming threat of Hurricane Dean. Of the 73% that were aware of the threat, 57% found out about it from other people (word-of-mouth), 20% television, 15% radio and 8% read about the hurricane in the newspaper. The threat of Hurricane Dean was taken seriously by 63% of the sample (those who indicated they strongly agree or agree that the hurricane would hit Jamaica); a further 34% did not take the threat seriously while 3% were unsure. The results also showed that only 36% of the sample indicated they would do something on their farm to reduce the impact of the hurricane. The remaining 64% felt there was nothing they could do to save their crops.

Crop Protection Measures

Sampled farmers were asked about methods used to protect crops from the hurricane. An examination of the responses revealed that about 60% modified or adjusted their farming practices in accordance with the prevailing climatic constraints. Farmers spent more time securing their homesteads than protecting crops both before and after the hurricane (73% of the sample). This reinforces the fact that the house is an important part of the production space of farmers. Not only is the house a refuge for the farmer and his or her family when a hurricane threatens, but it is also a place to protect farm animals and store produce. As a result, farmers will endeavor to protect their houses to as a matter of priority. This represents an adaptive strategy firmly enshrined in the cultural ecology of domestic food farming systems in Jamaica. Plates 1a and 1b show the strategy employed by one farmer to protect his house from Hurricane Dean. The farmer covered his house with a thick canvas material which he bound together with binding-wire and braced with board against the gradient of the hill.

Plate 1. Strategy employed by one farmer to protect his house from Hurricane Dean. (Photographs by Donovan Campbell).

(a) **(b)**

The main damage-reducing strategies of farmers during the immediate period of Hurricane Dean were the protection of nurseries, (re) transplanting, crop bracing, lowering yam sticks, cutting trenches, spraying crops as well as the harvesting and storage of produce (See Table 2). These strategies are primarily dependent on (i) the stage of crop growth (ii) type of crops grown (iii) terrain (iv) scale of production and the availability of labour and (v) age, health and experience of the farmer.

Table 2. Damage-reducing strategies of farmers before and after Hurricane Dean.

STRATEGIES	FARMERS (%)
Before Hurricane Dean	
▪ Protection of nurseries	30
▪ (re) transplanting	2
▪ Cutting trenches	6
▪ Spraying	41
▪ Harvesting and storage	25
After Hurricane Dean	
▪ Post hurricane harvesting and Plant restoration	44
▪ Relocation of farm plot	6
▪ Scale down production	73

Protecting nurseries

Farmers tried their best to protect their nurseries from the anticipated damaging effects of Hurricane Dean. Using corrugated roof sheeting, wood, blocks and grass, some created either *roof-like* (Plate 2a) or *tomb-like* structures (Plate 2b) over nursery beds to protect them from excessive winds and rain. Farmers who had seedlings in trays took them inside their house. Of the 50 farmers surveyed, 20 had active nurseries (4 in trays and 16 in seedbeds) and 75 percent (15 farmers) of this total took steps to protect them. Seedbeds represent the traditional way of nurturing seedlings in Jamaica, while trays are a modern and more efficient way to do so. However, it is clear that some farmers still prefer the old-fashioned way primarily because of the high cost of seedling trays and the treated organic matter that is required. Overall, efforts by farmers to protect nurseries proved effective as there were no observed or reported cases of damage to seedlings under these structures.

Plates 2. (a) Roof-like and (b) tomb-like structures to protect seedlings. Photographs by Donovan Campbell.

(a)

(b)

(Re)transplanting

(Re)transplanting was performed by one farmer in the study area who was trying it for the first time as a hurricane precaution. The farmer carefully lifted his two weeks old tomato plants, put them in a box, sprayed the leaves with (leaf) fertilizer and brought them inside his house. After hurricane Dean passed he replanted the tomato plants. The farmer mentioned that he saw another farmer in the parish of Manchester doing it just before Hurricane Ivan in 2004 and it worked so he was trying it for himself to see the outcome. Re-transplanting can negatively affect the growth and development of any plant as it offsets the intake of vital micro-nutrients that often results in the wilting and dying of plants. Therefore, an observation of the plants' development until it reaches maturity is necessary before any reliable conclusions can be made about the effectiveness of the strategy. It will be interesting to see if this strategy spreads in this community and become a viable adaptation strategy. Its use by this farmer also raises interesting questions regarding a sentiment often expressed about local/traditional knowledges which holds that they are localized and spatially un-transferable.

