The impact of hydro-meteorological hazards on crop production among small-scale farmers in Crofts Hill, Clarendon.

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THE IMPACT OF HYDRO-METEOROGICAL HAZARDS ON CROP PRODUCTION AMONG SMALL-SCALE FARMERS IN CROFTS HILL, CLARENDON.

A Research Paper

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This research is dedicated to small-scale farmers who continue to strive after experiencing multiple impacts from hydro-meteorological hazards on their crop production.

Abstract

The impact of hydro-meteorological hazards on crop production among small-scale farmers in Crofts Hill, Clarendon.

Recent impacts of hydro-meteorological hazards have been influencing significant crop loss among small-scale farmers. Hurricanes and tropical storms have been increasing in occurrence and impacts of these systems affected economic and social aspects of farmers' life. Recovery periods vary among different farmers and affect crop production at both the local and national level. The direct and indirect impacts associated with hurricane and tropical storms are much more profound than those resulting from drought events and influence a longer recovery period. In response to the direct and indirect impacts experienced, a number of small farmers have lost interest in crop production and it is reflected in the output for both domestic and export production and a decrease in the acreage under cultivation. However, in order for farmers to increase resilience to hydro-meteorological hazards, farmers should employ the necessary coping mechanisms to reduce the impact caused from re-occurring hazards. Despite the losses or damages sustained, most farmers remain interested in the agricultural sector as they believe that there is a future for crop production for small-scale farmers.

Keywords: *Hydro-meteorological hazards, small-scale farmers, recovery period, crop production, resilience, crop loss/damage and coping mechanism, Crofts Hill, Dorlan Burrell.*

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List of Abbreviations and Acronyms

ADRM	Agricultural Disaster Risk Management
CARDIN	Caribbean Disaster Information Network
DRM	Disaster Risk Management
ECLAC	Economic Commission for Latin America and the Caribbean
EMU	Environmental Management Unit
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GPS	Global Positioning System
ha	Hectares
ID	Identification
MDGs	Millennium Development Goals
MOA	Ministry of Agriculture
ODPEM	Office of Disaster Preparedness and Emergency Management
PIOJ	Planning Institute of Jamaica
RADA	Rural Agricultural Development Authority
SIA	Sugar Industry Authority
SIDS	Small Island Developing States
SPSS	Statistical Package for the Social Sciences
STATIN	Statistical Institute of Jamaica
UDS	Unit for Disaster Studies
UNEP	United Nation Environmental Programme
UWI	University of the West Indies

Chapter One - Introduction

1.0 Introduction

The cultivation of crops began when society changed from hunter gathering (Tauger 2011), to give rise to a sedentary human civilization that saw the need to domesticate species, both flora and fauna. Since then, a number of changes have taken place where agriculture is concerned, especially in the area of production (Tauger 2011). Based on the eating habits and the demand for particular crops, agriculture is needed more than ever in order for humans to survive given the current level of the world's population (over 7 billion people).

Jamaica is known for agriculture although traditional crops that were once exported such as sugar cane and banana (Burrell 2010), are no longer the most significant crops produced now. Over the years, however, the sugar industry has been through a number of phases where sugar production has either increased or decreased. Despite the various challenges that exist within the agricultural sector, the small-scale farmers have been trying to adapt to these conditions. Small scale farmers are usually defined by the area of land cultivated which is normally lower than 5 hectares.

Crofts Hill is a small farming community where persons cultivate several crops. A number of these crops are normally 'cash crops' which are sold at the local market in Kellits, Clarendon. However, these crops also act as a means of subsistence for the farmer and his or her family. 'Cash crops' are short term crops grown intensity over a short period of time. It is important to note, that sugar cane is the predominant crop in this area (Burrell 2010). Sugar cane is grown on a large scale by a few farmers but the majority of the farmers cultivate sugar cane on a small-scale.

During most extreme weather conditions, the operations of the small-scale farmers are usually affected. As a result of these conditions, small-scale farmers are not able to maximize the benefits of their labour based on the amount of damage done. Other limitations that affect small-scale farmers include location, size of their farmlands and an adequate market to consume the crops produced. As a result, these factors can affect small-scale farmers’ economic stability to cope under such financial burden and market competition.

In the past, farmers in Crofts Hill have suffered from several hydro-meteorological hazards such as hurricanes (major and minor), tropical depressions and storms, droughts and flooding in particular areas. These hazards affect the normal operation of small-scale farmers. However, the level of displacement is often determined or influenced by the magnitude and duration of each hazard event. When crops are damaged by hydro-meteorological hazards, the farmer’s economic gain can either increase, decrease or removed entirely.

Over the past 25 years, Crofts Hill has been affected extensively by hurricane Gilbert (1988), hurricane Ivan (2004), hurricane Dennis (2005), hurricane Dean (2007), tropical storm Gustav (2008) and tropical storm Nicole (2010). These systems, for the most part, inflicted wind damage but hurricane Dean and tropical storm Nicole brought considerable amounts of rainfall which induced flooding in many areas. The flood rains in May 2002 and May-June 2011 also caused flooding in particular areas of the community.

Droughts and dry conditions have also affected farming within the community of Crofts Hill. Moisture is an important ingredient for plant growth, without which the growth of the plant would be retarded. The 2009-2010 droughts caused the soil in the area to become hard and in some cases to crack, as moisture content was low. However, few farmers were able to use nearby streams until they became dry. The duration of the two dry seasons has been increasing, which have caused prolonged dry conditions. This affects how much and when farmers are able to grow crops, since they mostly depend on rainfall for irrigation.

This research seeks to focus on particular hazards namely floods, droughts and hurricanes/tropical storms that affect farmers' crop production in Crofts Hill. The effects of these hazards can result in a 'trickle down' or cascading effect on persons who depend on the farming sector. The implications of these hazards will also be assessed and recommendations will be provided where necessary.

1.1 Research Problem Statement

The agricultural sector is vulnerable to internal and external shocks in which natural hazards are no exception. The Caribbean region is prone to natural hazards in which small-scale farmers have been affected repeatedly especially over the last ten (10) years (Campbell and Beckford 2009; Campbell et al. 2010; Spence 2008; Spence 2009). Each year small-scale farmers lose large quantities of their produce which has significantly affected their livelihoods (the very basis of their survival) in most cases, whether due to hurricanes/tropical storms, drought or pest outbreaks. The extent of damage from natural hazards has been associated with the frequency and intensity of hurricanes/tropical storms and receipt of less rainfall. The latter normally induce dry spells which can lead to drought conditions over a short or prolonged period.

Small-scales farmers are vulnerable to both internal and external shocks directly and indirectly (Campbell and Beckford 2009; Campbell et al. 2010; Spence 2009). In addition, they do not have the mechanisms to address the problems of natural hazards by themselves. After suffering successive events, it becomes extremely difficult for small-scale farmers to re-cultivate their fields due to revenue loss. Depending on the intensity of the event which affects farmers, their recovery period may vary from weeks, months or years (Campbell and Beckford 2009; Spence 2009). The local production within the agricultural sector is then affected by the recovery period which may give rise to higher food prices due to the great demand for the limited supply that would be available.

Jamaica has 384,000 ha of land with slopes below 10^{o}, 330,000 ha have moderately steep slopes and 290,000 ha have slopes greater than 30^{o} (McGlashan et al. 2008). Small-scale farmers normally operate farm plots on slopes which usually range from gentle sloping to steep (Thomas-Hope et al. 2000; Burrell 2010). Spence (2009, 20) highlights that "the steep terrain on which over 90 percent of Jamaica's farmers operate is susceptible to the impacts of strong winds and mass wasting." However, this research will focus on the small-scale farmers in Crofts Hill who have been affected by hurricanes, floods and droughts. Small-scale farmers are usually more vulnerable to both internal and external shocks and such impacts should be highlighted and mitigation/adaptation measures implemented (Spence 1996; Barker 1993; Spence 2008; Spence 2009; Campbell and Beckford 2009; Campbell et al. 2010). In addition, through observation, the researcher realized that there have been small-scale farmers who have undergone long recovery periods after the impact of hydro-meteorological hazards. As such, a number of farmers saw it necessary not to produce crops until they received income or assistance from government officials, family members and/or friends.

Having done previous research in Crofts Hill (Burrell 2010), it was highlighted that there was a relationship between hazards, the recovery period and agricultural production. As such, the researcher believes that this is an area in agricultural research that needs to be studied. This area of research is supported by Campbell and Beckford (2009) who states that the recovery period or the time it takes small-scale farmers to re-cultivate farm plots is usually not highlighted and should be assessed. Hazards affect livelihoods whether directly or indirectly and the implications of these effects must be examined in order to get a broader understanding of the relationship that exists between the different variables.

Various strategies can be employed within the community to offer support to farmers so that the levels of damage accrued are reduced to a minimum (Campbell and Beckford 2009; Campbell et al. 2010; Spence 2008; Spence 2009). In order for the agricultural sector to survive, it must either prove viable to persons involved or provide incentives for persons to get involved. Agriculture has been the foundation of the Jamaican society and as such, stringent measures or strong actions are required for it to regain its former prominent position. The paper seeks to assess impact of mainly hurricanes and droughts on crop production of small-scale farmers in the Crofts Hill, Clarendon.

1.2 Research Contribution

Research of this nature is of importance to the agricultural sector, firstly to add knowledge on crop production among small-scale farmers; and secondly, to contribute meaningfully to hazard risk reduction initiatives to ensure that sustainable development is achieved as outlined in Agenda 21, the Small Island Development States (SIDS) Programme of Action, the Millennium Development Goals (MDGs) and the Mauritius Strategy. Hazards are considered to be potentially damaging phenomena, however, impacts from such events vary from country/area to another due to a number of underlying factors.

It is important to conduct such a study, as it will reveal vital information which can be used to determine the impacts of hazards and how they can influence production among small-scale farmers. Clarendon is among the top five parishes which contribute significantly to Jamaica’s GDP through domestic and export crop production along with employment. In addition, Clarendon is one of the parishes with the most agricultural land with 14% of parish land in agriculture (McGlashan et al. 2008). Clarendon contributed 7.5% of the overall domestic crop production in 2009 compared to St. Elizabeth with 20.6% (MOA 2010). Clarendon also contributes significantly to sugar export (Burrell 2010).

Extensive research has been done on the effects of hydro-meteorological hazards on the agricultural sector in the Caribbean and more so Jamaica (Ahmad 1997; Barker 1993; Campbell et al. 2010, Goldenberg et al. 2001; Campbell and Beckford 2009; PIOJ 2010; Spence 2008; Spence 2009). Mitigation measures, when implemented correctly, normally reduce the impacts of hazards and have been justified by several persons (Ahmad 1997; Beckford et al. 2007; Cooper et al. 2008; Campbell and Beckford 2009; Campbell et al. 2010; Edwards 1998; Henry 1999; Spence 2008; Spence 2009). In addition, the justification or rationale section of the National Agricultural Disaster Risk Management (ADRM) Plan demonstrates the relationship between hydro-meteorological hazards and crop production perfectly and should be assessed.

1.3 Research Aim

Aim: To critically assess the impact of hydro-meteorological hazards on crop production among small-scale farmers in Crofts Hill, Clarendon.

1.4 Research Questions

1. How frequent are hurricanes, floods and drought events in Crofts Hill, and how does frequency of events impact the small-scale farmers?
2. What are the possible effects (direct and indirect) resulting from hurricanes, floods and droughts among small-scale farmers?
3. What are the measures adopted by small-scale farmers to deal with such hazards and the recommendations that can be given for implementation to reduce the impact?

1.5 Research Objectives

The objectives of the study are as follows:

1. To understand the direct and indirect impacts experienced by small-scale farmers resulting from the frequent occurrence of hurricanes, floods and droughts.
2. To assess the coping mechanisms of small-scale farmers to deal with hydro-meteorological hazards and recommendations that can reduce the impact of such hazards.
3. To critically examine the impact of hydro-meteorological hazards on future crop production of small-scale farmers.

1.6 Conceptual Framework

The conceptual framework in Figure 1 highlights the focus of this research project. The main variables in the project are identified and linked based on their relationship with other variables. Small-scale farmers are engaged in crop production within the agricultural sector which can be affected be hydro-meteorological hazards. Factors such as location and size of farm plot among other factors, increases the vulnerability of farmers and will be examined in this research. In addition, the frequency of hydro-meteorological hazards occurrence on crop production will also be assessed. The hydro-meteorological hazards are normally seen as external shocks and can influence a loss in agricultural production among farmers.

When farmers are impacted, they can either experience a decrease or an increase in the income earned base on the level of damage sustained. The increased income is usually related to the increase in market prices based on demand. Farmers who experience an increase in income are usually more financially secure and more likely to increase crop production. On the other hand, farmers who experience a loss of income may resort to a reduction in agricultural production for the next crop and are less financially secure. In addition, in extreme cases, farmers may opt out of crop production due to the magnitude of losses experienced. Re-cultivation among scale farmers is often marked by a recovery period which is usually affected by the income level of the farmers. However, after re-cultivation then the cycle is repeated and may or may not be as extensive as before.

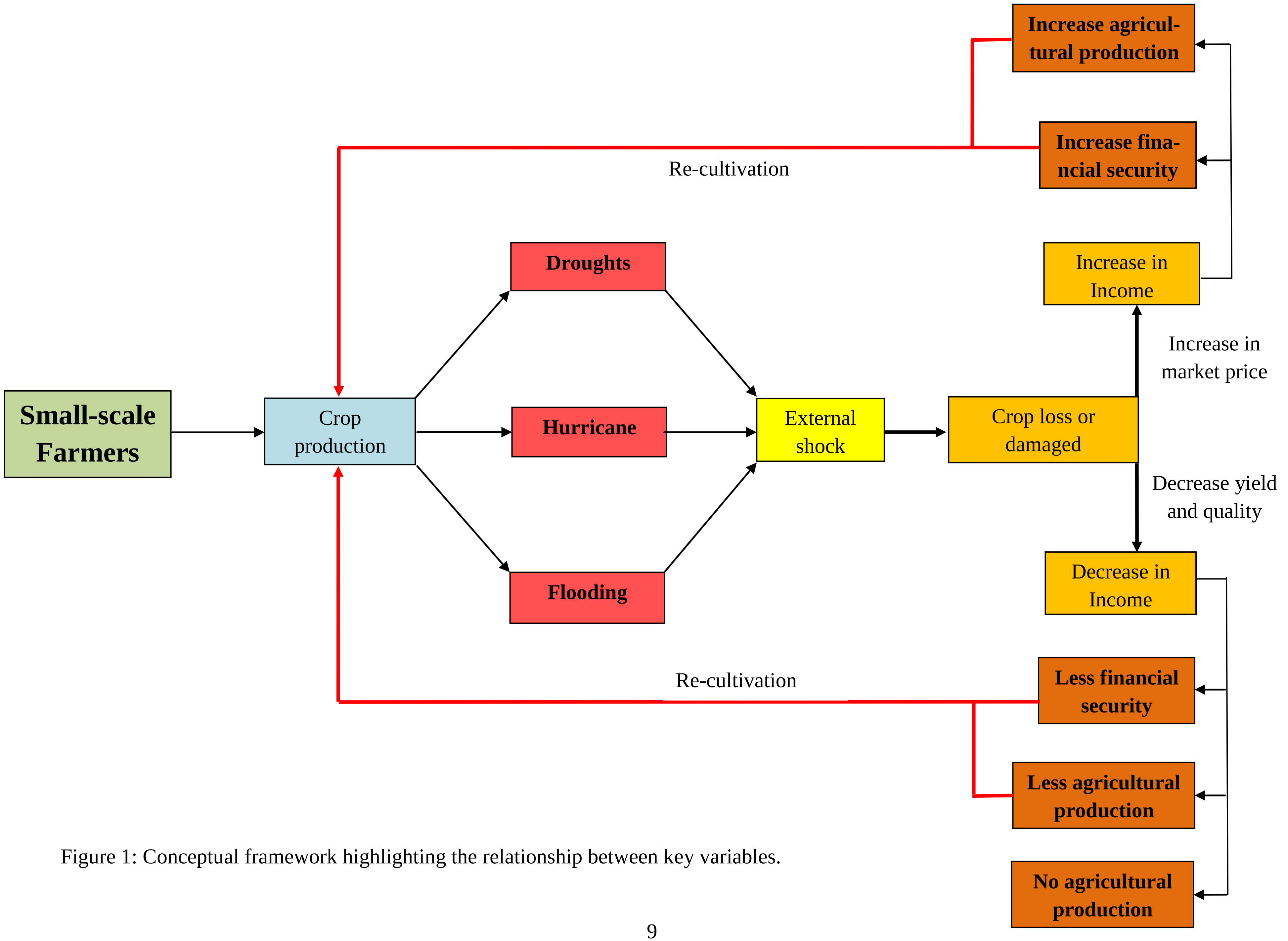


Figure 1: Conceptual framework highlighting the relationship between key variables.

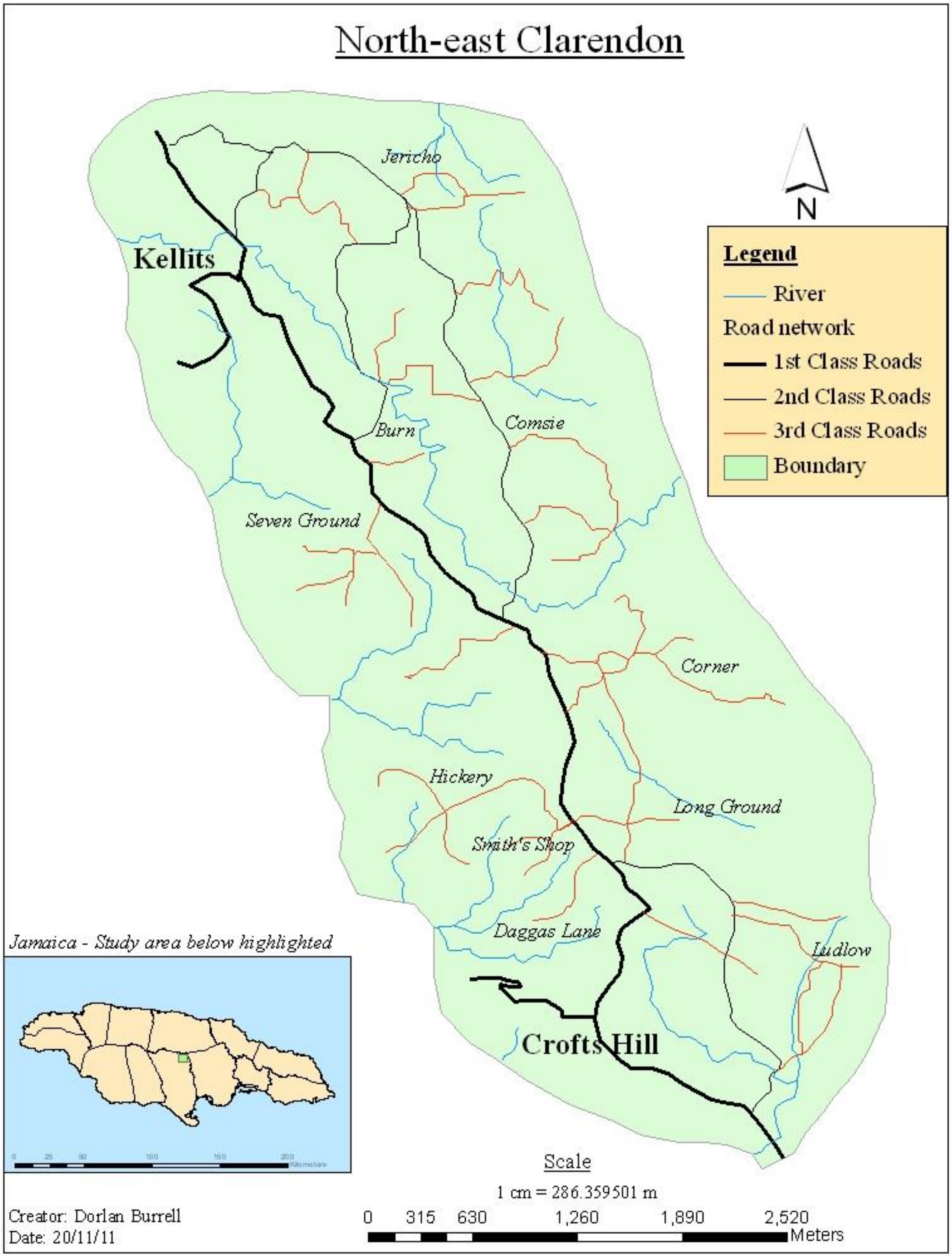
Chapter Two - Description of Study Area

2.0 Political and Geographical Location

The study area is located on the western side on the Crofts Mountain and north of Pindars Valley. Crofts Hill is located in the north-eastern section of Clarendon and is close to the borders of St. Ann and St. Catherine (see Map 1). The study area is within close proximity to Kellits which is the main area of commerce for north-east Clarendon (see Map 1). Crofts Hill also falls within the political constituency of Northern Clarendon. The study area ranges from a height of 800m to 1000m above sea level and is adjacent to the Crofts Mountain (a section of the central inlier of Jamaica which is characterized by mountain ranges and hills).

2.1 Hydrology and Hydro-stratigraphy

The hydrology of Crofts Hill is influenced by the soil, geology and geomorphology of the area. This includes a few surface streams and sub-surface drainage channels which drain the immediate watershed (see Map 1). However, the volume of water in the surface channels normally fluctuates with the seasonal changes in rainfall pattern. In terms of hydro-stratigraphy, the north-west section of the study area is grouped as Basal Aquiclude while the south-east section is characterized as Limestone Aquifer. The Limestone Aquifer is associated with wells and springs which are usually regenerated with the run-off from rainfall while the Basal Aquiclude is a solid impermeable area underlying or overlying an aquifer. Farrell et al. (2005) explains that the Limestone Aquifer sits on the Basal Aquiclude which covers a larger percentage of Jamaica.



Map 1: Study Area

2.2 Geology and Geomorphology

Jamaica is made up of 70% limestone of which Crofts Hill is no exception. The area is comprised mostly of limestone rocks from the Upper Cretaceous series. As a result, features such as round hills, valley, sink holes and steep sided slopes are typical. Although slopes over 30^{o} are not recommended for farming, farmers in Crofts Hill still include these areas into production. The study area is characterized by the Yellow Limestone group to the north-west and White Limestone to the south-east. Mitchell (2003, 607) identified the stratigraphic units as “an older suite of volcanics (Arthurs Seat Formation), an older Cretaceous sedimentary succession (Crofts Hill Synthem), a younger Cretaceous sedimentary succession (Kellits Synthem), and a cover succession of Paleogene, shallow-water limestones and associated clastics (Yellow Limestone Group)”. The Yellow Limestone group consists of low permeability rocks which gives rise to a number of drainage channels. On the other hand, the White Limestone group consists of permeable rock with high porosity which gives rise to sink holes.