Plant bracing and lowering yam sticks

Crops such as sweet pepper and yam are difficult to protect when they reach a certain stage of growth as they should neither be covered nor uprooted. One sweet pepper farmer operating on a hillside decided to use crotch-sticks to brace the plants against the gradient of the hill (Plate 3a). The farmer's experience with Hurricane Ivan was the real motivation behind this strategy. According to him, it was the wind from Hurricane Ivan that did the most damage to his crops and so he is using the crotch-sticks to try to support the plants. The farmer did not lose all of his crops but he attributed this more with the 'mercies' of Hurricane Dean than the crotch sticks. A yam farmer did something equally simplistic to save his entire garden; he uprooted the yam sticks and placed them on the ground (Plate 3b). According to him it is better the yams 'fight' on the ground rather than in the air, which simply means than their chances of survival were better on the ground. Left standing the sticks would be snapped or blown over by hurricane strength winds. This is very unique approach which has not been reported before and is not a feature in the main yam farming communities in Jamaica perhaps because of the difference in scales of production. It would be interesting to see how farmers in the main yam growing areas would assess the feasibility of this approach as a response to hurricanes.

Plate 3. (a) Lowering yam sticks; (b) Plant bracing. Photographs by Donovan Campbell.

(a)

(b)

Pre-Wet season strategies

Some farmers with fields on hillsides as well as in low-lying flood prone areas cut or cleared trenches on their farms to channel water away from their crops. Hillside farming is common in the Potsdam community, especially on lower slopes, and while steeper slopes may be in bush or guinea grass, they are part of the overall farming system. Cutting trenches to help control soil erosion is quite common on the steeper-sloping areas of southern St. Elizabeth's farming system. These trenches are cut across slope gradient. Some farmers also use stone lines across the contour to help control soil erosion due to torrential rainfall. In addition to cutting trenches, 41% of the sample indicated that they would spray their crops with either leaf fertilizer, (20:20:20 NPK) or diathane (fungicide) or a combination of both to enhance the resilience of their crops to extreme rainfall.

Harvesting and storage

The decision-making process of farmers is complex and often seems to run counter to what conventional wisdom might define as being logical. For example, if a hurricane threatens the island and a farmer has mature produce on his or her farm, then the logical thing to expect is that he would harvest and store them until after the event. However, to arrive at decisions such as these, farmers often "put historical experiences into perspective and to evaluate alternative management strategies for making improved decisions to take advantage of good years whilst minimizing the losses during the poor years" [50]. For example, based on a history of near-misses from hurricane, some farmers did not believe Dean would hit and that pre-harvesting would affect the quality of farm produce. This manifestation of *gamblers' fallacy* is common in the response of people to disasters. With the impact of Hurricane Ivan still lingering in their minds, however, other farmers did not hesitate to harvest and store produce in preparation for the advent of Dean. This is an example of adaptation but the different responses by farmers emphasize that adaptation can be uneven and non-uniform over small geographical spaces.

One of the many incentives to harvest and store produce before a hurricane is that farmers usually get good price immediately following the event. Data gathered from the wider sample indicated that after Hurricane Ivan, the price for carrot tripled (from J$40 to J$120/lb [US$1 = J$68]) and tomato quadrupled (from $50 to $200/lb). Of the 50 farmers sampled, 25% indicated that they would harvest and store produce (5 of these farmers were observed doing so) while 6% said they will not do so because Hurricane Dean will change its course just like most of the other near misses Jamaica has experienced in the past. See Plates 4a and 4b.

Plate 4. (a) Pre-hurricane harvesting; (b) Storage of Pre-harvested Tomatoes. Photographs by Donovan Campbell.