2.3 Climate

As a result of the geographic location and the topographic characteristics of Crofts Hill, climatic conditions are favourable for agricultural crop production. However, seasonal rainfall is predominant within the area but rainfall patterns have been affected by the impacts of climate change. The seasonal rainfall is characterized by the bi-modal peaks as shown in Figure 2 and 6. According to Hennemann and Mantel (1995, 3), “the elevated mountainous nature of the island’s interior has a marked influence on temperature and rainfall patterns creating different climatic zones on the island". In addition, the mean dependable annual rainfall for the intermediate agro-climatic zone is 1308mm (Batjes 1994). The overall 30yr mean for Crofts Hill was measured at 317mm (PIOJ 2005) but was recorded by a more accurate means by MOA (1988) with a minimum of 947mm and a maximum of 2822mm. MOA (1998) also indicated that the potential evapotranspiration was 1373mm. Most of this precipitation usually occurs in the months of October, September and May each year (see Figure 2 below). This pattern does not deviate much from the precipitation pattern for Jamaica as shown in Figure 6.

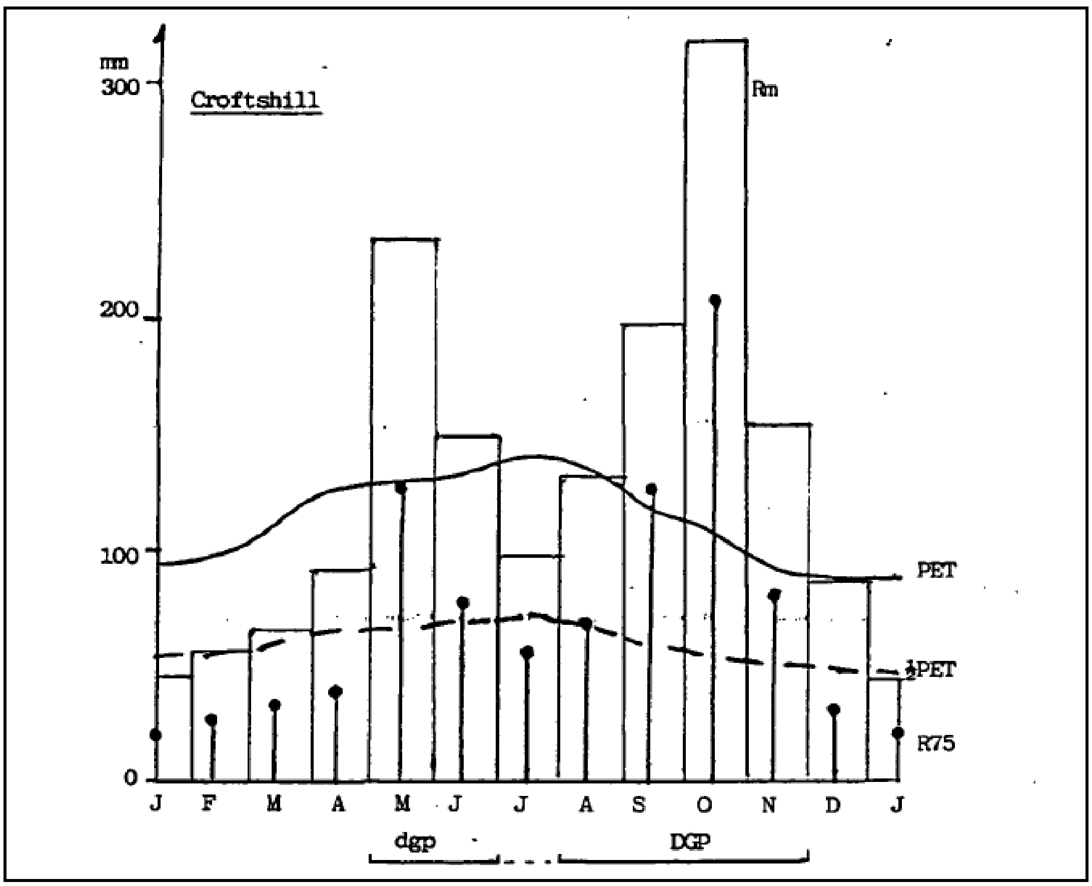


Figure 2: Rainfall histogram for representative rainfall station of subzone 1 of the "wet, cool" zone (Wc1). Source: MOA (1988).

2.4 Soils

The predominant soil type in the study area is clay loam but pockets of loam soil can be found in other areas. The clay loam topsoil is characterized by black loam while the subsoil is dark brown loam which is typical of Upper Clarendon (MOA 1964; Bailey 2003). The clay loam soil is a deep soil which is slightly acidic, has high fertility, good internal drainage but poor surface runoff. The loam topsoil is characterized by dark redish brown clay to loam while the subsoil is dark brown clay loam (MOA 1964; Bailey 2003). The loam soil is a deep soil which is neutral in ph value, has high fertility, good internal drainage and poor runoff. The clay soil in the study area has typical topsoil which is strong brown in colour (see Plate 1), while the subsoil is of a yellowish red colour (MOA 1964; Bailey 2003).

Plate 1: Cracks in the soil caused from the effects of extended dry conditions (Taken on January 2, 2011). Source: Arthur's Fieldwork.

The clay soil is quite deep, neutral in ph value, has low fertility, very rapid internal drainage and generally good surface runoff. The depth of the soil horizons vary from shallow to deep and are influenced by the topographic characteristics of the area. However, this does not limit the use of the land for agricultural use which is the main activity among the populace.

2.5 Land Use and Economic Activities

The main economic activity in Crofts Hills is farming which is done by mostly small-scale farmers (Burrell 2010; Bailey 2003). The main crops produced in the study area include sugar cane, yam, cabbage, lettuce and sorrel. Cash crops produced in Crofts Hill mimic the seasonal rainfall/bimodal patterns while sugar and yam are normally produce throughout the year. Economic activities also come in the form of wholesale and retail shops which can be found along the road network. In terms of land use, farming constitutes a large majority of the land area. However, Burrell (2010) highlighted that agricultural lands has been losing out to the development of houses or left idle. This coincides with general decrease in the farming population (Tauger 2011) and agricultural lands in Jamaica (STATIN 2011).

Chapter Three - Methodology

3.0 Overview of Mixed Methodology

Mixed methodology in research is becoming more widely accepted as an effective way of collecting research data (Grafton et al 2011; Bamberger 2010; Niglas 2008; Denzin and Lincoln 2005; Creswell and Clark 2007). Although both qualitative and quantitative research approaches are effective and can be used on their own (Thurmond 2001; Mitchell 1986), the researcher used both approaches to collect data for this study. Qualitative and quantitative approaches in research both provide solutions to the limitations of each other, which increases the reliability of the data collected (Bergman 2008; Denzin 1970; Creswell and Clark 2007). However, Denzin (1970) early highlighted that the validity, strength and the interpretative potential of a study could be increased with the use of methodologic triangulation.

The term triangulation refers to the use of two points to find a third. In applying this triangulation to research, the researcher has to employ two or a combination of data sources, methodological approaches and theoretical perspectives (Denzin 1970; Creswell and Clark 2007). Denzin and Lincoln (2005) argued that the synergistic approach between qualitative and quantitative research has softened the differences between each approach. In this regard, the use of qualitative and quantitative approaches or methodologic triangulation strengthens the result findings of a research project by counterbalancing the inefficiencies of one particular approach (Mitchel 1986; Hinds 1989). Thurmond (2001) further iterated the point of counterbalancing in methodologic triangulation.

Qualitative and quantitative approaches, despite their differences, provide unique information. Weick (1995) believes that observation allows for distinctive interpretation and allows interpretation beyond empirical data while understanding the group being analysed. On the other hand, focus group discussions provide an efficient way of gathering a large amount of information from a group of people over a short period of time (Kamberelis and Dimitriadis 2005). In addition, questionnaires which are considered as a mixed method can also gather large amounts of data in a short period of time (Creswell and Clark 2007). Interviews are important when gathering information from case studies. In the interview process, there is a need for a line of inquiry in which questions should be asked without bias (Yin 2003). Eisenhardt (1989, 534) defined case study "*as a research strategy that focuses on the dynamics present within a single setting*". However, Eisenhardt further stated that case studies could be used to provide descriptive information and/or generating grounded theory.

The quantitative approach used in this study was the administration of questionnaires and secondary data, while case studies, focus group discussions and participant observation were the qualitative approaches used. This highlights a typical example of a mixed methodological or across-triangulation approach (Denzin 1970; Mitchell 1986; Creswell and Clark 2007). Methodologic triangulation provides the opportunity of unearthing unique differences that may not be found with the use of only one approach (Polit and Hungler 1995). Methods such as the administration of questionnaires, case studies, focus group discussions and participant observations were done to ensure that the information collection could be cross-referenced or justified by one or more approaches. The data collected was distributed over the study area and allowed for local generalizations of the findings.

3.0.1 Questionnaire: This is the major and most important qualitative and quantitative approach used in the collection of field data. The questionnaire is comprised of 53 questions and consisted of both open and closed ended questions which gave the respondents a chance to express their opinions and to answer direct questions. The mode of questionnaire administration used by the researcher and field assistants was face-to-face administration. The questionnaire was written in standard Jamaican English and where necessary translation to the Jamaican dialect was used to explain the questions to these farmers. Questionnaires were administered based on the identification number of households selected from the random calculator. The random calculator selected households at random until the sample size was arrived at for each district to cumulatively create the sample size for the research. Each district was given a different Identification Number (ID #) in which the number of household selected in each district varied proportionally based on the number of small-scale farming households. However, where more than one farmer was identified at a particular household, a lottery system was used to select the farmer who participated in the study.

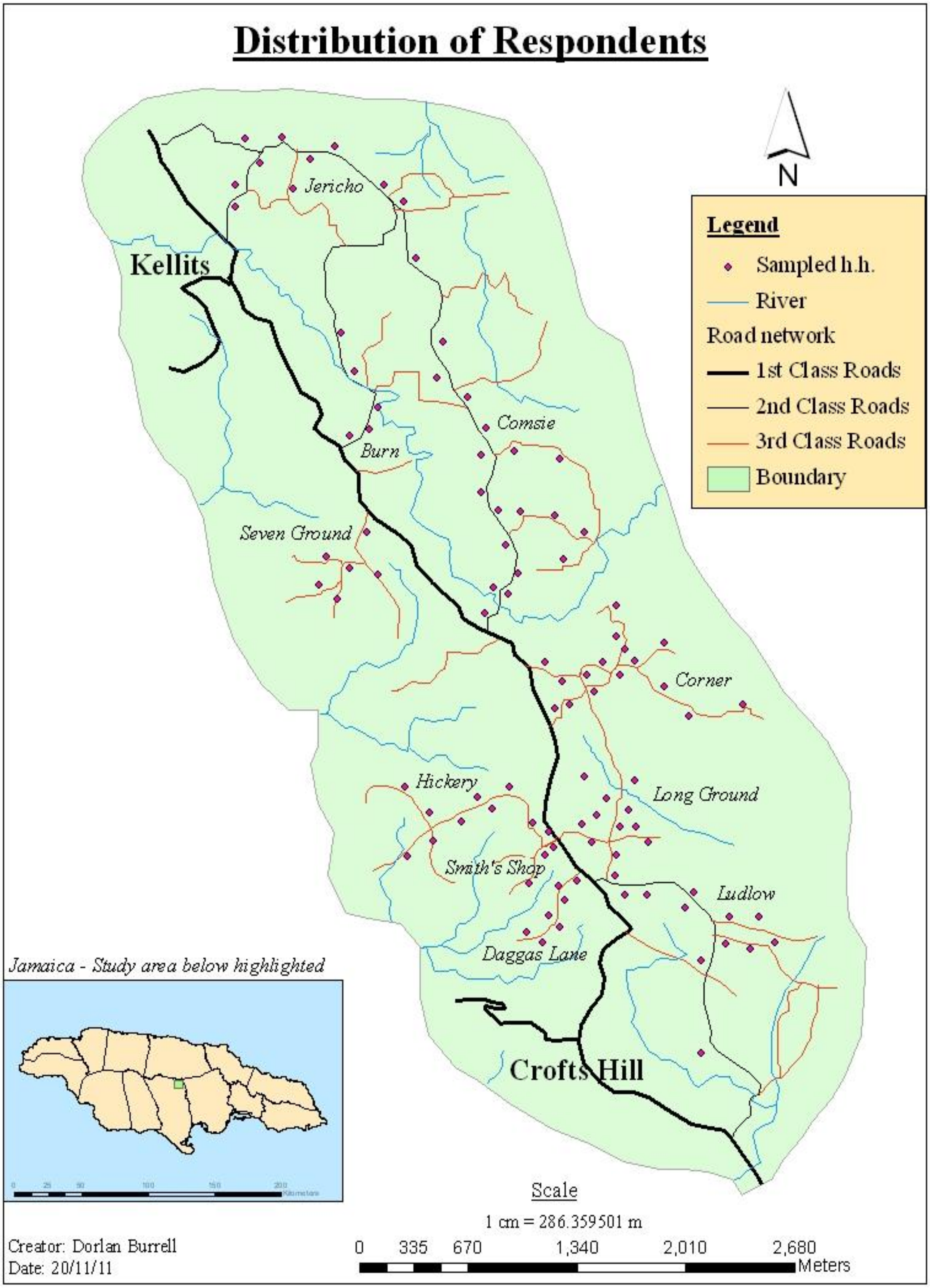
The researcher identified a suitable sampling procedure to collect data from questionnaires that would be accurate, and represent the views of the farming population of the area under study. As a result, a proportionate sampling procedure was used for this particular research. The demarked study area within Crofts Hill is comprised of 250 small-scale farmer households. In conducting the proportionate sampling method, the researcher mapped all the households of small-scale farmers within the different districts (see Table 1). A field assistant was employed to help with the mapping of small-scale farmer households using community maps and GPS units to reference each location (see Map 2). The proportionate sampling method ensured that the sample was evenly distributed throughout the community to increase representativeness and reduce researcher bias.

District Name	**Sample pop.**	**Sample size (SP/2.5)**
Ludlow	30	12
Long Ground	28	11
Daggas Lane	17	7
Hickery	23	9
Smith's Shop	10	4
Corner	40	16
Comsie	47	19
Seven Ground	15	6
Burn	12	5
Jericho	28	11
Total	**250**	**100**

Table 1: Number of small-scale farming households. NB. SP refers to sample population.

A total of 100 questionnaires were administered to small-scale farmers in the study area. The sample size was selected based on the Survey Random Sample Calculator (SRSC)[1]. The calculator was used considering that the number small-scale farmer households mapped for the sample frame was 250 (see Table 1). However, the researcher allowed for a 10% chance of error in which large scale generalization cannot be made. At the 99% confidence level, the sample size was calculated to be 100 small-scale farmer households. However, in creating the ideal sample size for this research, the number of small scale farmer households in each

[1] www.surveysystem.com/sscalc.htm



Map 2: Distribution of respondents.

district was divided by 2.5 (see Table 1). The mapping of the community provided an accurate sample population which was used to calculate the number of households for the sample size. The questionnaires were administered during the period of September 24, 2011 to October 9, 2011. The questionnaires were numbered and the questions coded for input into Statistical Package for the Social Sciences (SPSS) where the information was analyzed. Analysis was done using graphs, charts, and tables as statistical tests and correlation analyses could not be conducted based on the sample size.

3.0.2 Case studies: A case study was conducted to collect information from two (2) small-scale farmers whose production has been severely devastated by hydro-meteorological hazards and who are no longer in crop production. This was done in order to discuss the possible factors that have led to this loss in production and ultimately, loss of interest in the sector. It should be noted that the two farmers were selected from among the different districts from a sub-sample of small-scale farmers who suffered tremendous losses. Based on the ID number of farmers used in the questionnaires, the two farmers for the case studies were selected. These case studies were used to provide more detailed information and provide more insight of the effects and implications of meteorological hazards on small-scale farmers.

3.0.*3 Focus group discussions:* Two focus group discussions were conducted for the study where small-scale farmers were asked to comment on some key issues affecting production in an informal setting. The researcher included both males and female in the discussions with not more than 8 persons in each discussion.

The focus groups consisted of persons who were severely affected as well as persons who were not severely affected by hydro-meteorological hazards in the last decade. The focus groups discussions provided valuable information as the small-scale farmers agreed or disagreed on particular issues and provide information on their own experiences.

3.0.4 Participant observation: In order to justify a number of issues that were raised during the administration of the questionnaires, case studies and focus group discussions; the researcher found it necessary to observe the day to day activities of farmers over a two week period. This was done to get a broader understand of small-scale farmers and factors that influence the decisions they make. During the participant observation, photographs were taken and used within the presentation of the data. Participant-observation was done to support information that was collected from questionnaires, case studies and focus group discussion among small-scale farmers.

3.0.5 Maps: The maps were created using Geographic Information Systems (GIS) with the software ArcGIS 9.3 which was accessed in the Geography and Geology Department. Maps were used as an ideal means of displaying information on the layout of the general study area and the distribution/density of crop production among small-scale farmers being sampled.

3.0.6 Secondary sources: The researcher also incorporated a number of secondary sources such as books, peer-reviewed articles and research articles to help in the discussion of the topic. These sources provided literature and past discussions on the research topic. Organizations such as the Unit for Disaster Studies (UDS), Caribbean Disaster Information Network (CARDIN), Ministry of Agriculture (MOA), Statistical institute of Jamaica (STATIN) and the Office of Disaster Preparedness and Emergency Management (ODPEM) were visited for information relating to the impact of the hydro-meteorological hazards in Jamaica and more so the general study area.

3.1 Pilot Study

It is always important to conduct a pilot study, as one would be able to makes changes to the questionnaire where necessary in order to ensure that vital information is gathered (Flowerdew and Martin 2005). This ensured that the questionnaire was adjusted to fit the literacy of the farmers. Five randomly selected small-scale farmers from the community were used in the pilot study to test the questionnaire. The sample of five helped to identified problems with the questionnaires. The problems highlighted during the pilot study were corrected before the administration of the final version.

3.2 Ethical Considerations

Ethics are another very important aspect of this research project that must be considered when conducting research of any type (Flowerdew and Martin 2005; Creswell and Clark 2007). The names of respondents were not collected during the administration of questionnaires, case study interviews or focus group discussions. In cases where recording of the conversation was necessary, respondents were asked to give consent. The researcher was also aware of the fact that more than one farmer may reside in a particular household. Where such a situation was met, the researcher used a lottery system to select the farmer who participated in the study. This was done to reduce bias and create a true cross section of the farming community. Small-scale farmers are characterized based on their farm holding size which is usually five (5) hectares or less and does not exceed twelve (12) acres irrespective of the number of farm plots and the location of each plot. This will serve as the fundamental criteria in which small-scale farmers will be considered for this research.

3.3 Research Risk

The researcher did not experience any challenges while conducting this research in the community of Crofts Hill. The researcher is familiar with the area, as previous studies have been conducted within the general area by the researcher. Community members tend to be fairly co-operative, especially when they know they can provide information or be of assistance. However, the researcher ensured that safety of persons engaged in the study was considered at the forefront of data collection and participant observation.

3.4 Limitations of the Study

In an effort to conduct any investigation, it is not unusual for investigators to be faced with situations which will hinder the accomplishment of their task. The researcher found that conducting this research have been somewhat hampered by a number of factors. These include:

a. The reluctance of some small-scale farmers to give information about their involvement in agricultural production. However, in order to ensure participation, the nature of the study was explained and farmers were assured that information will be treated with confidentiality by the researcher and his field assistants.

b. The problem of finding an ideal sample in which all the persons in the sample would have an equal chance of being selected to complete the questionnaire or even take part in the study. The researcher used proportionate sampling to combat this problem by mapping the individual districts which was followed by a random selection of small-scale farmer households.

c. Time was a very important factor due to the limited duration of the research. The researcher ensured that an effective time management plan was developed in order that the research would be finished in time for submission.

d. The researcher at times spent a considerable amount of time reading and explaining some of the questions on the questionnaire to some of the farmers who had difficulty understanding them. However, the researcher ensured that the true meaning of the questions were not eroded so as to eliminate bias. The questionnaire was also designed in a simple manner where questions flowed from section to section.

e. The administration of questionnaires to selected households also brought about problems of its own. At times, small-scale farmers could not be located at their households when the visits were made. The researcher had to rely on a call-back system were second and third visits were made in some instances. In addition, some small-scale farmers were visited on their farms as it was more convenient to them.

f. The mapping of farming household within the individual districts proved costly to acquire over a short time period, but was covered with a research grant from the Environmental Management Unit (EMU).

g. The input of the data collected into SPSS proved challenging. However, having experience with the software the researcher was able to input the data over a short period of time.

h. The availability of MOA and RADA staff to assist the researcher as it regards to data gathering and collection for the research.

Chapter Four - Understanding Hydro-meteorological Hazards and Agriculture

4.0 Overview of hydro-meteorological hazards and agriculture

Within the context of the Caribbean region, hydro-meteorological hazards have affected the agriculture sector significantly (Me´heux et al. 2007; McGregor et al. 2009; Chen and Taylor 2002). Hazard refers to the probability of occurrence within a specified period of time and within a given area of a potentially damaging phenomenon. It should also be noted, that hazards vary over time and space and may have different impacts within a particular area, country or region (Taylor et al. 2002). However, for developed countries and some developing countries with economies of large scale growth, the impacts of hydro-meteorological hazards have led to decreased exports and income.

On the other hand, developing countries, such as those of the Caribbean, have experienced similar or worse situations where hydro-meteorological hazards have led to increased import bills, increased market prices, along with significant decreases in the traditional and non-traditional crop production and export crops (FAO 2002; McGregor et al. 2009; Spence 2009; Campbell et al. 2010). In addition, Spence (2009, 1) also explained that 'the vulnerability of Jamaica's agricultural sector to especially to hydro-meteorological hazards such as hurricanes, floods, drought, high magnitude rainfall and related hazards such landslides is underscored".

Domestic crop production and sugar exports in Jamaica have been fluctuating over the last decade (see Figure 3). Most of the decreases in production are recorded in years which were affected significantly by hydro-meteorological hazards such 2002, 2004, 2005, 2007 and 2008 (MOA 2003: 2005: 2010). The growth within the agricultural sector is restricted by increase in the number of hydro-meteorological hazards that have been affecting Jamaica. As such, it is quite difficult for the agricultural sector to recover fully to the production levels it once had in the mid 1990's. MOA (1997) explained that domestic crop production expanded rapidly after 1960's and peaked at approximately 583,000 tonnes in 1993. However, the highest level of domestic crop production was recorded in 1996. Since then, domestic crop production has decreased and has been fluctuating base on periodic impacts from hazards, a total of 500,304 tonnes was the highest output seen since 2000 (see Figure 3; Appendix 5). Similarly, sugar exports have also fluctuated over the last ten years with an all-time low of 122,104 tonnes in the 2009-2010 production year (see Figure 3; Appendix 4).

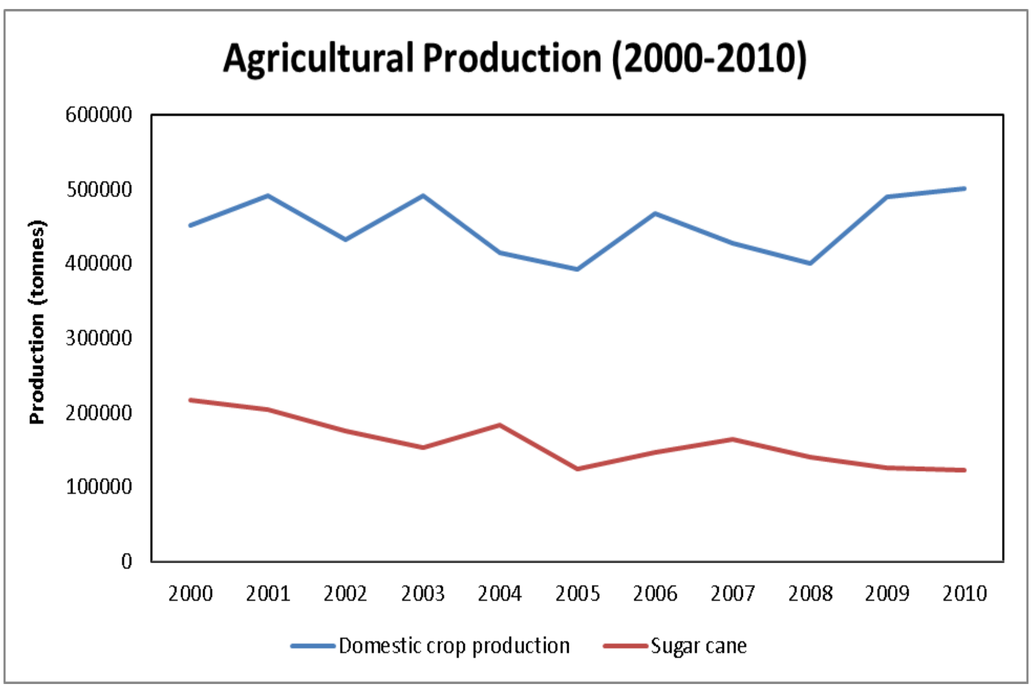


Figure 3: Jamaica: total domestic crop and sugar cane production 2000-2010. Source: RADA 2011 and SIA 2011.

The decrease in the export of banana, which is a traditional crop, can be attributed to hurricanes (especially hurricane Gilbert and Ivan) which affected crop production significantly. In addition, sugar cane has faced its share of impacts from past events with the recent drought in 2009-2010 and tropical storm Nicole in 2010. It should be noted that while traditional crops are being affected, cash crops are more vulnerable to the impacts of these hydro-meteorological hazards (McGregor et al. 2009; Spence 2009; Campbell et al. 2010). McGregor et al. (2009) and others also lamented that cash crops normally takes a shorter time to grow and require more resources for growth. In support, Campbell et al. (2010) argues that this is due to the fact that cash crops require more irrigation, fertilizers and more labour from farmers. However, all these processes can be affected significantly by hydro-meteorological hazards and can influence farmers to either reduce production or cease production altogether based on the level of impact or cumulative impact of several events.

According to Me´heux et al. (2007), natural hazard impacts can either be "direct (occur instantaneously in association with the physical event) or indirect (occur subsequent to the cessation of the physical processes and form part of a chain reaction of events that may extend for a significant period of time after the hazard(s) has occurred)". However, both direct and indirect impacts can affect farmers in multiple ways which influence farmers to reduce production based on the amount of pressure they face. However, although the impacts of natural hazards are usually negative, over a longer time frame, positive impacts from different events are also likely to occur (Me´heux et al. 2007; McGregor et al. 2009). It should be noted that the negative impacts normally outweigh the positive impacts of any hydro-meteorological hazard that small-scale farmers may experience.

Barker (1993) indicated that the Jamaican agricultural sector is marred by dualism and disasters will constrain the development at all levels in Jamaica. Dualism exists in the sense that the agricultural sector is characterized by both export and domestic markets. The export market is dominated by large scale commercial farmers which the domestic market is dominated by small scale farmers. Since then, the agricultural context has remained the same with the concept of dualism still impacting on crop production. On one hand, large scale farmers occupied the most suitable agricultural lands due to the unequal competition that exist.

On the other hand, hydro-meteorological hazards in Jamaica have been a major problem for small farmers and still continue to disrupt production, income generation and contribution to the Gross Domestic Product (GDP) (Barker 1993; Spence 1996; Spence 2008; Spence 2009; Mohan 1990; Campbell et al. 2010; Campbell and Beckford 2009; Barker and Beckford 2008). Small-scale farmers tend to have less than five (5) acres of farm land at their disposal (MAL, 1963), but the area of land under cultivation has been adjusted to under five (5) hectares (Spence 1999). It should be noted that the size of farm plots increases farmers' vulnerability to hydro-logical hazards as it limits the production of farmers. In addition, the total farm size of small-scale farmers is usually the sum of several fragmented plots which are used for crop production (King and Burton 1982; Edwards 1998; Brierley 1987).

4.1 Frequent impacts of hydro-meteorological hazards

The frequency and intensity of hydro-meteorological hazards have been increasing constantly over the past two decades (see Appendix 2). This is evident in the number of hurricanes, tropical storms and droughts that have impacted the Caribbean region and more so Jamaica. Recent climate variability is often seen as the sole cause for the increase in frequency in hydro-meteorological hazards (Taylor et al. 2002; Barker and Beckford 2008, Beckford et al. 2007; Campbell and Beckford 2009; Campbell et al. 2010). However, the increase frequency in the impact of hydro-meteorological hazards could also be associated with the cyclical increase and decrease related to the El Nino/La Nina phenomena influencing conditions over the Caribbean region (UNEP 2002; UNEP 2000; Campbell and Beckford 2009; Campbell et al. 2010).

Hurricanes, floods and droughts have been events in the recent past (1995-2010) which have occurred multiple times with varying effects. The 1996-1998 meteorological drought caused the greatest damage in the agricultural sector which was estimated at 94% of total damage (Spence 2009), and the largest percentage decline in domestic agricultural production with losses of over 20 percent (Barker and Beckford 2008). Campbell et al. (2010) also lamented of the impacts of the 2009-2010 meteorological drought on small-scale farmers was also significant. However, hurricane Ivan in 2004 as reported in McGregor et al. (2009) and ECLAC (2004), tropical storm Gustav and tropical Nicole also affected the agricultural sector significantly (Spence 2008; Spence 2009; Campbell and Beckford 2009; Campbell et al. 2010). Figure 4 below highlights the damages cause to the agricultural sector from 2004-2007 in which crop production was the most severely affected sector due to its vulnerability.

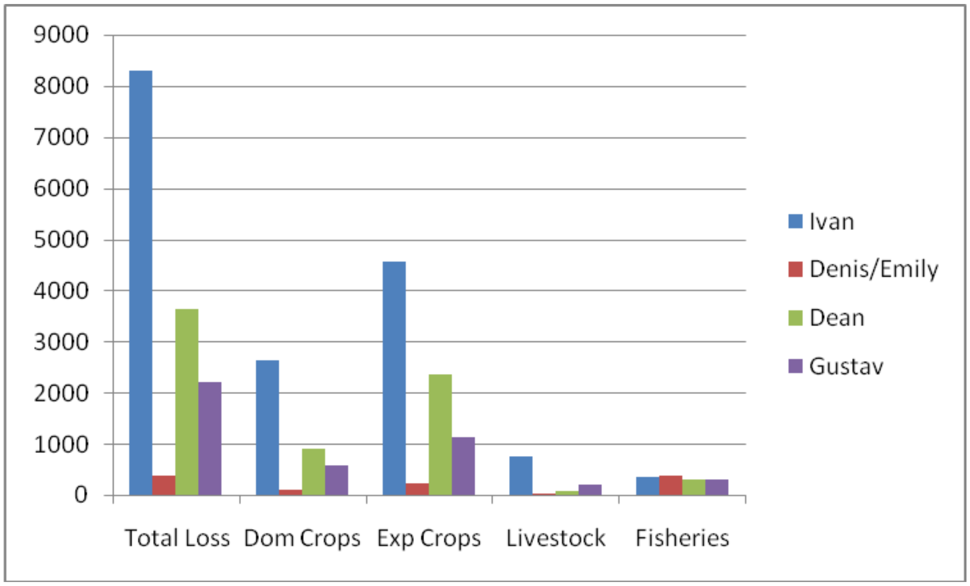


Figure 4: Trend in Agricultural Sector Losses (J$ Mill.) from hurricanes between 2004 and 2007. Source: Spence 2009 - *Compiled from the Planning Institute of Jamaica – Economic and Social Survey of Jamaica 2005-2008*

Hurricanes and tropical storms are associated with high volume of rainfall which induced flooding in particular areas across Jamaica (Me´heux et al. 2007; McGregor et al. 2009; Taylor et al. 2002). However, intense and prolonged rainfall within and outside the rainy season has also affected production among small farmers and should be considered as important. Droughts which occur on a less frequent basis may also result in extensive crop damage (Me´heux et al. 2007; McGregor et al. 2009; Barker and Beckford 2008; Campbell et al. 2010). As such, the 2009-2010 drought is one that farmers will remember quite vividly as production of many small farmers was either halted or destroyed completely.

The location of Jamaica within the tropics only makes small-scale farmers more vulnerable to the effects of these meteorological hazards. Jamaica is located in the Greater Antilles which makes it vulnerable to hurricanes, as a number of storms normally pass in close proximity to the island (Me´heux et al. 2007; McGregor et al. 2009; Taylor et al. 2002; ECLAC 2004). Figure 5 below shows the proximity of hurricanes and storm events to Jamaica and highlights the vulnerability of the agriculture sector. Spence (2009, 5) argues that the *"magnitude of impact from these storms is related to their 'closest point of approach' (CPOA). Nearly 65 percent of these storms had a CPOA of 50 miles and less implying high damage potential"* (see Appendix 1). It is also important to note that the frequency of hurricane and storm activities have also been increasing over the last two decades (see Appendix 2). Spence (2009) highlighted that 57% of all the hurricane activities affecting Jamaica has occurred in the last decade.

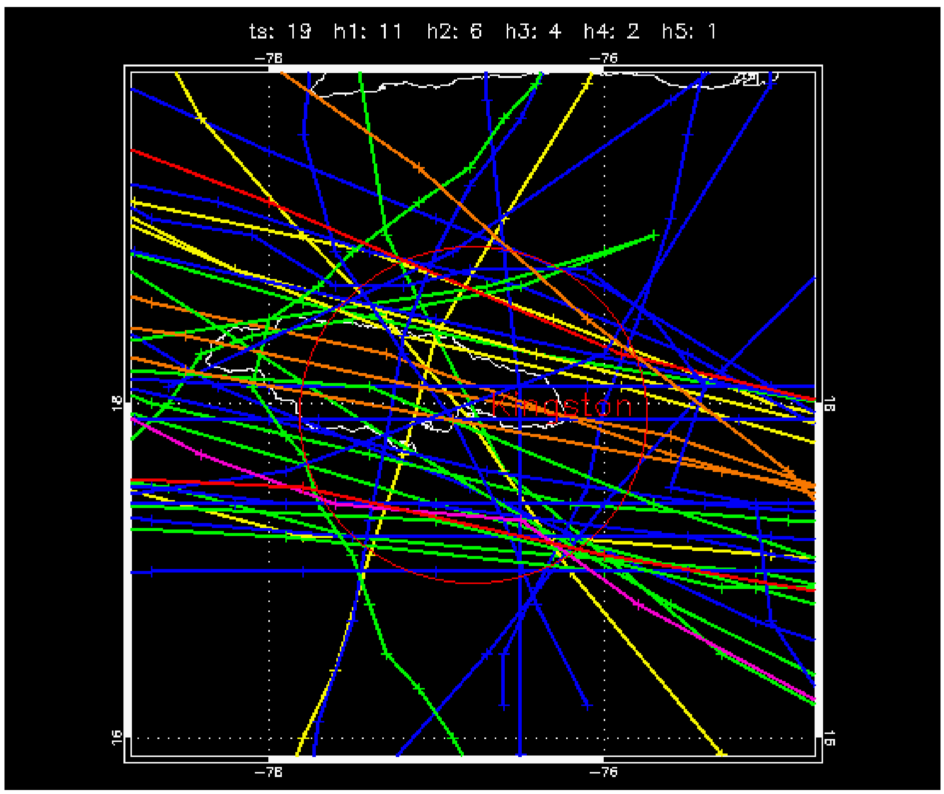


Figure 5: Track of Hurricanes and Tropical Storms Affecting Jamaica, 1851-2007. Source: Spence 2009.

The wind and rainfall from the storm events may at times inflict a considerable amount of damage on small-scale farmers such as tropical storm

Gustav and Nicole. In addition, prolonged rainfall events can also cause significant damage to the agricultural sector such as the May/June rain in 2002 and 2011. Taylor (2002) indicated that the rotation of the El Niño and La Niña phenomena plays a vital role in the development of these systems or influences prolong drought conditions. A prolonged drought event was evident between 2009 and 2010 in which crop production stagnated. Although changes in both El Niño and La Niña can be predicted (UNEP 2002; UNEP 2002), the extent of events (hurricanes and droughts) that are associated with each phenomenon can only be estimated. However, estimates are not always the best means of prediction in which mitigation/adaptation measures can be employed to reduce to the impact of these hazard events.

The impacts related to drought events are not as extensive as those relating to hurricanes and tropical storms. Barker and Beckford (2008) refer to the slow onslaught of droughts as insidious in terms of the impact to the agricultural sector. Despite the localized trend in drought impact especially in rain shadow areas in Jamaica, droughts may last for prolong periods in which the cumulative impact of the event can be quite significant. There are three types of droughts, namely, meteorological drought, hydrological drought and agricultural drought. Meteorological drought refers to the degree of dryness in relation to the average rainfall measured over a period; hydrological drought examines the level of stream flow and water levels in storage facilities such as reservoirs and dams; agricultural drought assesses plant moisture while considering lowing rainfall totals or water supply (Spence 2009; Campbell and Beckford 2009; Campbell et al. 2010). Spence (2009, 15) further elaborated that the "vulnerability of the agriculture sector to drought coincides with periods of low rainfall which occur between the bi-modal peaks of the rainfall regime” (Figure 6). These distinct bi-modal peaks in May and October effectively influence to growing pattern among small-scale farmers who rely heavily on rainfall as their main source of irrigation. Prolonged dry conditions may extend from December to March/April of the following year, which often reduce agricultural production.

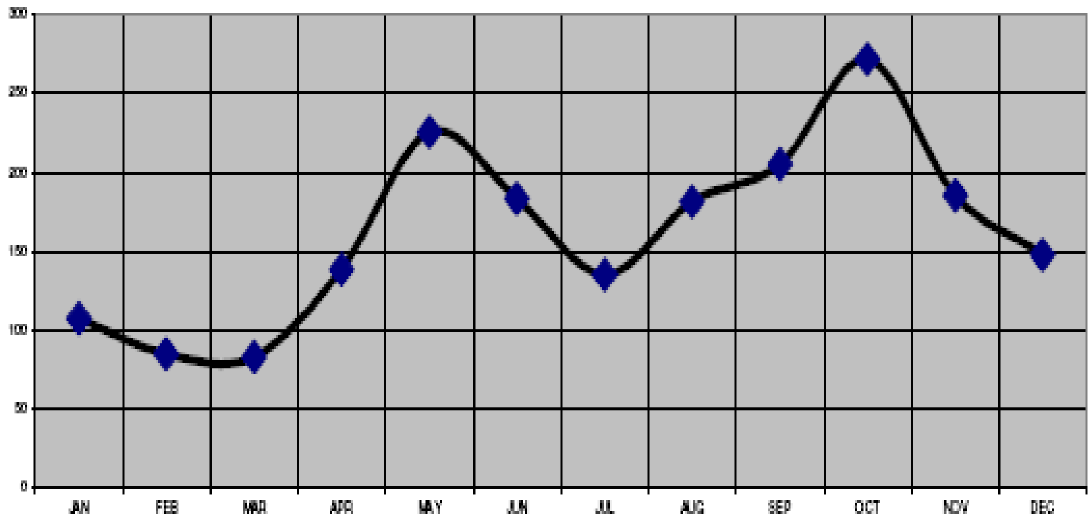


Figure 6: Jamaica: 30-Year Mean Rainfall 1951-1980 (mm). Source: Spence 2009 - Meteorological Services of Jamaica, 2009 (250 Stations).

Hydro-meteorological hazards affect the production of small-scale farmers’ household economics and also the time period it takes small-scale farmers to re-cultivate their farm plots (McGregor et al. 2009; FAO 2002; Campbell and Beckford 2009). The difference in recovery period among small farmers results from the degree of impact, amount of agricultural loss, loss of income and the resource base of individual farmers. These factors, when taken into account at the same time, affect the amount of time it will take each small farmer to successfully replant his/her farm plot(s). In addition, the recovery period usually affects the income earned and the livelihoods of farmers since crops will grow over a period of time (Campbell et al. 2010; McGregor et al. 2009).

The recovery period is of utmost importance as it can give insight for future growth among small-scale farmers or production within the agricultural sector. The implication of future growth can be based on the recovery period which results from the impact of hydro-meteorological hazards among small-scale farmers. However, it should be noted that the recovery period at times can be reduced based on assistance from the government, family members or other farmers (McGregor et al. 2009). Small-scale farmers usually lack resources that would influence faster recovery periods. This lack of resources among small-scale farmers increases the time period it takes individual small-scale farmers to re-cultivate farm plot(s) (McGregor et al. 2009; Chen and Taylor 2002, FAO 2002).

The period of time between the impact of the event and the start of the replanting process can determine the amount of particular crops that would be available both for the domestic and export markets. Berkes et al. (2003) and McGlashan et al. (2008) highlighted the concern that the growth period of crops should also be considered since small-scale farmers mostly grow crop for the domestic market. This is important as the growth periods of different crops vary. The recovery period of farmers and the growth period for crops could be used to calculate the cumulative recovery time among small farmers. This would aid in the prediction of crop production for the domestic market based on the expected cumulative recovery time.

4.2 Effects of hydro-meteorological hazards on crop production

Although losing the status of the most vibrant industry and number one contributor to the GDP, the agricultural sector remains an important one for a considerable percentage of the Jamaican population as it relates to employment. "Between 2001 and 2006, the percentage of agriculture to total GDP dropped from 6.7 to 5.9%" (McGlashan et al. 2008, 15). Spence (2009) argues that the increasing intensity and frequency of storms affecting farmers have contributed to the decrease in contribution of the agricultural sector to the GDP (see Figure 7).

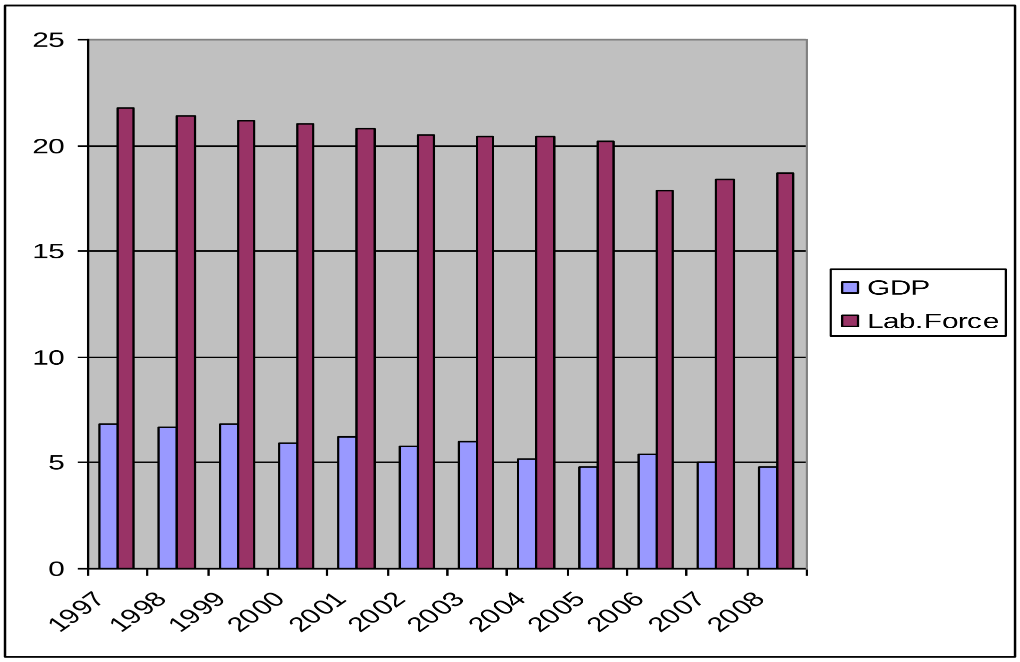


Figure 7: Contribution of Agriculture to GDP and employment in Agriculture (1989-2009). Source: Spence 2009 - Computed from the Planning Institute of Jamaica – Economic and Social Survey of Jamaica, 1997-2006.

This is evident in the impact of hydro-meteorological hazards on domestic crop production and foreign exports (see Appendix 3). There is a clear correlation between reduced employment rates and contribution of agriculture to GDP based on the year of impact, such as the hurricane Ivan in 2004, hurricane Emily in 2005 and tropical storm Gustav in 2008. In addition, Tauger (2011) emphasizes the issue that the farming population globally has been decreasing. “In 2004 the agricultural sector contributed J$13.8 billion to Jamaica’s economy but damages caused by the impact of Hurricane Ivan amounted to J$8.5 billion or roughly 62 percent of agricultural earnings for that year” (Spence 2009, 1).

Small-scale farmers constitute a large percentage of the farming population in Jamaica (Spence 2008; Spence 2009; McGregor et al. 2009; Campbell et al. 2010). However, due to their farm size, location of farm plots, topography of farm plots and the fragmentation of farm plots, production among small-scale farmers is usually less than that of large scale farmers. However, their contribution towards domestic production and foreign export should be highlighted as they are as significant as the large scale farmers. Spence (2009, 8) iterates this point by stating that:

> “the greatest impact from hurricanes is felt by small-scale farmers, most of whom produce domestic crops at the subsistence level. High level of economic loss in the export crop sub-sector also reflects impact on small-scale farmers, many of whom produce for the export market alongside their domestic crop orientation.”

This is typical of Crofts Hill which produces export crops such as sugar cane and yam along with several domestic crops such as lettuce, cabbage and sorrel.

McGlashan et al. (2008, 14) explained that Jamaica:

> “has encountered serious food shortages after devastating hurricanes. In 1988, Hurricane Gilbert left US$4 billion in damage, 40% of it to agriculture which was left in shambles. As a result of Hurricanes Charley and Ivan in 2004, 190,000 tonnes of sugar cane were lost and 100% of the banana crop, causing damage amounting to $85 million. It took three months before agricultural produce was again available. In 2005 Hurricanes Emily and Dennis exacerbated the damage, while in 2007 Hurricane Dean resulted in further damage amounting to $3.7 million. The banana industry always suffers the most from hurricanes. After Hurricane Dean the banana chip industry had no raw material to use for over six months and the factory had to diversify into making chips from breadfruit and cassava to survive. No banana was imported for fear of diseases.”

If small-scale farmers were to take an extensive period to re-cultivate their farm plot(s) after specific hazard events, then production for the period after the event would be reduced until they are able to re-cultivate farm plot(s) to maximum production. This indicates that agricultural production will be affected for the period of time that the farm plot(s) is left idle. This creates more stress on active farmers (both small and large scale farmers) to supply existing markets both local and foreign as demand increases. When demand outweighs supply, market prices tend to increase for various crops (McGregor et al. 2009; MOA 2010; FAO 2002). However, when supply outweighs demand, there is usually a 'glut' on the market in which farmers are forced to reduce to cost of their produce thus losing the profitability of that particular crop. Increase demand usually occurs directly after the hazard event in the cause of hurricane and storms while it may occur throughout the entire drought event. On the other hand, the 'glut' in supply is often associated with a boom in crop production immediately after a hydro-meteorological hazard.