(a)

(b)

5. Post-Hurricane Dean

Adaptation is a continuous process of adjustment that seeks to provide an adequate compromise between losses and gains. The process has to make sense to the farmer within the context of his/her livelihood. In this sense, adaptation is usually "the result of individual decisions influenced by forces internal to the farm household and external forces that affect the agricultural system at large" [5]. After Hurricane Dean the efforts of farmers were mostly geared towards restoring their livelihoods to a state of normalcy. Some farmers utilized financial resources (e.g., savings) available to them to restart production and restore damaged properties. However, the majority of farmers surveyed reported limited financial assets and as a result had to depend on other forms of capital (physical, human and social) in their restoration efforts.

Table 3. Percentage crop loss to Hurricane Dean.

Crop loss	Frequency	Percent
<50%	3	6.0
50%	11	22.0
>50%	18	36.0
100%	18	36.0
Total	**50**	**100.0**

Hurricane Dean struck at a time when farmers usually start preparing for the rainy season (August to November). Thirty six percent of the sample reported that they had lost 100% of their crops (See Table 3) compared to 70% of the wider sample that claimed they lost all their produce to Hurricane Ivan in 2004. During the immediate period following Hurricane Dean, some farmers employed a number of strategies to cope with the changes. Most common among these were: (i) Post hurricane harvesting and plant restoration, (ii) relocation of farm/plot (iii) scaled down production.

5.1. Post Hurricane Harvesting and Plant Restoration

In the aftermath of Hurricane Dean, farmers identified marketable produce which they harvested and tried to sell immediately. Not surprisingly, all 50 farmers sampled indicated that the price for produce was better in the immediate period after Hurricane Dean than for the period preceding the hurricane. News reports indicated that there was a 300% price increase in vegetables such as tomato, carrot and sweet pepper in many parts of the island after the hurricane.

In addition to harvesting, farmers were also interested in the ‘rehabilitation’ of crops. With little Government relief available, they turned to a range of tried and proven traditional or customary agronomic practices to salvage crops and mitigate losses. These included, weeding, moulding, mulching, fertilizing and manuring, spraying, and watering. Sweet potato, scallion and beetroot were identified by farmers as the easiest crops to revive, while tomato, melon, sweet pepper and cabbage were included among the hardest. The crops experiencing the worst damage were identified as carrot, yams, tomatoes, melons, and scallions.

5.2. Relocating Farm Plots

Farmers are generally hesitant to change the location of their farm plots. Chief among the factors which explain this attitude are; land availability and tenure; indigenous technical knowledge—specifically knowledge of environmental conditions such as soil type, rainfall and pest and insect behavior; type of crops being cultivated; distance from homestead; access to road and water; and the availability of labour. In the aftermath of Hurricane Dean, only 3 farmers indicated their intention to relocate farm plots. Two of the three farmers were cultivating on hillsides and planned to move to the foot of the hill where eroded topsoil and fertilizers and manure applied had accumulated.

5.3. Scaled down Production

Sampled farmers were asked whether or not they would scale down production as a result of the impact of Hurricane Dean. More than 70% of the farmers indicated that they will scale down production as a short term measure. One of the major contributing factors to the scaling down of production as explained by farmers, was a sudden increase in fertilizer prices in the immediate aftermath of both Hurricane Ivan in 2004 and Hurricane Dean in 2007. The scaling down of production occurs both in terms of land area and number of crops cultivated. In terms of land area, the decrease was about 25% of the total area under cultivation before the Hurricane.

Through a natural process of vegetation succession, land taken out of crop production in the area typically reverts to the growth of guinea grass (*Panicum Maximum*) which is a ubiquitous feature of farming systems in the area where it is used as mulch and is a profitable if unsustainable alternative to crop production in the area. Some farmers have also indicated their intentions to give up farming altogether while others have been reduced to the growth of a single cash crop which increases their vulnerability. Others have been reduced to working for richer farmers at an average rate of $US15 per day. These changes can have serious implications for sustainable livelihoods and food security.

6. Relief Efforts and Recovery

It has been argued that the 'period of recovery, is an important factor that is given little attention and is especially important because of the nature of the annual hurricane season and possible trends as a result of anthropogenic climate change' [51]. The period of recovery is fundamentally a function of the socio-economic and political factors (such as effective government policies to assist affected persons after a disaster) as well as the health and well-being of the affected. The degree of damage to the environment (e.g., the erosion of valuable top soil and destruction of road networks) can also affect the recovery time of farmers. Governments can help to shorten the recovery time by working with farmers to understand their needs as well as to facilitate the implementation of community-specific policies geared towards increasing resilience. This means that robust adaptive measures must be in place. This has scarcely been the case in Jamaica, and the reported experiences of farmers is replete with statements of discontent about the disorganized and inappropriate relief strategies of the government after both Hurricanes Dean and Ivan.