Although small-scale farmers have been trying their best to overcome the challenges of hydro-meteorological hazards, the impact of these hazards continues to affect crop production (Ahmad 1997; Barker 1993; McGregor et al. 2009; Spence 2008; Spence 2009; Campbell and Clinton 2009; Campbell et al. 2010). For most small-scale farmers, agricultural production is the only means of survival and as such, any impact from hydro-meteorological hazards will also affect farmers as well. The impact from these hazards will always vary overtime and from location to location. However, at times the impacts from these hazards are so significant that most farmers will be affected. This provides the opportunity for research to be done in order to highlight the key variable as identified in the conceptual framework of the research. Recommendations provide the best means possible to combat the challenges that do exist with hydro-meteorological hazards among small farmers. The Agricultural Disaster Risk Management (ADRM) Plan developed by Spence (2009) seeks to ensure that the impact of hydro-meteorological hazards is reduced by providing farmers with the tools necessary to reduce the impact of hazards and the recovery period after hazard events.

The main components of the ADRM Plan outline a number of strategies and activities to be used in the agricultural sector to reduce the impact of hydro-meteorological hazards (Spence 2009). Mitigating, preventing and preparing for the impact of disasters on the agricultural sector are important to the pre-impact phase of the hazards event. The promotion of appropriate and effective emergency response to the impact of hazards and disasters after the event, acts as an efficient way of reducing losses. In addition, ensuring the timely and effective recovery and rehabilitation from the impacts of disasters is essential to the ADRM to reduce to recovery period of farmers' crop production after a hazard event. In addition, the establishment of a monitoring and evaluation framework will effectively measure progress in ADRM in which future adjustments can be made. Based on the increased impacts of hydro-meteorological hazards over the last decade, it was imperative that such a plan be developed and implemented.

4.3 Coping mechanisms of small-scale farmers to re-occurring hazards

Over the past decade, a number of studies and research have been carried out to seek best practices and effective adaptation measures which can be employed in different locations to reduce the level of impact before and after a hazards event.

This include work done by Edwards (1998), Henry (1999), Thomas-Hope et al. (2000), Beckford et al. (2007), Beckford and Barker (2007), Beckford (2009), Campbell and Beckford (2009), Campbell et al. (2010), Spence (2008) and Spence (2009). In order to reduce crop loss resulting from hydro-meteorological hazards significantly, small-scale farmers should be open minded in accepting changes to their farming patterns.

It should be noted that small-scale farmers are not the easiest of groups to embrace innovations and mitigation measure within their occupation. This is extremely high among the elderly population (Woodsong 1994; Beckford et al. 2007; Beckford 2009), who can be regarded as laggards who are the last group within the innovation model to accept the new knowledge. This is often attributed to their years of farming along with the wealth of local/indigenous knowledge they have among themselves. As such, it is essential for policy makers to include local knowledge to aid the development of new coping mechanisms for small-scale farmers (Beckford et al. 2007; Beckford and Barker 2007; Beckford 2009; Spence 2009). Spence (2009, 46) highlighted that:

> "the identification and promotion of good practices as a strategy in ADRM is an emergent paradigm in agricultural disaster loss reduction. While the identification process seeks to document existing measures that can be replicated for advancing the DRM agenda, its focus on local and sometimes indigenous measures is relatively new. One of the attractions of this new focus is its capacity to embrace local, often inexpensive coping strategies and integrate them into DRM plans, thereby promoting the participation of and partnership with local communities."

This approach would seek to transfer best practices that are cost effective in increasing the crop production of small-scale farmers.

Coping mechanisms, vary from farmer to farmer and area to area, but may or may not be expensive to implement based on the type of coping mechanism and the resource base of the farmer. Coping measures/mechanisms refer to activities done by a farmer before or after a hazard event, to reduce its impact. Cooper et al. (2008) highlight that the resource base of a farmer will ultimately influence the type of coping measure employed and the time period it would take for the farmer to re-cultivate his farm plot(s). This was re-iterated by Campbell and Beckford (2009) and Campbell et al. (2010) in arguing that farmers react differently to the impact of hazards whether before or after base on their economic well-being.

However, in order to achieve sustainability within the agricultural sector, it is imperative that farmers use adaptive measures rather than coping mechanisms. In this regard, Cooper et al. (2008) argues that adaptive measure are more sustainable and suited for impacts over a longer period of time, while coping mechanisms are more suited for impacts over a short period of time. By employing adaptive mechanism rather than coping mechanisms, farmers would be able to increase the economic viability of their crop production. However, Campbell and Beckford (2009) highlighted that both coping and adaptive mechanisms when employed before and after a hazards event, significantly reduces the recovery period of farmers. Spence (2008) provide a list of good practices that can be employed by farmers to reduce crop production.

Impacts from hydro-meteorological hazards can be reduced once the necessary precautions are taken. It is important for small-scale farmers to adapt best practices which have been used by other farmers and have succeeded where loss reduction is concerned. This would increase production output, economic earnings, financial security as well as food security. This ought to be the way forward for a country that relies heavily on the agricultural sector.

Chapter Five – Small-scale Farming in Crofts Hill

In understanding small-scale farmers, factors such as age, gender and period of involvement should be examined. Farm plot characteristic are usually unique for small-scale farmers as holding size, topography and land ownership which vary from large-scale farmers. The perception of worst and best production years provides an insight of events that would have been responsible for such perceptions. This chapter assesses farmer's age, gender, period of involvement, farm plot characteristics, crop production along with the worst and best production years.

5.0 Farmer's age, gender and period of involvement

In Crofts Hill males dominate where farming is concerned and was evident in the number of males versus the number of females that participated in the research. The sample had 82% of the respondents being male and 18% being female (see Figure 8). Agriculture in the context of Jamaica has always been dominated by male farmers (Woodsong 1994; Barker 1993). In order to get a good understanding of the impacts of hydro-meteorological hazards, the senior farmers had the experience of multiple hazards to yield this result. This is due to their long involvement in farming and years of living within the community in which they would have the best experience of the hydro-meteorological hazards and their impacts on the agricultural sector. Forty one percent of the respondents were over the age of 65 years, 30% of the respondents were between the ages of 56-65 years, 19% were between 46-55 years of age while 8% and 2% were between 36-45 years and 26-35 years respectively (see Figure 9).

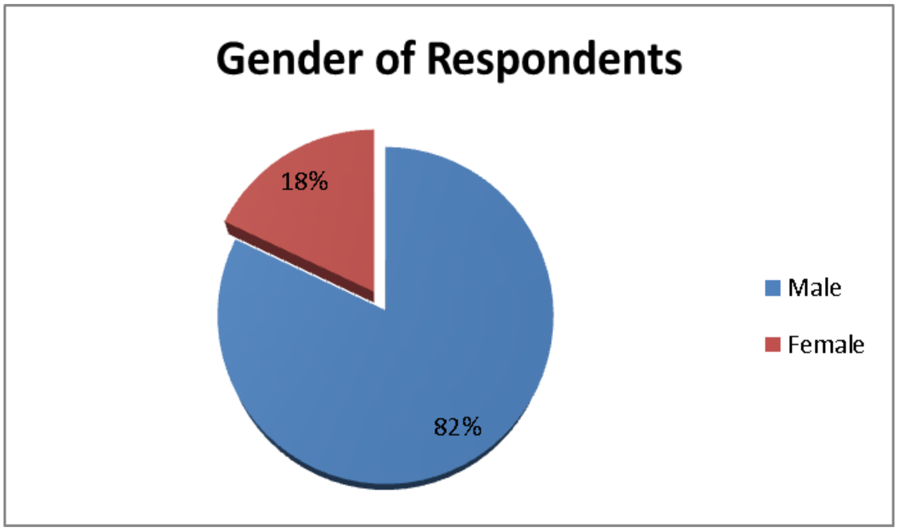


Figure 8: Gender of respondents. Source: Arthur's Fieldwork.

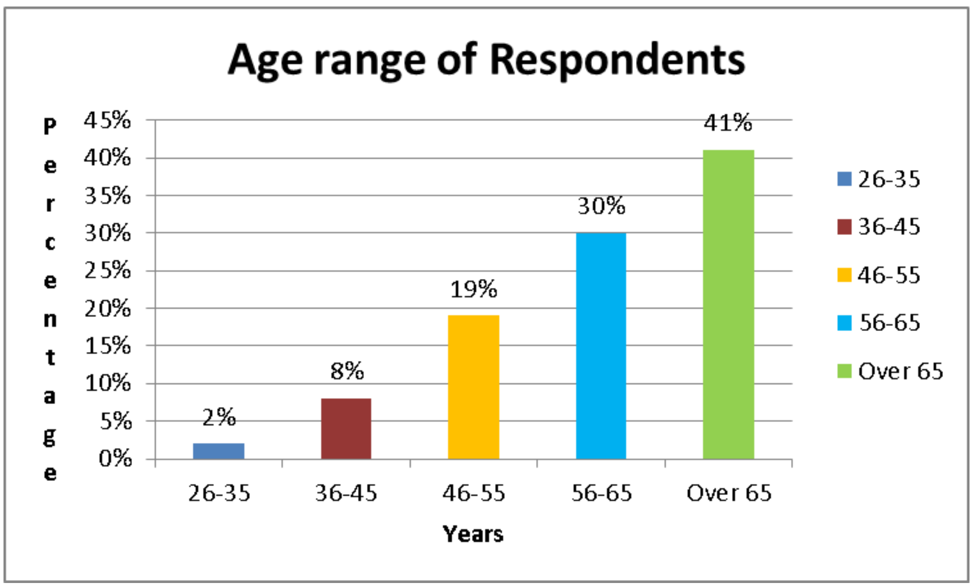


Figure 9: Age range of respondents. Source: Arthur's Fieldwork.

With age, comes experience especially when you are within a particular occupation for a period of time. The period of involvement in crop production among the small-scale farmers was significantly high. Twenty four of the respondents were involved in crop production for more 40 years, 31% were involved between 31-40 years, 19% were involved between 21-30years, 12%

were involved between 11-20 years and 14% were only involved between 1-10 years (see Figure 10). The sample selected was ideal for this particular research as a significant percentage of the small-scale farmers in the sample were over the age of 60 years which is higher than the national average for farmers in Jamaica. This provided the researcher with the opportunity of collecting information from farmers who have been affected multiple times. In addition, the small-scale farmers also had more than 30 years of farming experience and would have local knowledge (Brierley 1987) of the hydro-meteorological hazards which have affected the community.

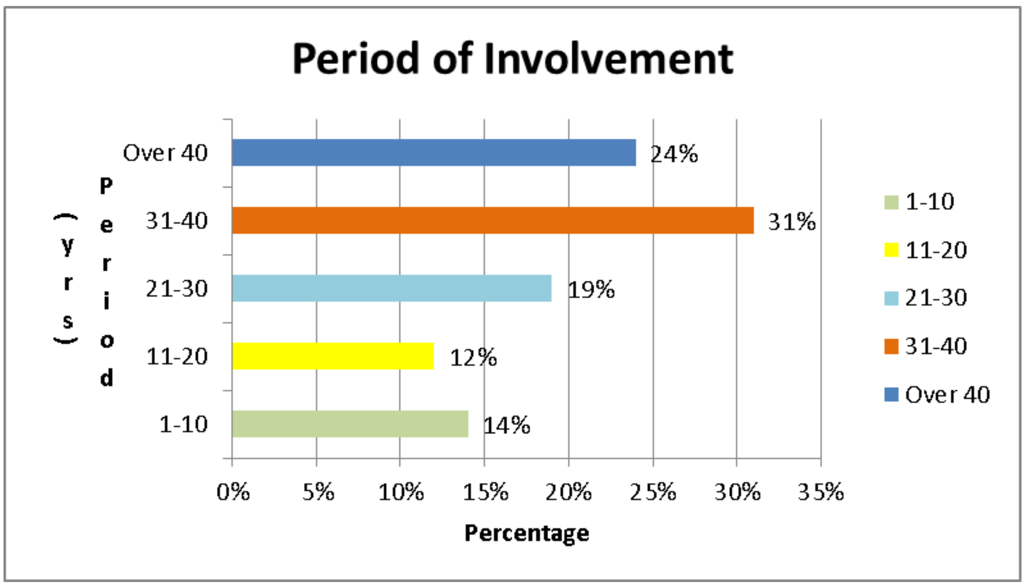


Figure 10: Respondents period of involvement. Source: Arthur's Fieldwork.

All the respondents (100%) stated that they were full time farmers although some farmers stated that they operated a part-time grocery shop to provide supplemental income. Agricultural production was given first preference in which the shop was only operated for particular hours or on particular days. More attention was given to crop production and the shop was only opened during the time that they would not be in the field. Most of the farmers were also the head of the households for their respective home. Eighty three percent of the respondents stated that they were the head of the households while 17% were not head of households (see Figure 11). This meant they have the responsibility of providing for the households as they are the ‘bread winners’. Primary education was the predominant level among the farmers as the school system was much different from what we are accustomed to in today’s society. Ninety percent of the respondents indicated that they only had primary/all age education while 10% had secondary or high school education (see Figure 12). Most of the small-scale farmers did not have the opportunity to further their education after primary/all age as such a system was not in placed then (Burrell 2010).

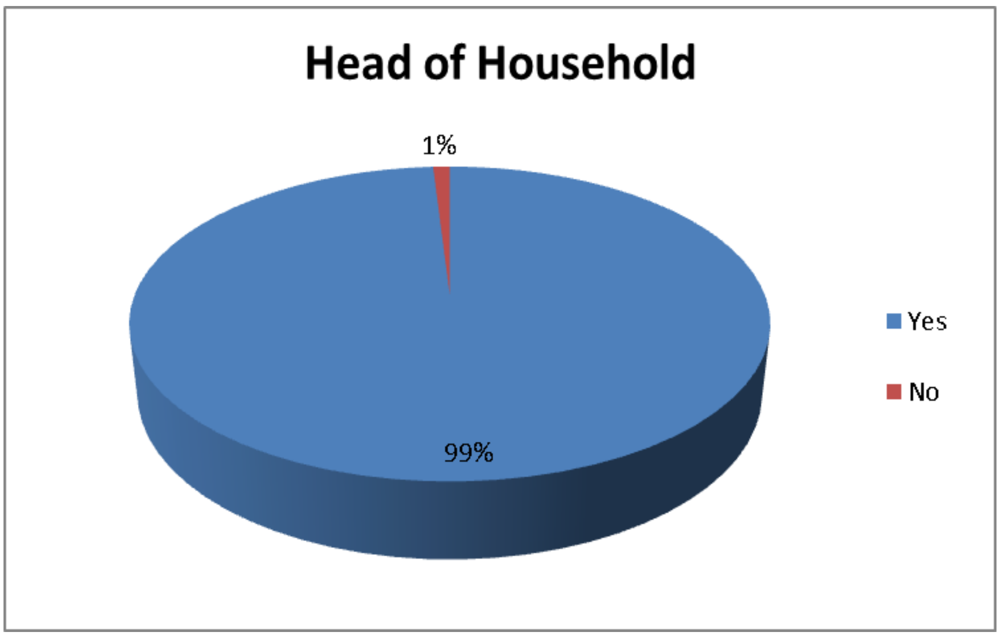


Figure 11: Head of household. Source: Arthur’s Fieldwork.

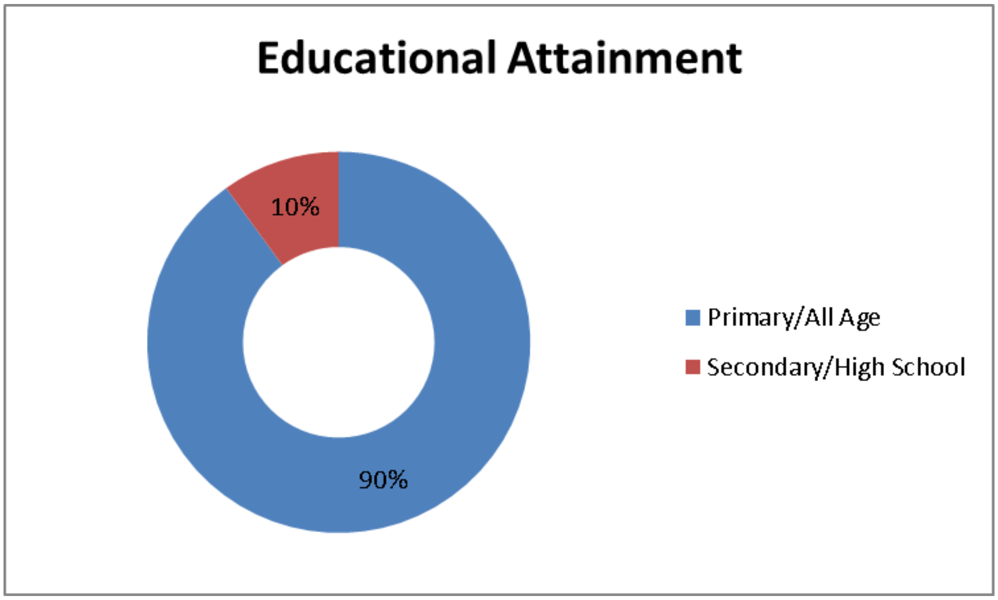


Figure 12: Respondents educational attainment. Source: Arthur's Fieldwork.

5.1 Farm plot characteristics

Land tenure and land fragmentation of farm plots are very important factors which may affect or increase the economic viability of crop production among small-scale farmers. According to King and Burton (1982, 476), "land fragmentation is the spatial dispersion of a farmer's plots (undersized farms) over a wide area". In the Caribbean, land fragmentation is often associated with small-scale farmers (Brierley 1987) and has been observed in Crofts Hill. Land fragmentation influences farmers' agricultural lands to be located over a wide area (see Table 2). The fragmented farm plots varied in slope topography, 22.7% of the farms plots were flat, 40.4% were gently sloping, 9.8% were flat and sloping, 13.3% were fairly steep and 13.8% were very steep. The topography influences they type of crop grown as well as the labour needed to manage each plot effectively. It should be noted that farm plots located on slopes are not easily accessed by the old farmers which plays a vital role in crop production within the general study area.

Land tenure refers to the legal regime where the ownership or the acquisition of land is concerned. Land that is bought, rented or leased may not necessarily be located near the home of farmers (Brierley 1987), as such, this usually influences the farmers' plots to be dispersed. This creates the problem of access between the farmer and his/her farm plot(s). Farmers without reliable transportation indicated their tendency to neglect distant plots which are usually F3 to F6 (see Table 2). According to Chisholm (1979) and Brierley (1987), the intensity of land use declines with an increase in distance from the farmer's house. Forty percent of the farm plots identified were located at a distance more than 400m from the farmers' household while 49% were located more than 400m from the Main Road (see Table 2). This often contributes to the underutilization of distant plots below their true potential. In this respect, the viability of small-scale farmers' distant plots should be of concern to policy makers in crop production for both local and foreign market.

From the data collected (see Table 2), 65.8% of the 225 farm plots recorded were between 0-2 acres and do not allow for large scale crop production. Farm size varied from farmer to farmer with most farmers cultivating fragmented farm plot(s). The small nature, topography and fragmentation of farm plots affect the use particular machinery that would normally enhance land preparation. Land fragmentation was evident as 73% of the farmers had more than one plot cultivating at different locations within the community; 41% and 20% cultivating 2 and 3 farm plots respectively (see Figure 13). However, twenty seven percent of the respondents only had one farm plot in cultivation.

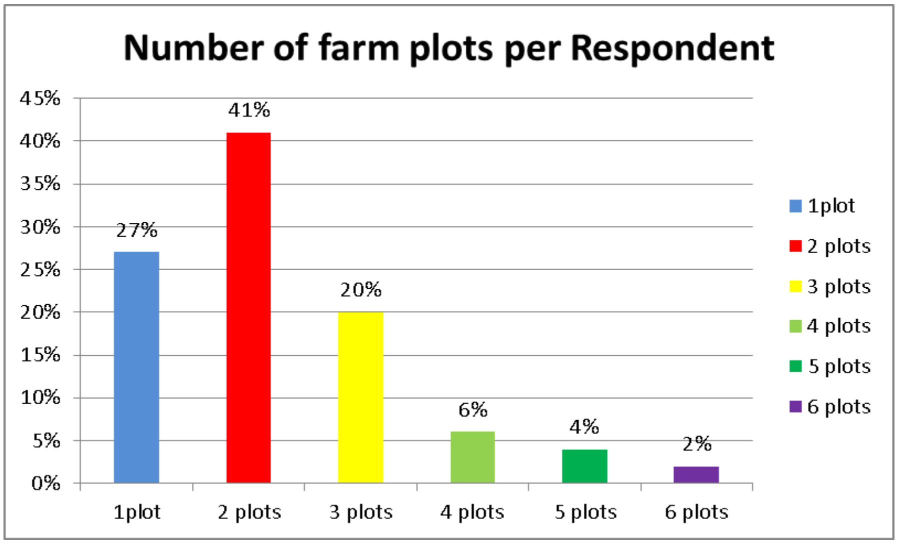


Figure 13: Number of farm plots. Source: Arthur's Fieldwork.

In addition, land tenure has the potential to affect a farmer's interest to in-cooperate such advancements as the land may not be directly owned by them especially where plots are rented (3.1%), leased (13.3) or family land (37.3%) to a lower extent (see Table 2). On the other hand, farmers who own farm plots (46.3) are more like to invest and show more interest towards crop production since they would not have to worry about eviction. Economic viability is more likely when farmers are able to make decisions that will not be affected by land tenure (Brierley 1987) and the size of farm plots where one can only take full advantage of the land available to them. A number of farmers during the focus group discussions and questionnaire administration complained that their (or someone they knew) cultivation was interrupted when family members opted to claim equal share of family land. Issues of this nature have affected the agricultural sector as it relates to crop production in which future decreases in crop production and output may occur.

Table 2: Fragmented farm plot information: Basic characteristics of 225 farm plots in Crofts Hill.

	Fragment plot number						Total	
Size of Plots	F1	F2	F3	F4	F5	F6	225	Per.
0-2 acres	65	48	20	10	3	2	148	65.8%
2.1-4 acres	17	13	6	2	2	0	40	17.8%
4.1-6 acres	8	3	2	0	1	0	14	6.2%
More than 6 acres	10	9	4	0	0	0	23	10.2%
Ownership of land								
Family land	41	28	12	2	1	0	84	37.3%
Land title	52	29	12	7	4	0	104	46.3%
Rented	0	2	3	2	0	0	7	3.1%
Leased	7	14	5	1	1	2	30	13.3%
Relief of land								
Flat	21	16	9	5	0	0	51	22.7%
Gentle	45	27	12	3	2	2	91	40.4%
Flat and sloping	10	7	4	0	1	0	22	9.8%
Fairly steep	12	11	5	0	2	0	30	13.3%
Very steep	12	12	2	4	1	0	31	13.8%
Distance from house								
0-400 m	87	34	10	2	1	0	134	59.6%
401-800 m	4	19	5	5	1	0	34	15.1%
801-1200 m	0	2	3	0	0	0	5	2.2%
1201-1600 m	1	5	8	0	1	0	15	6.7%
More than 1600 m	8	13	6	5	3	2	37	16.4%
Distance from main road								
0-400 m	65	33	12	1	1	2	114	50.7%
401-800 m	12	13	5	6	2	0	38	16.8%
801-1200 m	2	6	5	2	0	0	15	6.7%
1201-1600 m	14	10	3	1	1	0	29	12.9%
More than 1600 m	7	11	7	2	2	0	29	12.9%
Type of farming								
Sugar cane	33	50	20	8	4	2	117	52%
Inter-cropping	16	4	9	3	0	0	32	14.2%
Sugar cane & other crops	10	16	3	1	1	0	31	13.8%
Mix farming	40	0	0	0	0	0	40	17.8%
Nothing	1	3	0	0	1	0	5	2.2%

Source: Author’s fieldwork (adopted from Brierley 1987 and Burrell 2010).

5.2 Crop production

Small-scale farmers in Crofts Hill cultivate a variety of crops which are suitable for the area. Sugar cane, cabbage, sweet pepper, hot pepper, sorrel, yam, ginger and tomato are among the list of crops that farmers reported that were most profitable to them (see Table 3). Most of the crops identified are supplied to the domestic market while sugar cane is mainly for the export market. During cultivation and reaping periods, farmers provided assistance through labour agreements with each other. Fifty eight percent of the respondents indicated that they got assistance from other farmers, while 42% did not. In the past, farmers usually consider day-for-day services for free, but recently, farmers have indicated that persons who are now practicing day-for-day services were asking for payment. In other cases, farmers did not receive any assistance and had to pay workers or employ family members. Farmers who received assistance noted that hired labour (75.9%), day-for-day labour (10.3%) and hired and day-for-day labour (13.8%) were the services provided (see Figure 14).

Most profitable crops	Percentage of respondents
Sugar cane	38%
Cabbage	13%
Hot pepper	11%
Sweet pepper	2%
Sorrell	6%
Yam	16%
Ginger	9%
Tomato	5%

Table 3: Most profitable crops produced. Source: Arthur's Fieldwork.

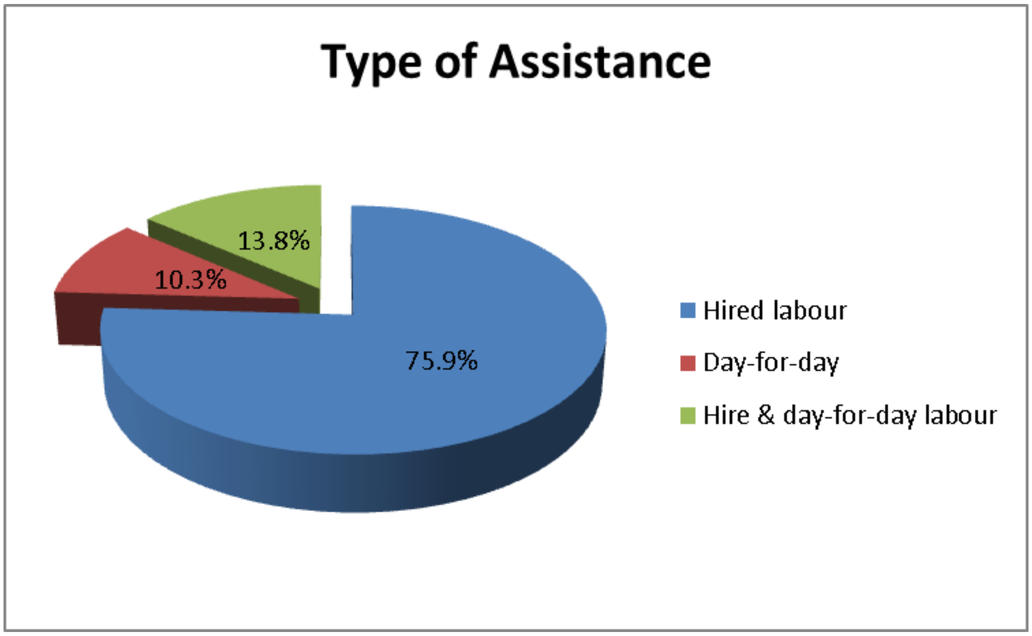


Figure 14: Type of labour arrangement offered by farmers. Source: Arthur's Fieldwork.

Notwithstanding the determination behind crop production among small-sale farmers, it is evident that production levels are not as high as they were previously in the early to mid-1990s. With the exception of 2010, domestic crop production since the year 2000 has not been over 500,000 tonnes. However, the relationship that exists between crop production at the parish and the national level is quite significant. Majority (87%) of the farmers stated that their production over the last 10 years has decreased while a few farmers (11%) reported that their production increased over previous levels and 2% highlighted that their crop production remained unchanged over the same period (see Figure 15). Clarendon is among the top parishes to contribute to Jamaica's crop production, a reduction among small-scale farmers in the parish can have serious implications where GDP, food security, rural livelihoods and employment opportunities are concerned. Farmers also indicated a change in the crop grown mostly due to the economic viability of the previous crop. In other cases, farmers explained that due to old age and the lack of strength to perform certain tasks, one would not yield fruitful results from a particular crop. Old age farmers in agriculture, especially those involved in crop production, are very dominant in today's society (Woodsong 1994; Tauger 2011). The crop change is also evident based on seasons as particular crops are planted in wet or dry seasons base on their receptiveness to the weather conditions. This affects the type of crops farmers are able to grow and form the basis for alternative cropping or part-time employment outside of agriculture.

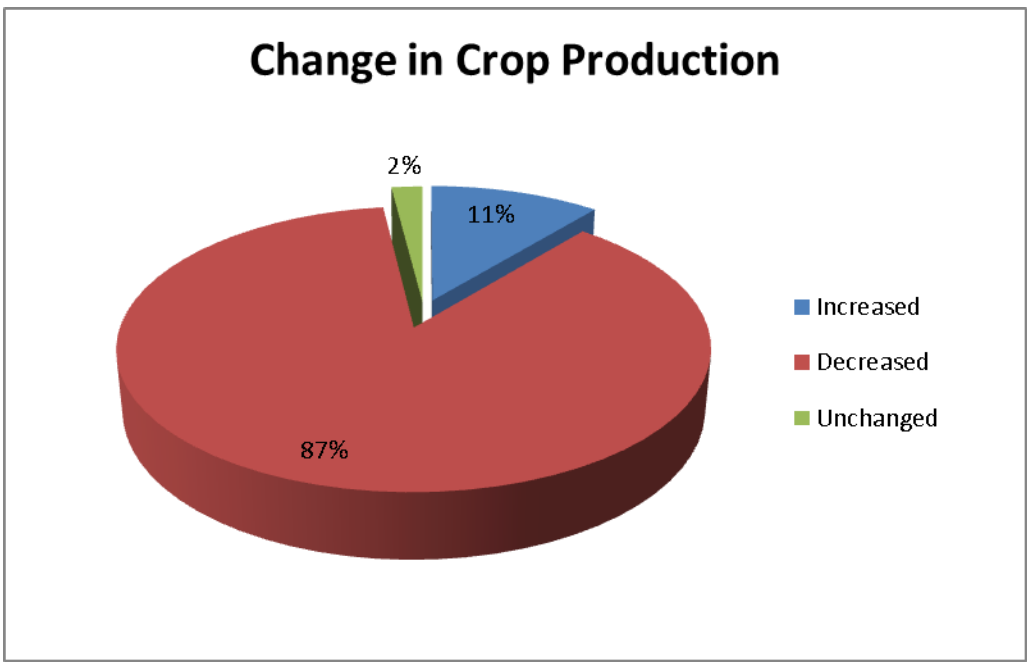


Figure 15: Change in crop production over the last 10 years. Source: Arthur's Fieldwork.

Although crop production among small-scale farmers in Crofts Hill has been decreasing steadily, farmers are still interested in agricultural production as it is their main source of income. Several factors which affected crop production were identified by the small-scale farmers in which some of these factors are similar to those that affected annual income. Natural hazards (23%) and high production costs (42%) where to two main factors identified by 65% the respondents (see Figure 16). Other factors which influenced a changed in crop production include land fertility (5% of respondents) and land availability (10% of respondents). However, sixteen percent of the respondents reported more than one factor which affected crop production while 4% of the respondents stated that nothing affected their crop production.

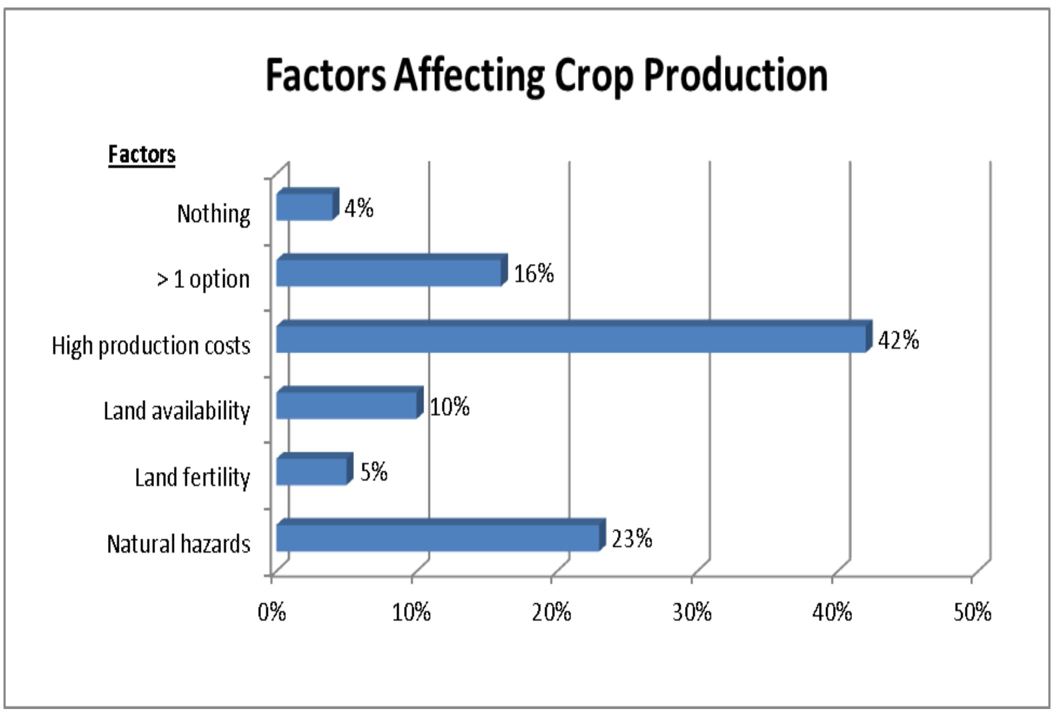


Figure 16: Factors affecting crop production. Source: Arthur's Fieldwork.

For the most part, rainfall was relied on by most farmers as other means of irrigation seemed farfetched or too expensive for farmers to consider. This is evident as 79% of the respondents rely on rainfall for irrigation, while 10% and

11% stated that they relied on rivers and ponds/wells respectively (see Figure 17). As a result, farming within Crofts Hill can be said to be heavily reliant on suitable climatic conditions. However, without rainfall these farm plots would suffer more from the two dry seasons experienced in Jamaica. In other cases where farmers are located along steams or near ponds/wells, they rely on those sources more because of the availability of water from those sources as well as the proximity to farm plots.

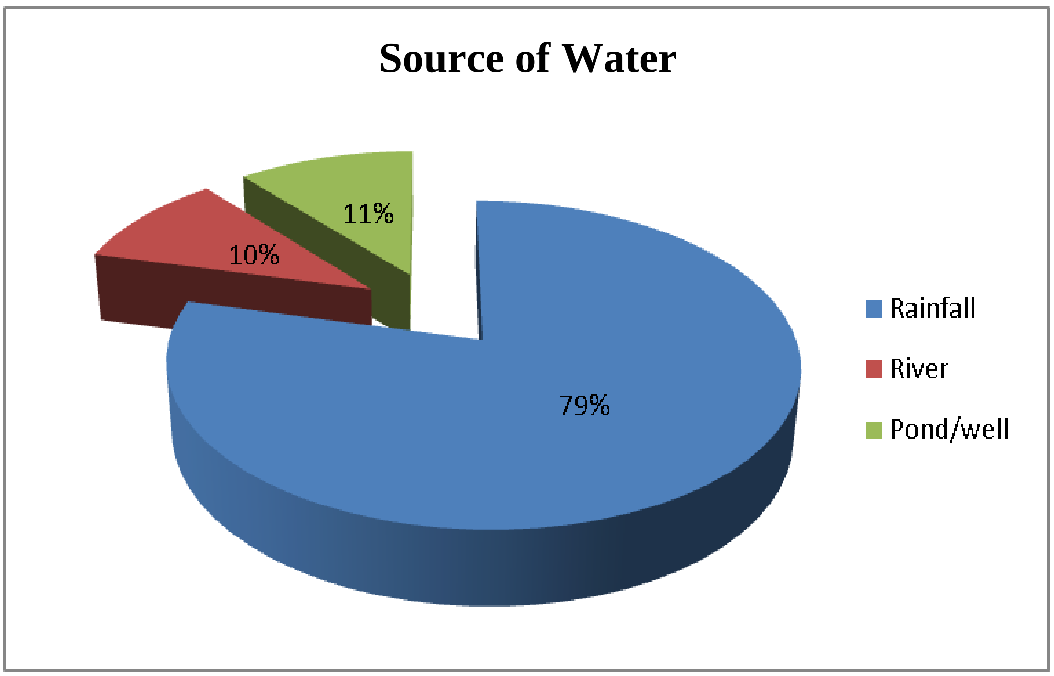


Figure 17: Source of water for agricultural use. Source: Arthur's Fieldwork.

However, the growing period/months for crop production is heavily influenced by the two wet seasons which includes May-June and September-October accounting for 41% and 20% of respondents respectively (see Figure 18). The selected growing month was influence by reliable rainfall which makes good farming conditions, as indicated by 56% of the respondents (see Figure 19).

Thirty three percent of the respondents stated that they planted in a particular month due to the potential of the expected market while 11% planted in months that were outside the hurricane season. Based on the type on crop grown, farmers will rely on different sources to meet the water demand for that particular crop. For example, most sugar cane farmers rely on rainfall which might be due to a lack of interest in accessing water sources or that the crop can do well with just rainfall as adequate moisture for full growth. In addition, the area is usually known for frequent and reliable showers throughout to year due to convectional rainfall influenced by the Crofts Mountain (see Figure 2).

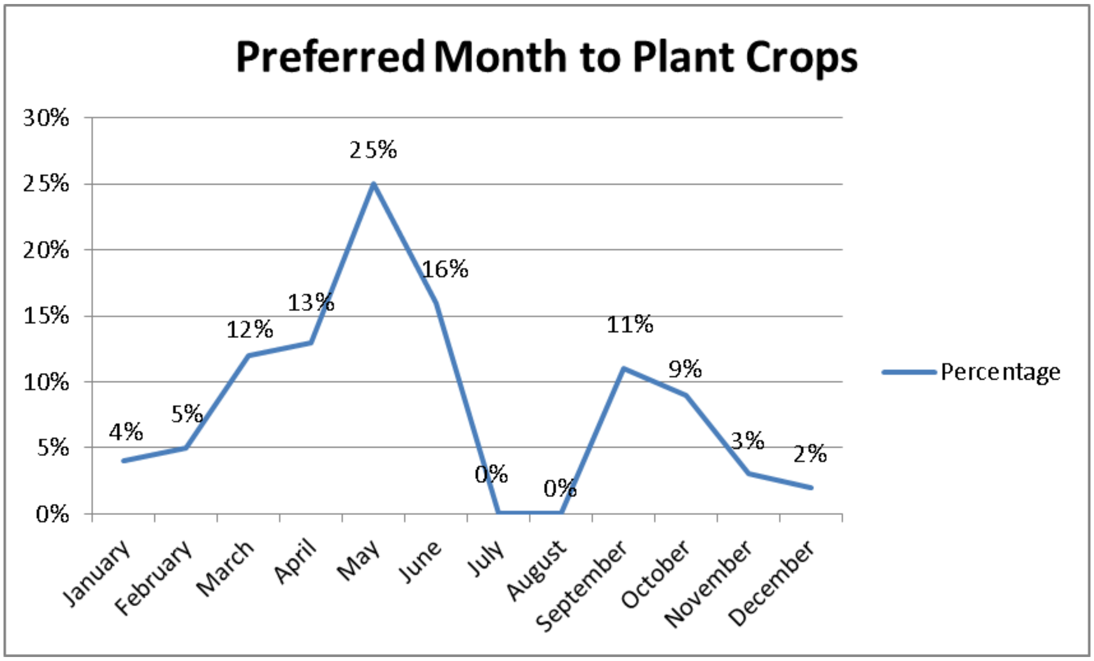


Figure 18: Preferred month to plant crops. Source: Arthur's Fieldwork.

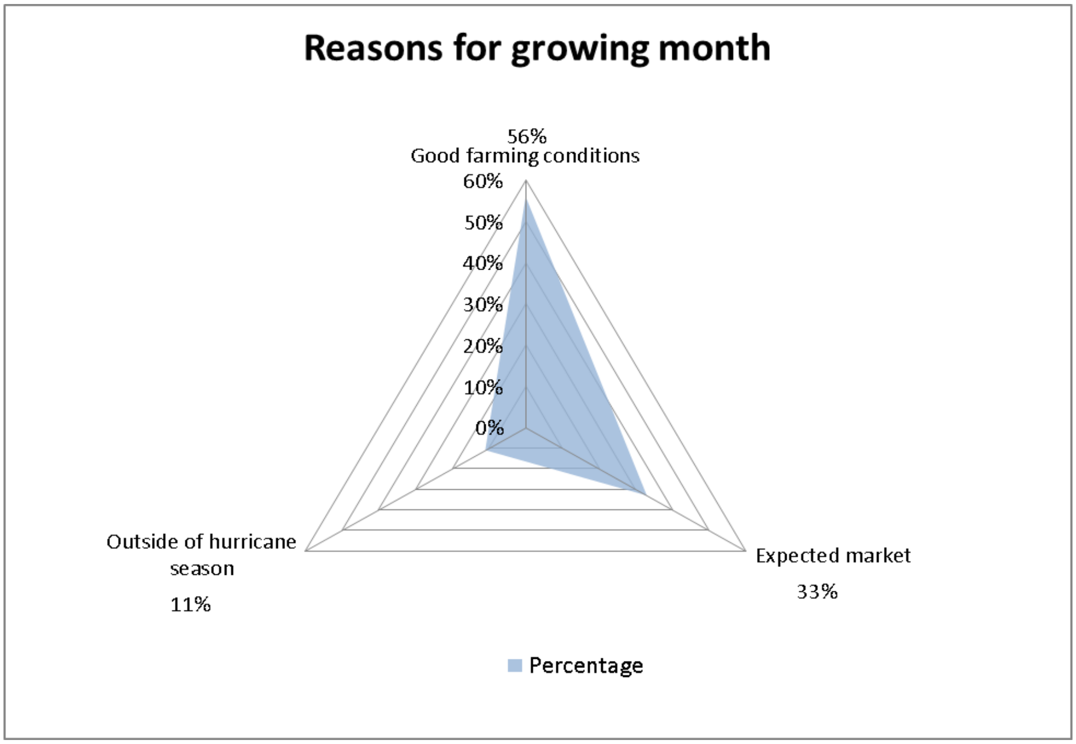


Figure 19: Reasons for the planting month selected. Source: Arthur's Fieldwork.

5. 3 Best and worst production year

The best year in crop production for farmers was considered based on; increase production (25%), good market access (25%), low production cost (4%), more land acquisition (12%) or minimal loss of crop/good farming conditions (30%) (see Table 4). On the other hand, four percent of the respondents did not indicate their best year in crop production. The best year in crop production varied from 1985-2010 among the respondents. However, the majority (64%) of respondents highlighted the years from 2006-2010 as their best year of crop cultivation. The best year in crop production varied from 1985 to 2010. Farmers explained that after a hazard event, there is always a shortage of domestic crop production which affects the balance between supply and demand. The imbalance between demand and supply allow farmers to increase the food price based on the high demand for the crops produced. The crops produced among small-scale farmers were marketed to various entities based on accessibility and the price paid for the particular crop. The main markets for crop production were the higglers (36%), Worthy Park Sugar factory (28%), local market (8%) and hotel (2%) while 26% of the respondents selected more than one option for the sale of their produce.

Respondents Account of Best/Worst Farming Year			
Best Account	**Percentage**	**Worst Account**	**Percentage**
Good farming conditions	30%	Bad farming conditions	4%
Lower production cost	4%	Natural hazards	72%
Good market	25%	High cost of production	2%
More farming plot/land	12%	Wild fire	13%
Quality/quantity of produce	25%	Low production	2%
Missing	4%	Other	7%
Total	100%	Total	100%

Table 4: Respondents account of factor influencing the best and worst farming year. Source: Arthur's Fieldwork.

On the other hand, the worst year in crop production was marked with significant crop loss resulting from wild fire (13%), natural hazards (72%), bad farming conditions (4%), high production cost (2%) and low crop production while 7% of the respondents stated that other factors contributed to their worst year in crop production (see Table 4). Production failure was reported among all the respondents in which natural hazards played a significant role in the crop loss. In addition, natural hazards have also influenced the increase in production failure among small-scale farmers. As shown in Figure 20, sixteen percent of the respondents experienced 1-2 production failure, 33% had 2-4 production failure, 32% had 5-6 production failure and 19% had over 6 production failure over the last ten (10) years which points to the susceptibility of the crop production within the agricultural sector. This further highlights the vulnerability of crop production, 90% of the last production failure among the respondents took place between 2007 and 2011 (see Figure 21). It should be noted that this coincides with the worst year of farming for 75% of the respondents.

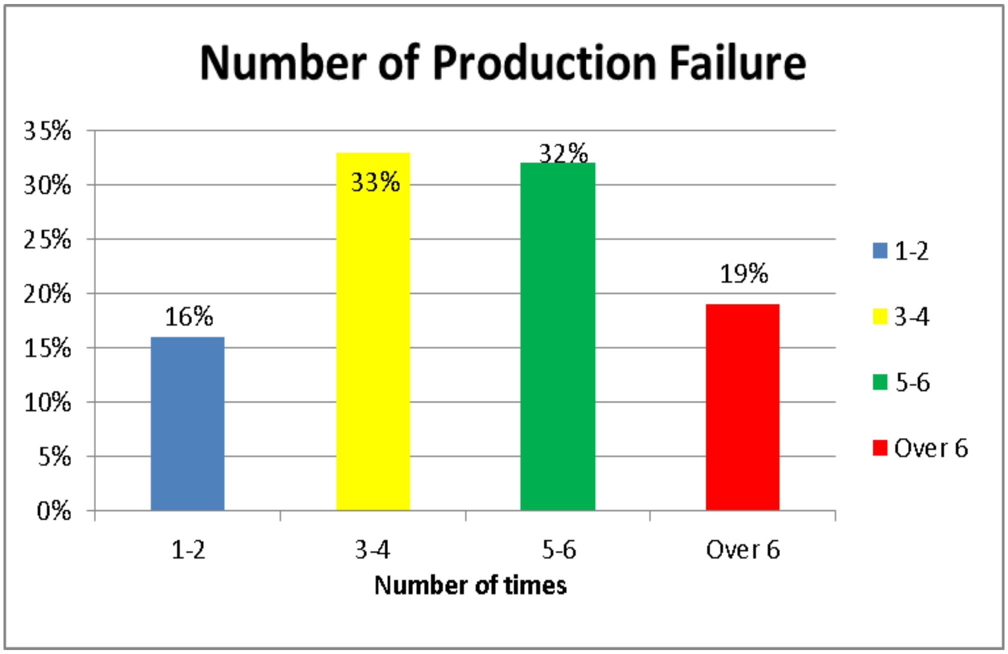


Figure 20: Number of production failure in the last 10 years. Source: Arthur's Fieldwork.