Recent research documented a poorly orchestrated relief effort by the Ministry of Agriculture through the Rural Agricultural Development Authority (RADA) for farmers after Hurricane Ivan in 2004 when farmers were given a J$5,000 coupon (<US$70), redeemable only against carrot seeds supplied by a single large Jamaican agro-processing company, and regardless of a farmer's particular cropping specialty [4]. According to the researchers 'Farmers reported that the registration arrangements for assistance were chaotic, requiring them to travel out of the area to nearby towns, and the registration system was so loosely managed it allowed persons who were not farmers to claim assistance' [4].

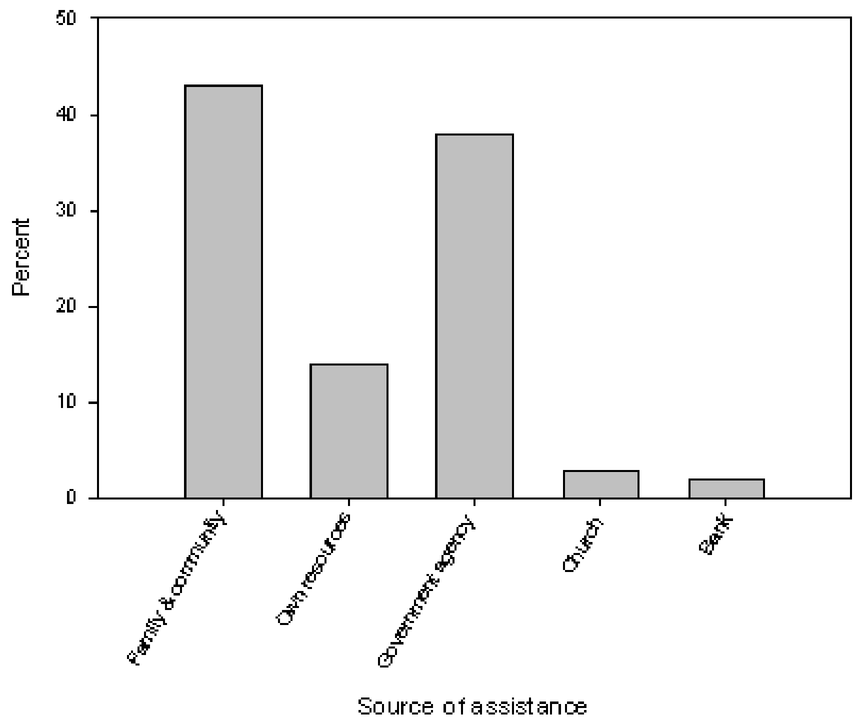
The relief effort after Hurricane Dean was quite similar to that described for Hurricane Ivan. Farmers lamented the loose and poorly managed relief efforts by the Ministry (through RADA) that did not ensure that the worse affected and most vulnerable farming households got assistance.

Assistance was in the form of fertilizers and farmers got on average 1–3 bags, regardless of the size of their farms. Over 84% of the respondents were not visited by RADA after Hurricane Dean and 74% did not receive any assistance from the government. This suggests quite clearly that farmers were in essence left to fend for themselves as they attempted to recover.

While typical relief efforts in farming communities in Jamaica scarcely build resilience and in many cases create dependency it is difficult to overstate its importance in accelerating the recovery process in the immediate aftermath of a disaster. Recent literature has stressed the importance of assisting affected persons after a disaster not just to return to 'normalcy' but to build capacity so they will be better able to respond and cope in the future [52]. This is the essence of adaptability. However, poorly organized and inadequately financed relief efforts also impinge on farmers' ability to recover from such shocks and stresses [4].