The cause of production failure according to the respondents was influenced by natural hazards (80%), wild fire (13%), bad farming conditions (2%) and other factors (5%) (see Figure 22). Respondents explained that these impacts were associated with the recent occurrence of hydro-meteorological hazards such as hurricane Dean in 2007, tropical storm Gustav in 2008, the extensive meteorological drought in 2009-2010, tropical storm Nicole and the flood rain in June 2011. In addition, the impacts of these hydro-meteorological hazards were also confirmed in the case studies and focus group discussions that were carried out.

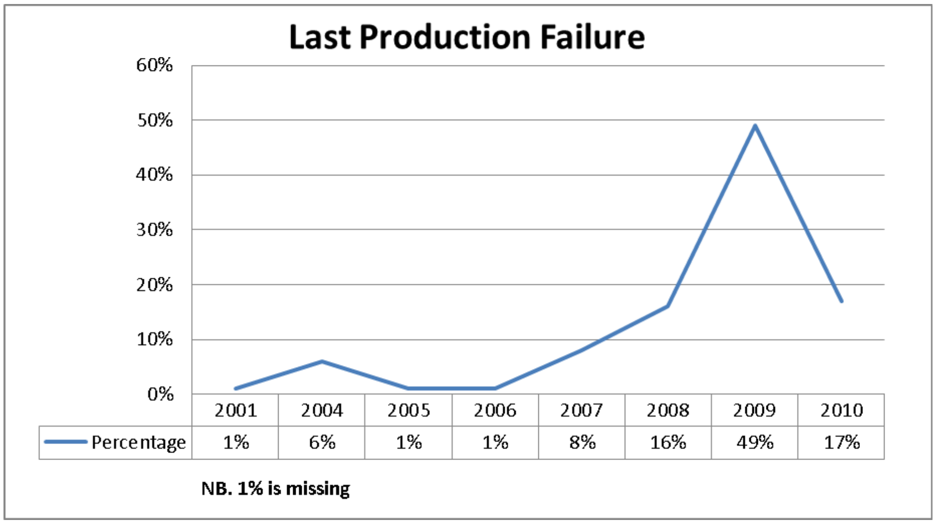


Figure 21: Last production failure experienced. Source: Arthur's Fieldwork.

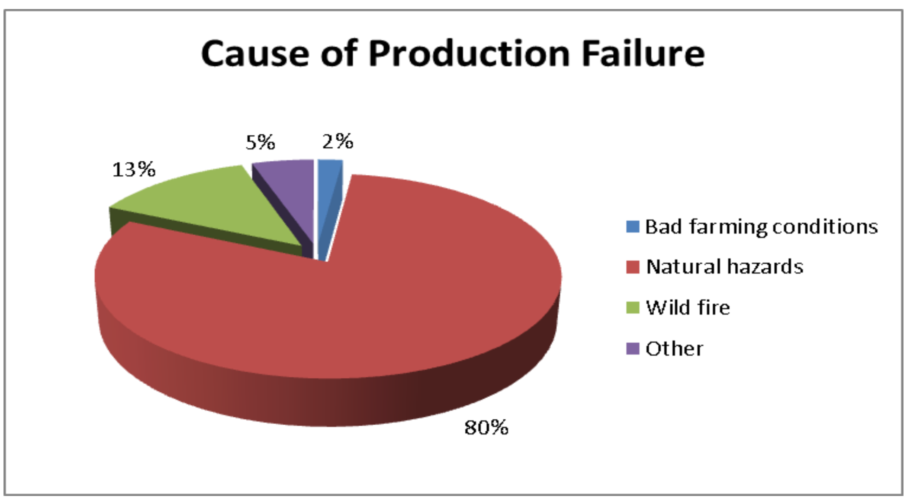


Figure 22: Cause of the last production failure experienced. Source: Arthur's Fieldwork.

Chapter Six – Hydro-meteorological Hazards and Agriculture

Direct and indirect impacts from hydro-meteorological hazards have affected the income and recovery period of several small-scale farmers. The income earned is limited to re-invest as needed and results in lower crop production. The frequent occurrence of hydro-meteorological hazards has also contributed to a declining industry. Coping mechanisms are known to reduce hazard impact and should be explored by small farmers in reducing their recovery period. This chapter assesses income, extreme hydro-meteorological hazards affecting production, direct and indirect impacts of hydro-meteorological hazards, coping mechanisms, recovery period and the frequency of hazard impact in relation to small-scale farmers.

6.0 Income

The economic viability of agriculture seems to be decreasing among small-scale farmers in Crofts Hill, Clarendon. This is a result of the decreasing production levels along with the income earned. Although showing more interest and having spent more time in the fields, the end result does not equate to effort being exerted. Over the past five (5) years, annual income from crop production among small-scale farmers has highlighted this relationship. The annual income earned influences the decision making process, 50% of the respondents indicated that they earned under $59.999.00. Twenty eight percent of the respondents earn between 60,000.00-$89,999.00, 18% of the respondents earn $90,000.00-$199,999.00 while only 4% of the respondents earn over $199,999.00 (see Figure 23).

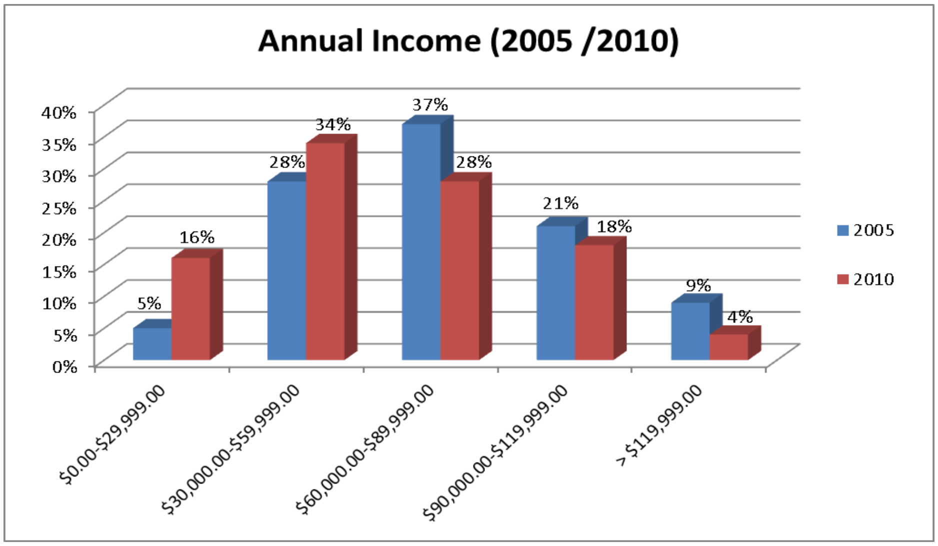


Figure 23: Comparison of the annual income in 2005 and 2010. Source: Arthur's Fieldwork.

Compared to the income earned achieved in the last five years, it is evident that income among the small-scale farmers have decreased. Five years ago, 33% of the respondents earned under $59.999, 37% percent of the respondents earn 60,000-$89,999, 21% of the respondents earn $90,000-$199,999 while only 9% of the respondents earn over $199,999 (see Figure 23)

Irrespective of the type of crop grown, several factors were mentioned as the main cause for the change in the annual income earned among small-scale farmers. These factors vary among farmers, eighteen percent of the respondents reported that they cultivated less farm plots, 5% reported that they changed the type of crop, 10% percent added that the price of the crop affected their income, 19% attributed the loss of annual income to natural hazards while 4% stated that praedial larceny influenced they annual income change. However, major of the farmers (44%) reported that the high production cost associated with farming affected the income earned as production costs were rather high (see Figure 24).

As a result, the financial security and socio-economic responsibilities of the small-scale farmers were affected due to the significant loss of income over the past five (5) years.

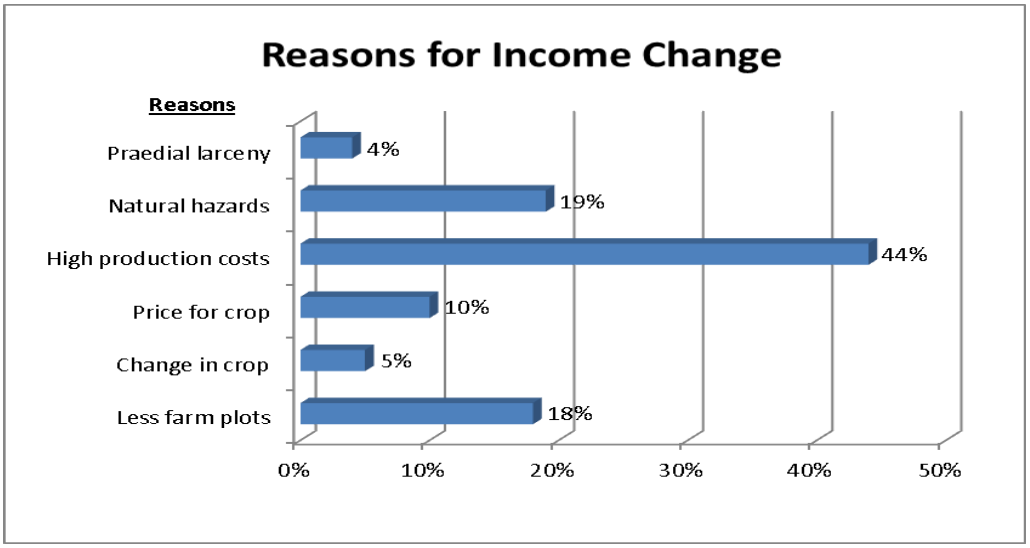


Figure 24: Reasons for the change in income. Source: Arthur's Fieldwork.

6.1 Worst hurricane/tropical storm and drought experienced

Although a number of hurricanes/tropical storms and droughts have affected Jamaica and the agricultural sector in particular, a few of the meteorological hazards have been more memorable than others to small-scale farmers based on impact and duration. Due to long involvement period in agriculture, the respondents were able to select without bias the worst meteorological hazards to affect their crop production. Hurricane Gilbert and Ivan were stated as the worst hurricane by 68% and 23% percent of the respondents to have affected their crop production (see Figure 25). On the other hand, hurricane Dean, tropical storm Gustav and Nicole were given less focus as 3%, 2% and 4% respectively based on their impact on crop production. Droughts are usually defined by prolong periods of dry condition which affects the availability of water within the immediate environment. Sixty four percent of the respondents indicated that the worst drought was experienced between 2009/2010, 2% stated that early 2004 drought was their worst yet and 30% highlighted the 1995-1997 drought as their worst while 4% of the respondents did not reply to the question (missing data). It is important to note that the worst hydro-meteorological hazard experienced by the small-scale farmers also affected other sectors within Jamaica significantly.

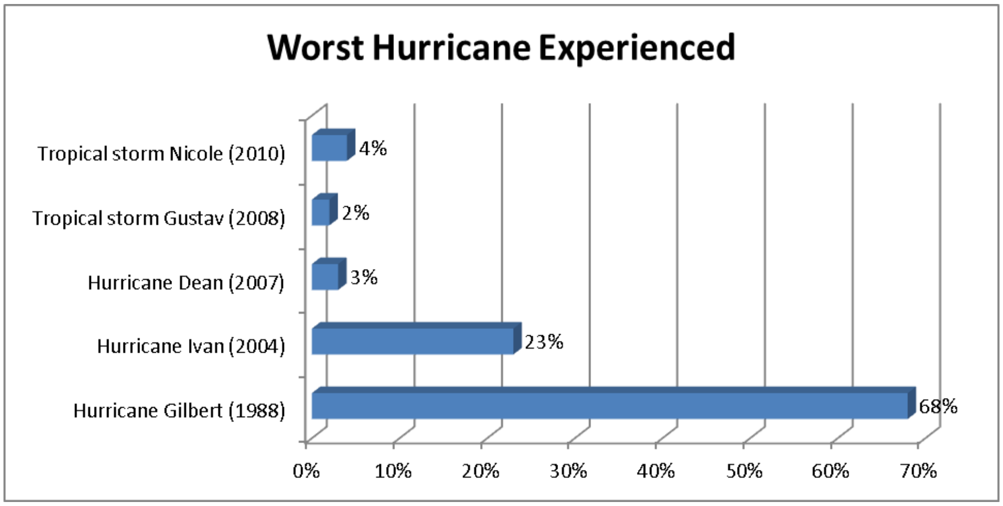


Figure 25: Worst hurricane/tropical storm which affected crop production. Source: Arthur's Fieldwork.

The impacts of these hydro-meteorological hazards were quite profound as was indicated in the level of damage sustained among small-scale farmers. As expected, the crop damage from the worst hurricane/tropical storm experienced was higher than the damage suffered from droughts. The small-scale farmers expressed that more than 50% of their crops and 100% of the crops were damaged by the worst hurricane/tropical storm experienced by 87% and 13% respectively by the respondents (see Figure 26 and Plate 2). On the other hand, 6% of the respondents experienced 100% crop damage during the worst drought, 48% experienced more than 50% crop damage, 11% experienced 50% crop damage while 35% experienced less than 50% crop damage (see Figure 26). It is evident that small-scale farmers suffer more damages from hurricanes and tropical storms than they do from drought events. Based on the level of damage suffered, the vulnerability of the agricultural sector along with the farmers involved is highlighted. The potential of impact of meteorological hazards to the agricultural sector should be of importance to the policy makers since domestic and export crop production provides jobs, income and contributes to Jamaica's GDP.

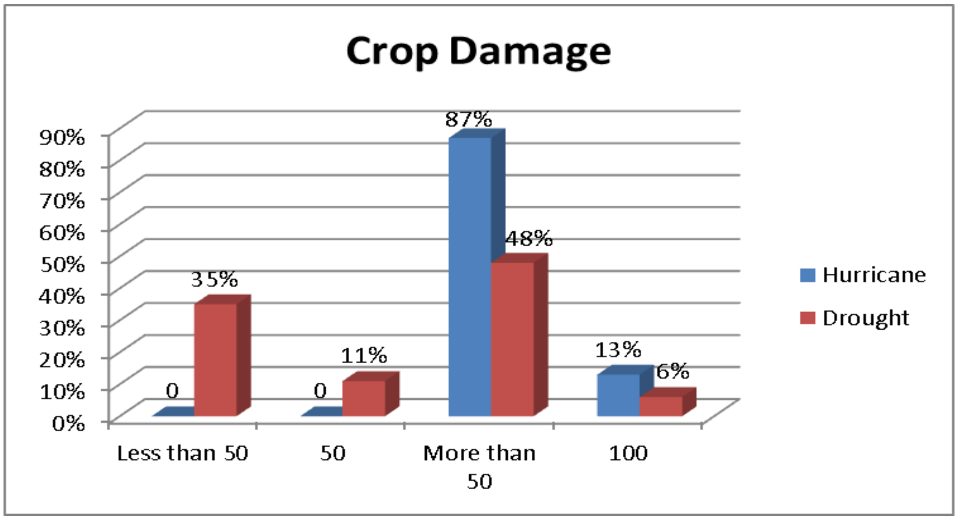


Figure 26: Crop damage from the worst hydro-meteorological hazard experienced. Source: Arthur's Fieldwork.

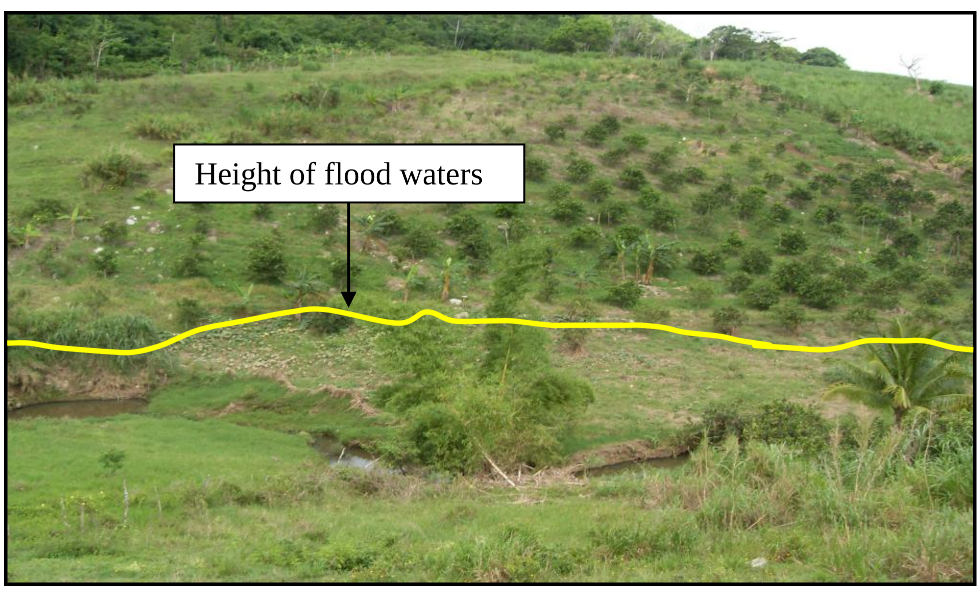


Plate 2: Flooding of farm plot cause by June 2011 flood rains (Taken on June 18, 2011). Source: Arthur's Fieldwork.

6.2 Direct and indirect impacts

Events resulting from hurricanes/tropical storms and droughts, based on their time of impact, can affect the different production periods/phases of small-scale farmers. Forty three percent of the respondents stated that the worst hurricanes/tropical storms affected plant growth, 19% reported that their reaping period was affected, 14% indicated that the quality of the crop was damaged, 9% stated that their recovery period was affected while 15% of the respondents identified more than one area of their crop production which was affected (see Table 5).

Aspect of Crop Production affected (1) Hurricane/tropical storm (2) Drought		**Age range of farmers**					**Total**
		26-35	**36-45**	**46-55**	**56-65**	**Over 65**	
Crop growth	(1) % of Total	1.0%	4.0%	8.0%	13.0%	17.0%	43.0%
	(2) % of Total	2.0%	4.0%	9.0%	14.0%	17.0%	46.0%
Reaping period	(1) % of Total	.0%	2.0%	6.0%	7.0%	4.0%	19.0%
	(2) % of Total	.0%	.0%	2.0%	.0%	.0%	2.0%
Recovery period	(1) % of Total	.0%	2.0%	1.0%	1.0%	5.0%	9.0%
	(2) % of Total	.0%	.0%	1.0%	.0%	2.0%	3.0%
Quality of crop	(1) % of Total	1.0%	.0%	4.0%	4.0%	5.0%	14.0%
	(2) % of Total	.0%	2.0%	4.0%	8.0%	18.0%	32.0%
> 1 option	(1) % of Total	.0%	.0%	.0%	5.0%	10.0%	15.0%
	(2) % of Total	.0%	2.0%	3.0%	8.0%	4.0%	17.0%
Total	(1) % of Total	2.0%	8.0%	19.0%	30.0%	41.0%	100.0%
	(2) % of Total	2.0%	8.0%	19.0%	30.0%	41.0%	100.0%

Table 5: Aspects of crop production affected by the worst hydro-meteorological hazard experienced. Source: Arthur's Fieldwork.

There were marked similarities between the different aspects of crop production affected due to hurricanes/tropical storms and droughts. The worst drought affected crop growth (46% of the respondents), the reaping period (2% of the respondents), the recovery period (3% of the respondents), the quality of crops (32% of the respondents) while 17% stated that more than one aspect of their crop production was affected (see Table 5). Output in production would be reduced and in most cases result in a decline of income which affects next growing period (see Plate 3 and 4). It was highlighted during the case studies and focus group discussions that crop production is reduced as small-scale farmers are unable to cope with the damages sustained. This is also evident is other areas where crop production is of importance in which crop production is scale down during and after in the impact of hydro-meteorological hazards (Campbell and Beckford 2009; Campbell et al. 2010).

Plate 3: Flooding of farm plot cause by blocked sink hole after June 2011 flood rains (Taken on June 18, 2011). Source: Arthur's Fieldwork.

Plate 4: Flooding of farm plot cause by blocked sink hole after June 2011 flood rains (Taken on June 18, 2011). Source: Arthur's Fieldwork.

In addition, hurricanes and tropical storms outside of the direct impacts on the agricultural sector may also affect household operation directly and/or indirectly. As shown in the Table 6 below, the primary direct impact of hurricanes and tropical storms on small-scale farmers is damage to houses. This is often associated with the strong winds which at times can remove roof of buildings based on the intensity of the hazard. Financial problems and food provision were indirect impacts which were highlighted 29% and 18% respectively by the respondents (see Table 6). In addition, 49% of the respondents stated that every aspect of their household operation was affected by hurricanes and tropical storms. Various aspects of the household were also affected by droughts experienced. Financial problem (45% of respondents), provision of food (14% of respondents), water shortage (9% of respondents), every aspect (17% of respondents) while 15% of the respondents stated that their households were not significantly affected (see Table 6). It is important to note that a number of these household impacts occur indirectly from losses sustained from farmer's crop production. Each of these impacts is unique and threatens the well-being of small-scale farmers.

Household operation Affected		**Age range of farmers**					**Total**
Hurricane		**26-35**	**36-45**	**46-55**	**56-65**	**Over 65**	
Financial problem	% of Total	0%	2%	3%	9%	15%	29%
Damaged house	% of Total	0%	0%	0%	2%	2%	4%
Provision of food	% of Total	0%	2%	0%	7%	9%	18%
Every aspect	% of Total	2%	4%	16%	12%	15%	49%
Total	% of Total	2%	8%	19%	30%	41%	100%
Drought							
Financial problem	% of Total	2%	4%	8%	15%	16%	45%
Not much damage	% of Total	0%	0%	2%	7%	6%	15%
Provision of food	% of Total	0%	2%	4%	1%	7%	14%
Every aspect	% of Total	0%	2%	1%	6%	8%	17%
Water shortage	% of Total	0%	0%	4%	1%	4%	9%
Total	% of Total	2%	8%	19%	30%	41%	100%

Table 6: Aspects of the household operation affected from the worst hydro-meteorological hazard experienced. Source: Arthur's Fieldwork.

Providing for one's family during and after a hydro-meteorological hazard may prove challenging based on the duration and impact of the hazard. In addition, the effects can also be exacerbated based on the household size of a particular farmer. Twenty three percent of the respondents had a household size of 1-2 persons, 31% had 3-4 persons, 32% had 5-6 persons and 14% had over 6 persons (see Figure 27). As such, the well-being of the farmer and his/her family can be significantly affected by the indirect factors mentioned above. It is important that crop production remains viable to farmers as family structures can be affected due to the related impacts of hydro-meteorological hazards.

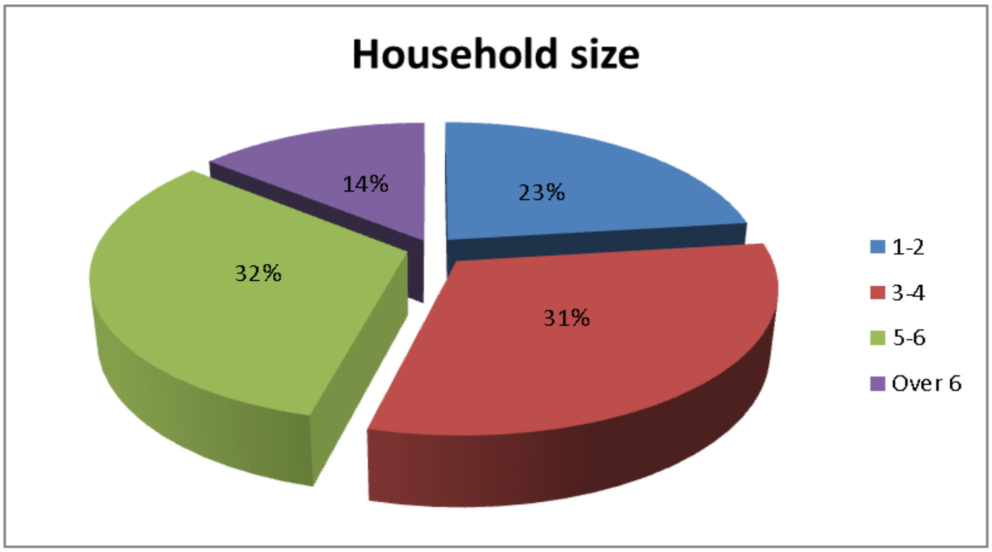


Figure 27: Respondents household size. Source: Arthur's Fieldwork.

6.3 Coping Mechanisms

Having experienced several meteorological hazards throughout their involvement in crop production, it is imperative that small-scale farmers develop or establish coping mechanisms to mitigate or recover from the impacts of these hazards. However, based on the interaction and responses of the small scale farmers, most of the coping mechanisms employed were geared towards recovery rather than to mitigate the impacts of hydro-meteorological hazards. As a result, 29% stated that they replanted crops, 11% requested assistance, 6% accessed saving to recover from the hazard event (see Table 7). However, 45% of the respondents had to adjust their routine operation whether on the field or in the household while 9% did nothing to cope with the impacts from these hazards. Similarly, the small-scale farmers also found several ways to cope with the effects of droughts. Twenty percent of the respondents replanted crop(s), 44% adjusted routine operations, 5% sought assistance, 10% access savings, 3% irrigated the fields more than usual and 15% did nothing to cope with the impacts of droughts. Base on the responses given, attention is only given to hydro-meteorological hazards during or after the event. If more focus were to be given to the pre-impact phase of the meteorological hazards, the related impacts from such hazards would be reduced and then require less recovery mechanisms from the small-scale farmers.

Hurricane Coping Mechanism	Percentage	Drought Coping Mechanism	Percentage
Replant crop(s)	29%	Replant crop(s)	23%
Seek assistance	11%	Seek assistance	5%
Access savings	6%	Access savings	10%
Adjust routine operation	45%	Adjust routine operations	44%
Nothing	9%	Nothing	15%
		Irrigate fields more	3%

Table 7: Coping mechanisms employed to reduce the impacts of hydro-meteorological hazards. Source: Arthur's Fieldwork.

Despite losing crop production to re-occurring meteorological hazards, small-scale farmers receive very little assistance from family members/friends or government agencies. RADA and the MOA are responsible for the provision as assistance to farmers where necessary. The respondents (100%) of the respondents reported that they did not receive any assistance from any government agencies whether to mitigate or recovery from the impacts of hurricanes/tropical storms and droughts. On the other hand, only 13% of the respondents received assistance in several different ways from family members/friends. As a result, majority of the respondents (87% and 94%) did not receive any assistance from family members/friends and had to the cope with the effects hurricanes/tropical storms and drought respectively on their own (see Figure 28).

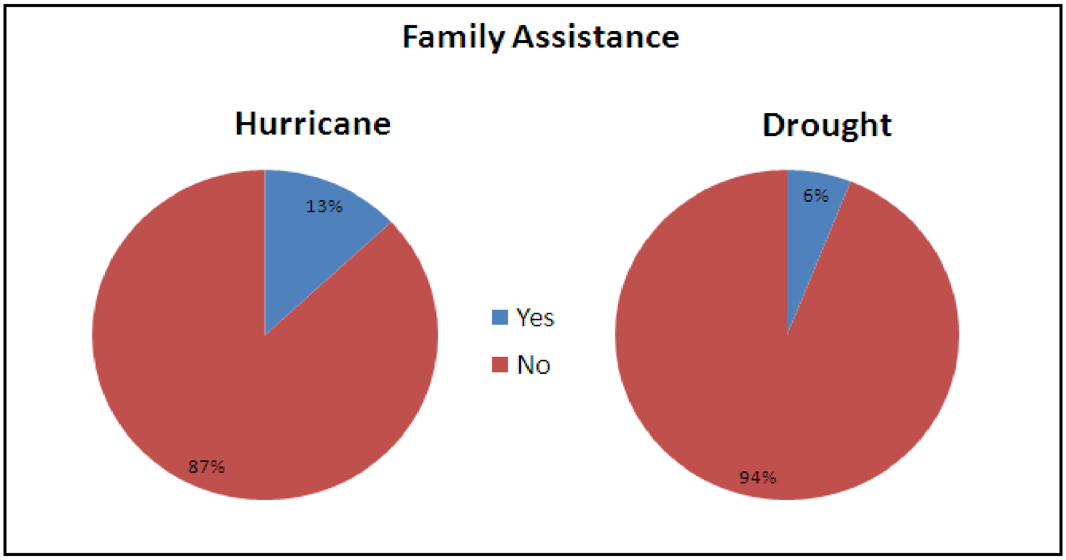


Figure 28: Family assistance received to aid with hazard impact. Source: Arthur's Fieldwork.

As it relates to assistance received for hurricanes/tropical storms, eleven percent of small-scale farmers got financial assistance while 2% got seedlings to replant their farm plots from family member/friends. In order to deal with the conditions of drought, 6% of the respondents received financial aid. During one of the focus group discussions, farmers highlighted that it was much harder for farmers who did not receive assistance to cope with the effects of meteorological hazards. This is mostly due to the poor resource base among small-scale farmers (Campbell et al. 2010; Campbell and Beckford 2009) and the inability of government agencies to provide assistance where necessary.

In order to reduce to impacts of drought events, the small-scale farmers in Crofts Hill have relied on several different coping mechanisms. Twenty seven percent of the respondents irrigated their fields more, 17% stored water (see Plate 5), 4% practiced mulching, 2% planted fewer crops, 2% reared livestock, 1% planted more resistant crops and 47% did nothing to cope with the impacts of drought events (see Figure 29). A number of these mechanisms have been employed by other small-scale farmers in other farming regions in Jamaica (Spence 2008; Spence 2009; Campbell and Beckford 2009; Campbell et al. 2010). However, other coping mechanisms could also be adapted as one could employ more than one mechanism to mitigate the resulting impacts of droughts. Much work has been done in the area of coping mechanisms and adaptation measures which have been used to reap successful results (Spence 2008; Campbell et al. 2010). Without the implementation of mitigation measures, small-scale farmers will be more vulnerable to the significant impacts of hydro-meteorological hazards.

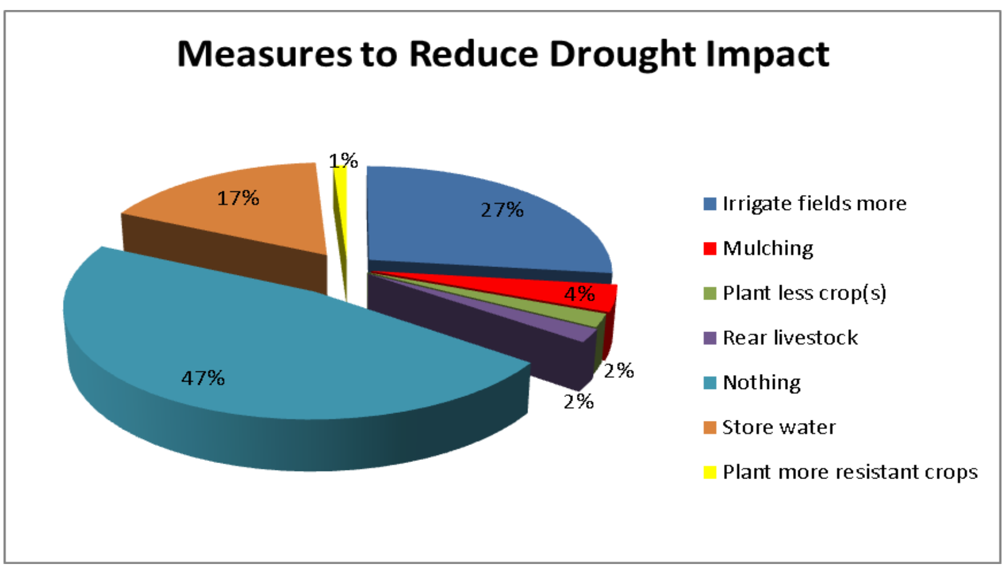


Figure 29: Measures employed to reduce the impacts of droughts. Source: Arthur's Fieldwork.

Plate 5: Water being stored in drums to mitigate against drought and/or extended dry conditions (Taken on January 2, 2011). Source: Arthur's Fieldwork.

6.4 Recovery Period

The continuation of crop production by small-scale farmers after the impact of a particular hazard is marred by what is known as a recovery period. As express before, the recovery period represents the amount of time it takes a farmer to re-cultivate his farm plots after a hazard event. Sixty four percent of the respondents indicated that their recovery period was less than 6 months, 34% of the respondents took 6-12 months and 2% of respondents stated that their recovery period was more than 12 months after a hurricane/tropical event (see Figure 30). Compared to drought, farmers take a longer period to re-cultivation farm plots after a hurricane or tropical storm as a result of more severe impacts. Eighty one percent of the respondents indicated that their recovery period was less than 6 months, 17% of the respondents took 6-12 months and 2% of respondents stated that their recovery period was more than 12 months after a hurricane/tropical storm event (see Figure 30).

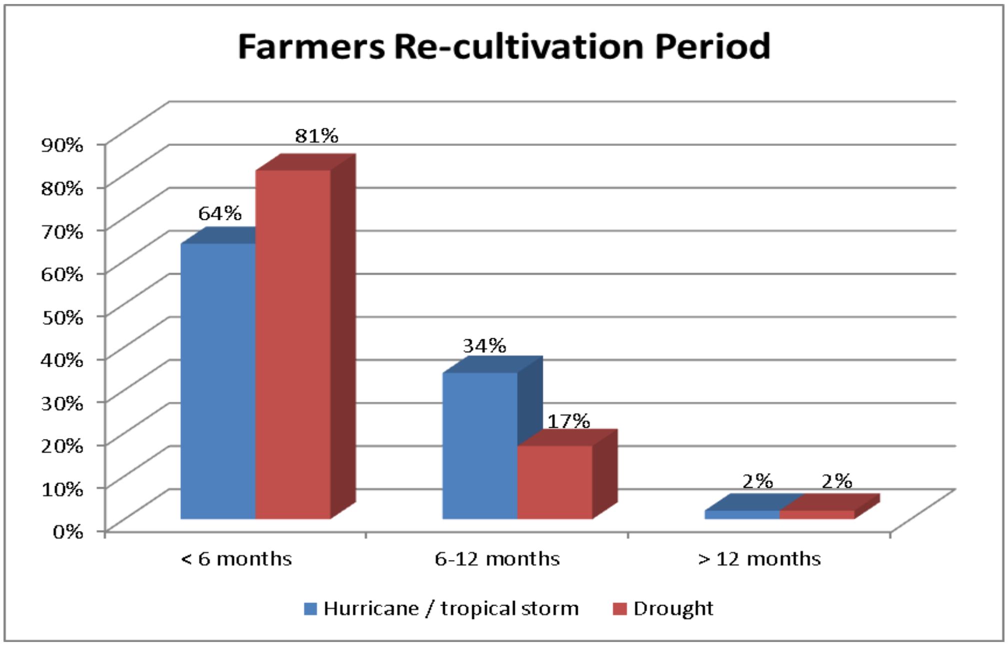


Figure 30: Re-cultivation period after impacts of hurricanes/tropical storms and droughts. Source: Arthur's Fieldwork.

This has serious implications since small-scale farmers are the main contributors to domestic crop production in Jamaica in which a hurricane or a tropical hazard may occur. The length of time it would take farmers to re-cultivate farm plots and the time it takes for plants to reach maturity could influence concerns where food security is an issue. In addition, Crofts Hill is a main supplier of sugar cane to the Worthy Park sugar factory (Burrell 2010), in which a prolonged recovery period could affected the amount and the quantity of sugar produced. As such, measures should be implemented by policy makers to reduce to recovery period of small-scale farmers after hazards events and thereby increasing their resilience.

6.5 Frequency of hazard impact

The recent past has seen several years of re-occurring hydro-meteorological hazards in quick succession (see Appendix 2). This frequency in the impacts of hydro-meteorological hazards should be noted as this can influence a longer recovery period among small-scale farmers. The increase in the frequent re-occurrence of hurricanes/tropical storms was identified by 98% of the respondents while 2% of the respondents stated that an increase in the frequency of hurricanes/tropical storms is not evident (see Figure 31). In addition, the increase frequency of hurricanes/tropical storms has been affecting the crop production among small-scale farmers significantly (Spence 2008; Spence 2009; Campbell and Beckford 2009; Campbell et al. 2010). Seventy eight percent of the respondents claim that that their crop production was affected by the increase in the frequency of hurricanes/tropical storms while the other 22% stated that their crop production was not affected (see Figure 32).

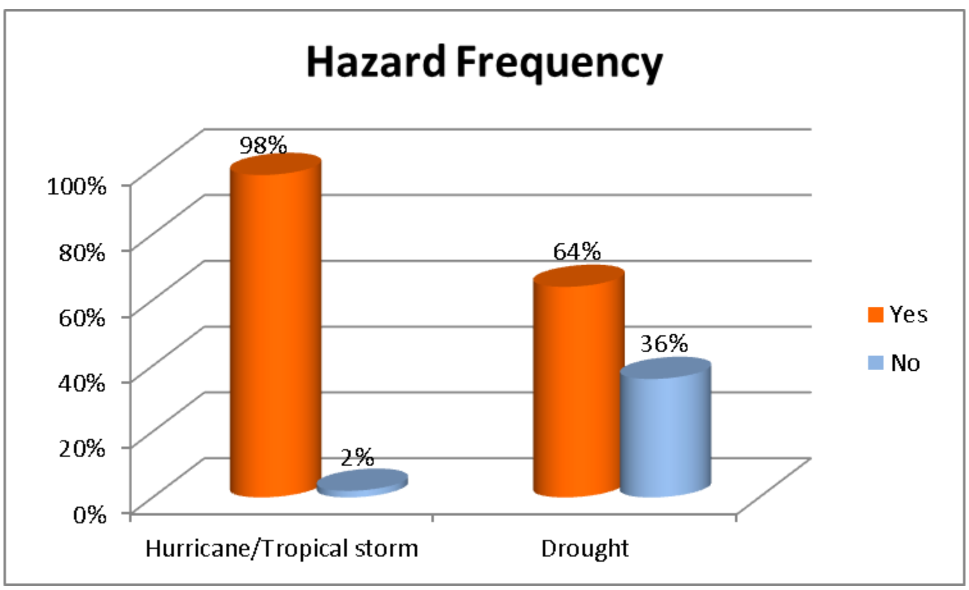


Figure 31: Frequency in the occurrence of hydro-meteorological hazards. Source: Arthur's Fieldwork.

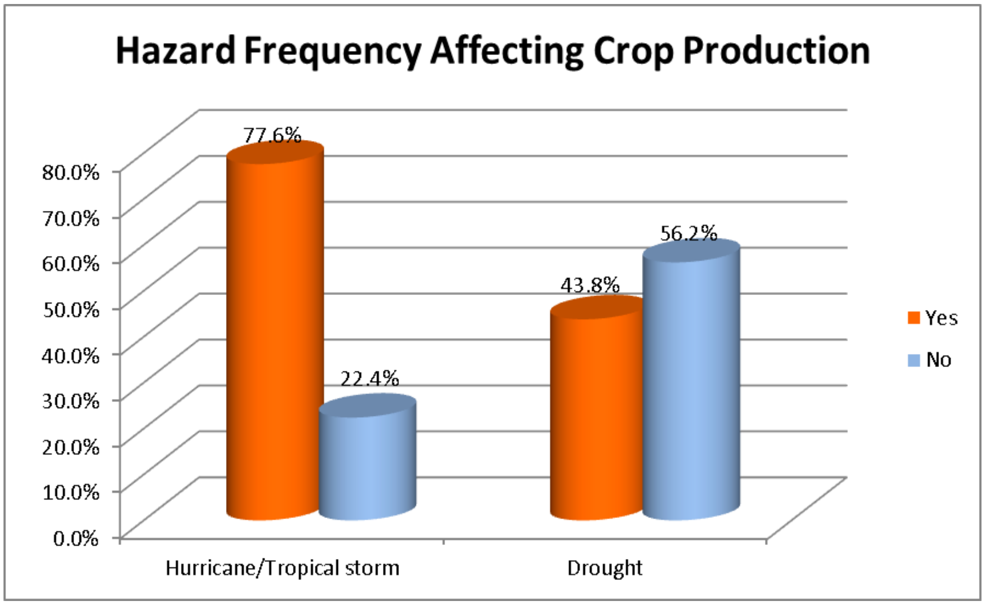


Figure 32: Frequency in the occurrence of hydro-meteorological hazards affecting crop production. Source: Arthur's Fieldwork.

In addition, the increase frequency of drought events also had profound impacts on small-scale farmers in Crofts Hill. Sixty four percent of the respondents indicated that there is an increase in the frequency of drought events while 36% did not see any marked increase (see Figure 31). Jamaica has two bi-modal dry periods in which drought conditions can be easily influenced with minimal climatic variation (see Figure 2). Water is important for plant growth, without which, production can be affected as highlighted by the small-scale farmers. Twenty eight percent of the respondents stated that the increase frequency of drought events have affected their crop production while the crop production of remaining 36% of the respondents were not affected. However, forty four percent of the respondents claim that their crop production was affected by the increase in the frequency of droughts while the other 56% stated that their crop production was not affected (see Figure 32). The significant impact on crop production from drought events is influenced by a farmer's dependence on rainfall, in which 79% of the respondents rely on rainfall as their main source of water (see Figure 17). As such, it is necessary that farmers develop coping mechanisms to deal with both the short and long term impacts of droughts in order to increase crop production and economic viability.

To further highlight the vulnerability of small-scale farmers to hydro-meteorological hazards, the respondents were asked how regularly their crop production was affected by hurricanes/tropical storms and droughts. In response, 26% of the respondents were always affected, 40% were affected very often and 19% were affected sometimes while 15% were rarely affected by these hazards (see Table 8).

Frequency of Hazard Impact		**Age range of farmers**					
(1) Hurricane/tropical storm **(2) Drought**		**26-35**	**36-45**	**46-55**	**56-65**	**Over 65**	**Total**
Always	(1) % of Total	1%	4%	7%	8%	6%	26%
	(2) % of Total	0%	0%	0%	0%	6%	6%
Very often	(1) % of Total	0%	2%	8%	9%	21%	40%
	(2) % of Total	1%	2%	6%	10%	11%	30%
Sometimes	(1) % of Total	1%	2%	1%	5%	10%	19%
	(2) % of Total	0%	4%	12%	10%	12%	38%
Rarely	(1) % of Total	0%	0%	3%	8%	4%	15%
	(2) % of Total	1%	2%	1%	10%	12%	26%
Total	(1) % of Total	2%	8%	19%	30%	41%	100%
	(2) % of Total	2%	8%	19%	30%	41%	100%

Table 8: Frequency in the impact of hydro-meteorological hazards. Source: Arthur's Fieldwork.

Similar to the recovery period, it is evident that farmers are more vulnerable and are likely to be impacted by hurricanes/tropical storms. Only 6% of the respondents were always affected by drought, 30% were very often impacted, 38% were affected sometimes and 26% were rarely affected (see Table 8). However, this highlights the susceptibility of small-scale farmers as majority (85% and 74%) are most likely to be affected from hurricanes/tropical storms and drought events respectively. Being so highly vulnerable to these hydro-meteorological hazards, it is imperative for the government of Jamaica to implement the ADRM plan to reduce impact among small-scale farmers.

Chapter Seven – Recommendation and Conclusion

7.0 Future of crop production

Although impacts have been sustained, interest within crop production still remains high among the small-scale farmers. As such, it was reported by 77% of the respondents that they would be able to increase their crop production (see Figure 33). However, twenty three percent of the respondents claimed that they are not capable on increase their current levels output in crop production. This is mainly to the average age of small-scale farmers in Crofts Hill. Most of the farmers are not able to invest of much money and time which is required to effectively cultivate farm plots. In addition, even where money is not a problem, acquiring the necessary labour force to perform specific duties may be a problem.

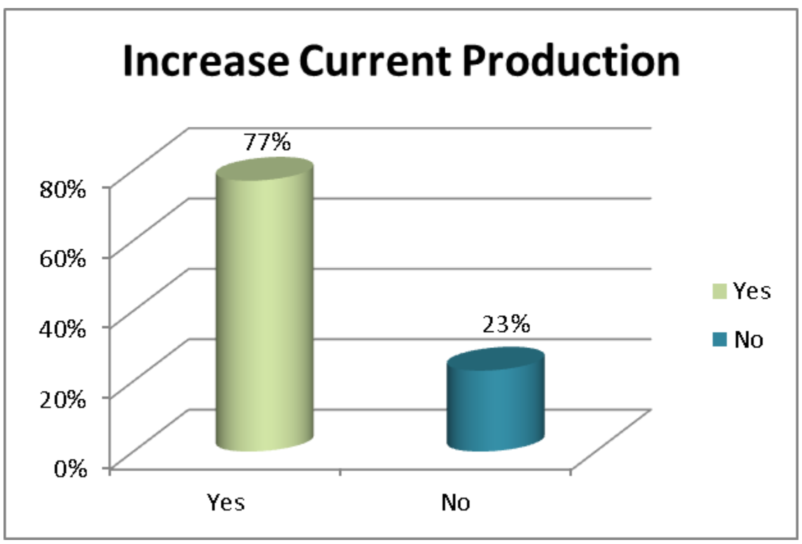


Figure 33: Increase current yields in crop production. Source: Arthur's Fieldwork

Respondents who indicated that they could increase their crop production also justified the means by which they would be able to do so. Increases in the amount of crop produced (40.3%), the acquisition of more farm plots (29.9%), the use of more fertilizers (22.1%) and the acquisition of more labour (7.8) were the main ways to increase crop production (see Figure 34). The implication is that the area under cultivation and production output would increase.