The Inter-Governmental Panel on Climate Change Third assessment Report highlighted the important role governments have to play in the post hurricane adaptation process. If they are well organized and prepared, the adaptive capacity of the most exposed sectors will improve. However, 'a disorganized and unprepared government will mean a lower adaptive capacity for a country' [53]. It is clear from this study and previous work that the agriculture sector was improperly prepared for both Hurricane Ivan and Dean along with other recent climatic events. While most farmers (43%) indicated that they planned to seek assistance from their families and friends to restart production after Hurricane Dean, an important 38% were depending on government assistance to do so (Figure 4). The fact that most farmers depend on family members and friends for support after the disaster reinforces the importance of social capital—the 'features of social organization such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated actions' [54] as a critical component of rural livelihood and adaptation.

Figure 4. Source of assistance to restart production.



While acknowledging the importance of social capital, literature on the subject also argues that 'strong bonding ties are associated more with survival than development and are often observed in recovering from natural disaster and conflict' [55]. Therefore, while social capital helps farmers to recover from natural disasters, it is hardly associated with an improvement in their standard of living. Put another way strong bonding ties are helpful in coping but not so much in adaptation. However, there is also literature arguing that the presence of 'bonds' (strong kinship network) can increase the adaptive capacity by providing economic, managerial and psychological help [3]. The presence of bonds and ties with these communities also provides fertile ground for governmental intervention to facilitate the development of agrarian policies and rural programs.

To further compound the difficulties faced by farmers, the passage of Hurricane Dean was followed by a two-week rainfall event produced by Tropical Storm Noel that caused severe flooding, water-logging, and destruction of crops. The continuous disruption of livelihood activities by successive extreme events amplifies the plight of these farmers who operate in a relatively marginal agricultural system.

7. Conclusions

Data collection in the study area in the period leading up to Hurricane Dean, during the passage of the hurricane and in the period immediately after, provided a rare opportunity to observe and investigate the response of farmers to the threat and subsequent devastation and assess the adaptive capacity in the area. The response of farmers and farm families was to a large degree dependent on their awareness of the impending storm and their "assessment" of the credibility of the threat. Farmers who took the threat seriously prioritized the security of the homestead which is considered to be central command of farm operations even though it may not be a farm plot. They then used a variety of customary practices to secure their cultivated fields. These practices were largely based on local and traditional agro-ecological knowledge learned through years of observations and farm level experimentations. These innovative and mostly rudimentary measures proved to be fairly effective in minimizing crop loss and damage.

The farmers in the study displayed strong adaptive and coping capacities in the aftermath of the storm. This was remarkable as Hurricane Dean was the most recent in a series of debilitating cyclonic episodes over the last four or five years from which they were still recovering. Many were resolved to pick up the pieces and move on often temporarily scaling down their operations. For some being hit while they were down was more overwhelming prompting contemplations to quit farming. The study emphasized the role of farmers' personal resourcefulness, ingenuity and resilience in coping with natural disasters and everyday hurdles in a challenging farming environment where risk and uncertainty are ubiquitous and their livelihoods are never secure. Left to their own devices before and after the storm, they drew on community and personal strength and a fatalistic philosophy in which disasters are treated as simply realities of life. The importance of this attitude as an important piece of adaptation is intangible and very difficult to quantify but should not be underestimated.

The study also underscored the urgent need for more State institutional support for the agricultural sector in general but for the small-scale food producing sector more specifically. Governments in the Caribbean have tended to invest in disaster planning systems which focus on mitigating loss of lives.

We argue very strongly that strategies to protect rural livelihoods must also be incorporated. Given the importance of agriculture to rural livelihoods, the Jamaican economy, and national food security, steps should be taken to moving beyond helping farmers to cope in the aftermath of a shock event to building adaptive capacities in rural farming communities. This could include a special warning system in deep rural communities where communication challenges could reduce awareness of an impending storm. Agricultural extension services must be expanded and intensified to include hazard mitigation education for farmers and rural dwellers. Investments in modern agricultural storage systems and facilities and education around proper storage of fresh farm produce are also critical. State relief efforts and support must be better coordinated and significant to assist farmers in rehabilitation and restoration efforts after a disastrous event. Central to this should be a system to allow farmers to affordably access state provided loans and grants as they recover from natural disasters. Studies should be conducted to research the most appropriate crops for the region in the context of climatic variability and environmental change. Finally, farmers should be involved in the development of any disaster management plan for the sector.

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