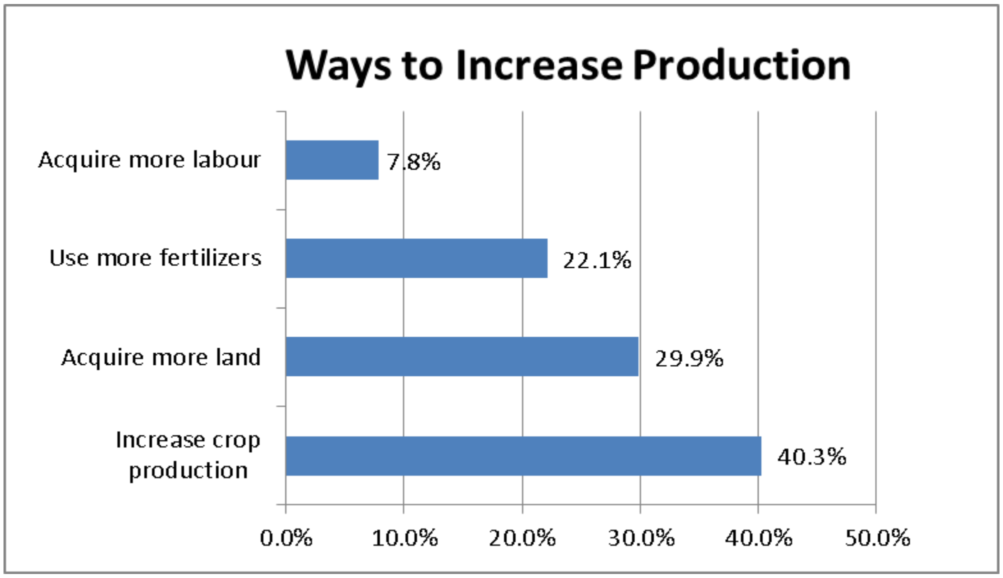


Figure 34: Ways to increase crop production yields. Source: Arthur's Fieldwork

Based on the continued support or the lack thereof and the period of involvement, small-scale farmers had varying views on the future of crop production. Sixty three percent of the respondents stated that there was a future for crop production while the remaining 37% stated that there was no future for crop production based on the economic and social factors affecting small-scale farmers (see Figure 35). This is a major concern as it is possible that small-scale farmers who do see a future in crop production may not be interested in re-cultivating their farm plots (see Plate 6). The potential of farmers going out of production is quite high and was highlight on more than one occasion. Thirty seven percent of the respondents indicated that they know of small-farmers who have gone completely out of crop production (see Figure 36). However, twenty four percent did not know of anyone that stop cultivating entirely while 39% of the respondents were not sure.

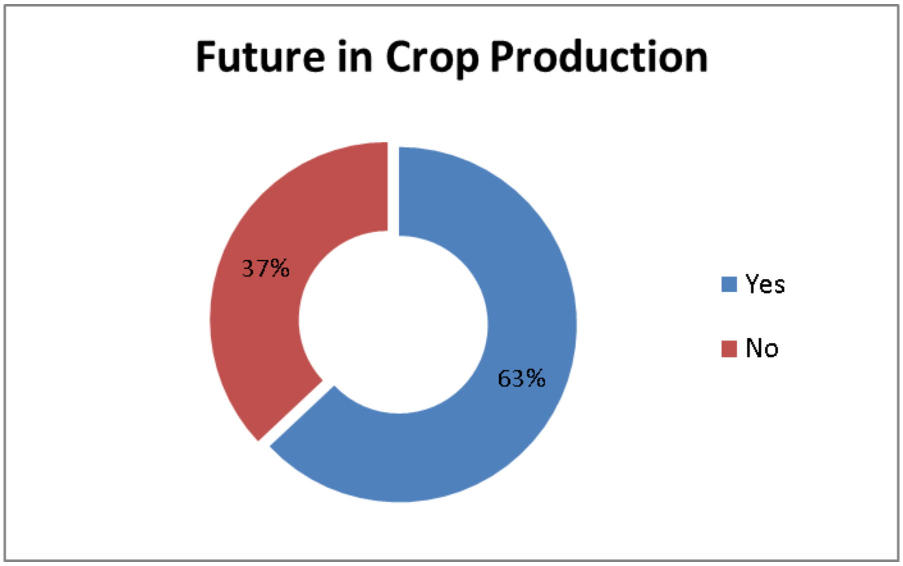


Figure 35: Involvement in future crop production. Source: Arthur's Fieldwork

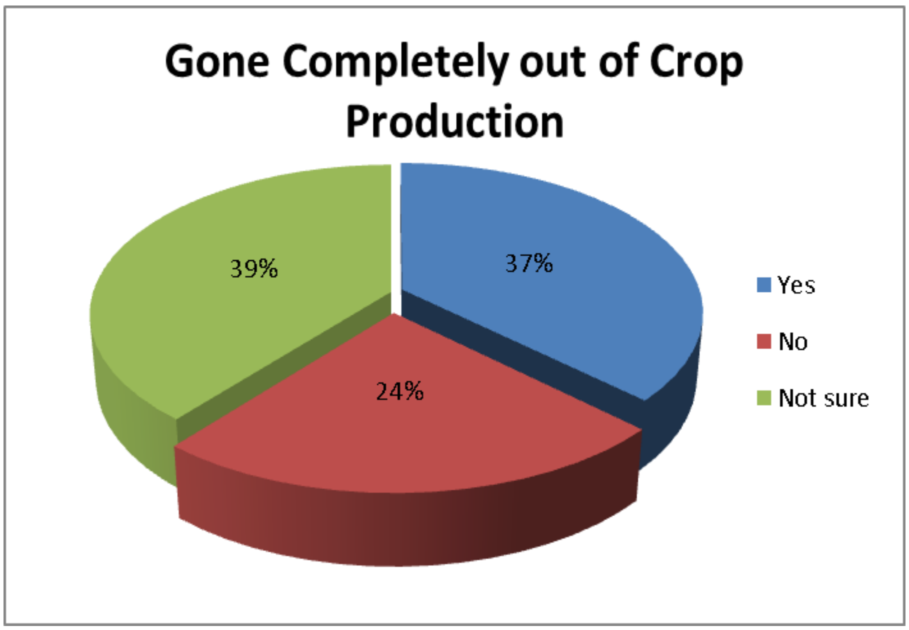


Figure 36: Gone completely out of crop production. Source: Arthur's Fieldwork

A number of reasons were used to justify the responses given for future crop production. Future crop production is dependent on income generation and a high demand for particular crops which was expressed by 33% and 17% of the respondents respectively (see Figure 37). On the other hand, respondents reported that farming was no longer profitable (32% of the respondents), youths not interested in crop production (11% of the respondents) or praedial larceny (1% of the respondents) would affect the future of crop production. In addition, six percent of the respondents indicated that their only reason for future crop production was due to the fact that they had nothing else to do.

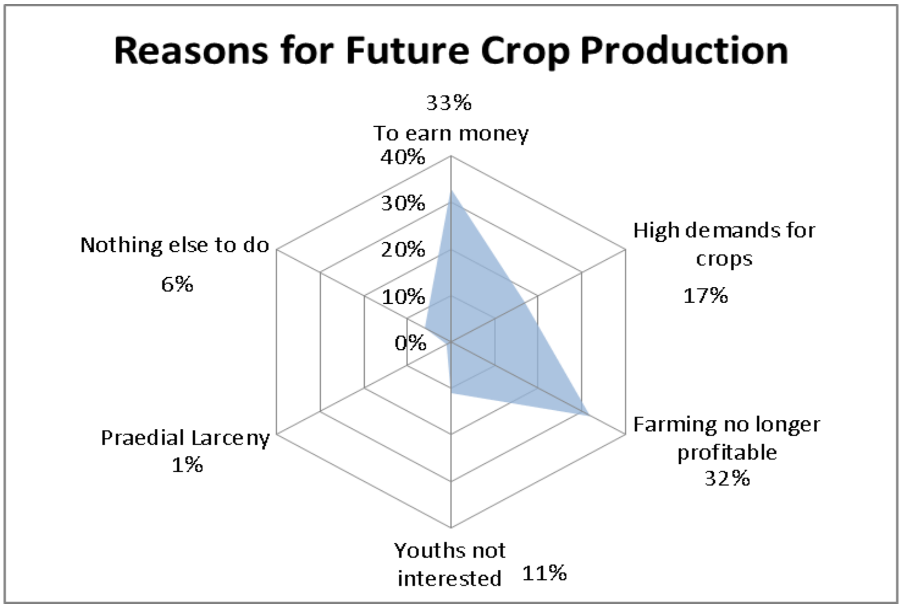


Figure 37: Reasons for future crop production. Source: Arthur's Fieldwork

Plate 6: Previous farm plots now left idle (Taken on June 18, 2011). Source: Arthur's Fieldwork.

7.1 Recommendations

Small-scale farmers usually have a low resource base which makes it difficult when coping with the impacts of hydro-meteorological hazards. Although farmers find it hard to access loans in general, the small-scale farmers in this research gave a different account. Thirty percent of the respondents stated that access to low interest or cheaper loans would be of slightly moderate help, 37% and 22% of the respondents stated that low interest loans would be of moderate and slightly major help respectively (see Table 9). However, seven percent of the respondents stated that low interest loans would be of major help while 4% indicated quite the opposite in that it would be of little or no help. As such, government agencies and the private sector should explore the option of making low interest loans available to farmers.

	Responses from the Respondents					
Recommendations	**Little or no help**	**Slightly moderate help**	**Moderate help**	**Slightly major help**	**Major help**	**Total**
Access to cheaper loans	4%	30%	37%	22%	7%	100%
Financial assistance	10%	14%	16%	41%	19%	100%
Provision of farm supplies	13%	21%	32%	23%	11%	100%
Market access	1%	0%	2%	41%	56%	100%
Crop insurance	17%	24%	25%	15%	19%	100%
Hazard forecasting and communication	3%	17%	18%	36%	26%	100%

Table 9: Recommendations to increase the resilience of small-scale farmers.

During or after the significant impacts of hydro-meteorological hazards, the Ministry of agriculture usually issues financial aid to severely affected farmers. However, the financial aid that is distributed by government agencies is not normally uniformed. As such, the respondents indicated that no assistance was ever received after hazard impact. Nineteen percent of the respondents claimed that financial assistance during or after hazard impact would be of major help (see Table 9). Slightly major help and moderate help from financial assistance was indicated by 41% and 16% of the respondents respectively. In addition, fourteen percent of the respondents stated that financial assistance would be of slightly moderate help while 13% claim that financial assistance would be of little or no help.

The frequent impacts of hydro-meteorological hazards affects the resource base and recovery period of farmers in which farm supplies may be affected. Without the necessary farm supplies small-scale farmers are usually forced to reduce or cease crop production. Sixty six percent of the respondents indicated that the provision of farm supplies would be of moderate (32%), slightly major (23%) and major help (11%) as shown in Table 9. However, twenty one percent of the respondents stated that farm supplies would be of slightly moderate while 13% stated that the provision of farm supplies would be of little or no help. The provision of farms supplies in the aftermath of a hazard can reduce the recovery period of small-scale farmers.

A major hindrance in crop production has always been related to market access. Farmers normally produce crops but when reaped cannot be readily sold as there is no available market. Fifty six percent of the respondents reported that market access would be of major help and 41% indicated that market access would be of slightly major help (see Table 9). Only 2% and 1% of the respondents claimed that market access would be of moderate and little or no help respectively. Policy makers should ensure there is available market to absorb the amount of crops produce. In addition, the available market should also be regulated in order to prevent gluts and shortages to occur.

Another important recommendation that would help farmers with various aspects of crop production is crop insurance. Crop insurance would ensure a reduction in the recovery period of small-scale farmers as funds would be disbursed to re-cultivate farm plot(s). Nineteen percent of the respondents stated that crop insurance would be of major help, 15% stated it was slightly major and 25% indicated that it would be of moderate help (see Table 9). In addition, twenty four percent stated that crop insurance would be of moderate help while 17% claimed that it would be of little or no help. Although much effort has been given towards the provision of crop insurance, the frequency and level of impacts related to hydro-meteorological hazards are making it hard for insurance agencies.

Hazard forecasting and communication was a recommendation that was highly favoured among the group of small-scale farmers. Twenty six percent, thirty six percent, eighteen percent and seventeen percent of respondents indicated that hazard forecasting and communication would be of major, slightly major, moderate and slightly moderate help respectively (see Table 9). Only three percent of the respondents stated that hazard forecasting and communication would be of little or no help. Effective forecasting and communication of hazards can reduce related impacts on small-scale by providing information that would influence small-scale farmers to implement the necessary mitigation measures and coping mechanisms.

7.2 Conclusion

Hydro-meteorological hazards continue to be a significant factor which affects crop production among small-scale farmers. A marked increase in frequency of occurrence and impacts of these hazards over the last decade or two have influence a number of direct and indirect impacts. However, the industry continues to be vibrant but not with the same vigour and vitality as crop production has been fluctuating over the past 10 years. Crop production among small-scale farmers is not usually seen as viable source of economic well-being. However, all hope in the industry is not lost but the level of interest that farmers once had is non-existent among the majority.

The small-scale farmers that are involved within crop production are as vital as the large scale farmers. This is influenced by the number of small-scale farmers who constitute a significant percentage of the farming population in Jamaica. Their contribution to the industry towards crop production has been declining but they still remain significant nonetheless. Small-scale farmers have been trying their best to cope with the impacts of hydro-meteorological hazards but their efforts are proving to be futile. Low income and the unavailability of low interest or 'cheap' loans are two fundamental factors that are currently restricting the respondents from achieving their true potential in crop production. However, the resilience and determination of this group should be reckoned with as most of these farmers are currently operating within the agricultural industry due to their continued involvement in crop production.

Crop production in Crofts Hill continues to be dominated by males who cultivate crops on fragmented plots, in most cases on slopes which vary from flat to very steep. This is attributed to the topography of the study area. A significant percentage of the farm plots are owned by the small-scale farmers which helps in the decision making process since the thought of eviction would not be of concern. It is important to note that most farmers (71%) in the community are over the age of 55 years of age which is higher than that of the national average. The main crops produced are sugar cane, tomato, cabbage and sorrel. Majority of the crops produced are sold to higglers, local market and the Worthy Park sugar factory.

Crop production failure usual affects different aspects of each household, however, economic generation stood out as the most affected area. In addition, impacts from hydro-meteorological hazards also influence a change in the routine operations of various households. However, a number of small-scale farmers employed different strategies in coping with impacts of hurricanes, tropical storms and droughts but received very limited help from family members/friends and/or the government. Resource for re-cultivation was not always readily accessible in all cases in which most farmers had problems while coping with the impacts of production failure. Base on the degree of the impact, farmers took different recovery periods to respond which was evident base on the amount of time they took to re-cultivate their farm plots.

Another area of concern relates to the recovery period of small-scale farmers after a hazard event has occurred. It is evident that small-scale farmers within the study area took a longer recovery period for hurricane and tropical storms rather than from the impacts of drought events. Hurricanes and tropical storms also occur quite frequently along with drought events which imply that farmers could be affected by another hazard event before the recovery period ends. This would increase the recovery period it would take for full re-cultivation to be achieved due to the impact of successive events. In addition, base on the level of impact sustained from these hazard events coupled with the issue of viability, a number of small-scale farmers were reported to have moved from crop production to other forms of agriculture and/or other jobs.

The recovery period of farmers was mainly influenced by the level of impact associated with each hazard event and their ability to cope with such events. A number of farmers iterated that droughts are worst now than they were in the past and claimed that present day conditions are more prolonged. In addition, the farmers also explained that they would receive scattered showers in the past but now they don't receive as much. However, the increase in the frequency occurrence of droughts did not change the behavioural action of some farmers as they did not do anything differently to cope with the drought.

In a few cases water was either stored, retrieved from further distances and/or utilized more in order to combat the adverse effect of the dry season so as to reduce crop loss or damage. In addition, some of the methods identified were also of importance during the drought by farmers who able to implement those practices. December, January, February, March and April were all identified as being low rainfall months and which may inflict damage to crop. May, June, September and October on the other hand, were identified as months with high levels of rainfall. However, other months were said to be good planting months (before or after high rainfall months) in order to make use of the moisture that would present in the soil or forecasted. The change in rainfall pattern was identified by farmers as factor affecting crop production as they complain that it affected plant growth especially during the dry seasons. In addition, farmers lamented during one of the focus group discussions that the dry seasons are becoming more predominant because of the increase in continuous dry spells.

Small-scale farmers are faced with several issues where the economic issues far outweigh the social issues, but both affect the economic earnings of small farmers. The social issues surrounding the small-scale farmers include their age, period of involvement, gender, level education attainment, level of interest, the use of indigenous technical knowledge and willingness to access changes in the form of coping mechanisms. On the other hand, the economic factors include high production cost, low prices paid for sugar cane, land tenure systems, land fragmentation, inability to access to loans and poor agricultural practices which also affect farmers economically. All the factors mentioned above have to potential to cause very devastating impacts on the economic well-being, viability and future involvement of small-scale farmers in crop production. Despite endless efforts that have been made by family and friends, the government of Jamaica is needed for assistance to aid particular situations where small-scale famers are usually affected. The alternative for most small-scale farmers is to either leave crop production, practice livestock rearing or to do nothing at all.

The annual income of most farmers have decline since 2005 due mainly to the decreased in crop production and natural hazards. Hurricane Ivan (2004), Charley (2005), Emily (2005) and Dean (2007) along with tropical storm Gustav (2007) and Nicole (2010) have been severe weather systems that have impacted crop production in Crofts Hill. In addition, the meteorological droughts of 1995-1997 and 2009-2010 had the most profound impacts towards small-scale farmers' crop production. The percentage of crop damage experienced by small-scale farmers is usually higher for hurricanes and tropical storms over drought events. In addition, the frequent occurrence and impacts related to hydro-meteorological hazards have been increasing and has serious implications for crop loss during the hurricane season and the bi-modal dry spells which can influence drought conditions.

However, small-scale farmers need to adapt to the economic constraints being experienced as a result of hydro-meteorological hazards. As such, the development and utilization of coping mechanism to combat these problems should be given utmost consideration. Although coping mechanisms such as mulching and the storage of more water during drought is practiced, majority of the farmers often do not employ any strategy to reduce and deal with the impacts of hydro-meteorological hazards. This is an area of concern as the resilience of farmers to such hazards needs to be increased. This is only way in which the level of impact relating to each hazard event will be kept to a minimum. It is also important to note that this would also increase the economic viability of crop production among small-scale farmers.

The future of the crop production will always be affected by hydro-meteorological hazards. However, policy makers and government agencies such as the Ministry of Agriculture (MOA) need to pay more to the most affected farmers within the industry and to make the necessary adjustments to ensure that a safe and secure future for individuals who are still involved or considering to be involved in the crop production can be attained. Large scale farmers normally find the economic viability of crop production but the same cannot be said about the small-scale farmers as they are the most vulnerable group. In order to protect crop production for both local and foreign market along with thousands of jobs, policy makers would have to take a holistic approach to mitigate hazard impacts while increasing the resilience of the farmer. However, the good thing is that it can be done once the necessary adjustments are made. In addition, more research is required to give a more detail account of relief funds and the intended population in order to influence shorter re-cultivation periods. Also, the related impacts from multiple or successive hazard events on small-scale farmers' crop production should also be assessed.

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Appendix 1: Major Hurricanes Impacting Jamaica, 1851-2007

Date	Sustained Winds (mph)	Category	CPOA (miles)	Name
Oct 6, 1852	104	H2	50	Unnamed
Sept 9, 1865	104	H2	48	Unnamed
Oct 5, 1870	58	Ts	69	Unnamed
Nov 2, 1874	104	H2	22	Unnamed
Oct 12, 1879	58	Ts	28	Unnamed
Aug 7, 1880	92	H1	54	Unnamed
Aug 19, 1880	92	H1	1	Unnamed
Aug 8, 1884	69	Ts	50	Unnamed
Aug 20, 1886	109	H2	2	Unnamed
Aug 25, 1895	92	H1	39	Unnamed
Sept 26, 1896	81	81	26	Unnamed
Oct 31, 1898	58	Ts	36	Unnamed
Nov 8, 1899	63	Ts	18	Unnamed
Jul 5, 1901	69	Ts	56	Unnamed
Aug 11, 1903	121	H3	12	Unnamed
Nov 12, 1909	69	Ts	63	Unnamed
Sept 8, 1910	81	H1	30	Unnamed
Nov 19,1912	92	H1	48	Unnamed
Aug 13, 1915	109	H2	31	Unnamed
Aug 16, 1916	86	H1	26	Unnamed
Sept 23, 1917	104	H2	25	Unnamed
Sept 12, 1918	40	Ts	50	Unnamed
Nov 8, 1924	46	Ts	32	Unnamed
Sept 2,1928	40	Ts	21	Unnamed
Sept 12, 1931	63	Ts	12	Unnamed
Sept 29, 1932	46	Ts	2	Unnamed
Jul 16, 1933	52	Ts	35	Unnamed
Oct 29, 1933	86	H1	69	Unnamed

Oct 20, 1934	46	Ts	8	Unnamed
Sept 18, 1942	52	Ts	39	Unnamed
Aug 20, 1944	121	H3	7	Unnamed
Oct 12, 1949	40	Ts	63	Unnamed
Aug 18, 1951	86	H1	5	Charlie
Aug 31, 1974	75	H1	58	Carmen
Sept 16, 1974	40	Ts	64	Fifi
Aug 6, 1980	132	H4	47	Allen
Sept 12, 1988	127	H3	4	Gilbert
Nov 13, 1994	46	Ts	5	Gordon
Oct 7, 2001	86	H1	46	Iris
Sept 29, 2002	58	Ts	58	Lili
Sept 11, 2004	155	H5	41	Ivan
July 7, 2005	115	H3	59	Dennis
Aug 19, 2007	144	H4	44	Dean

Source: Spence 2009 - Compiled from IADB/ECLAC 2007

Appendix 2: Hydro-meteorological Hazards Frequency and Impacts on Jamaica's Agricultural Sector (1979-2011)

Date	Impact/Comments
June 1979	New Market Flood – extensive damage to agriculture throughout western Jamaica
August 1980	Flooding associated with passage of Hurricane Allen- agricultural sector hardest hit $110 million dollars in damage to the sector
June 1986	Flood Rains – Devastation of agriculture in central Jamaica
April 1987	Flood rains cost $167 million in damage to food crops
November , 1987	$73 million direct damage to agriculture
September 1988	Massive damage to agriculture island-wide by Hurricane Gilbert
June 1991	June floods damage crops and livestock island-wide
January 1993	Millions of dollars in damage to agriculture, especially in St Thomas
May 1993	$millions damage to agriculture island-wide
November 1994	Infrastructural and agricultural damages across Jamaica from tropical storm Gordon, Clarendon mostly affected (US$11.8 million)
December 1995	Flood damage island-wide
October 1996	Extensive damage to agriculture in eastern Jamaica from flood rains
November 1996-April 1998	Extensive meteorological drought across a number of parishes (JA$331.6 million)
June 1997	Island-wide flood damage to agriculture
December 1998	Millions of agricultural damage
December 1999-August 2000	Prolong drought conditions affecting agriculture in several parishes.
May 2001	Extensive damage to crops in St Mary and St Ann
October 2001	Flooding and wind damages from Hurricane Iris
November 2001	Flood effects of Hurricane Michelle devastate agriculture in Portland

May/June 2002	Millions of damage to agriculture in Clarendon, Manchester and St Thomas (US$15 million) from prolong rainfall.
September 2002	Millions of agricultural damage from Hurricane Lili
January-March 2004	Extensive drought across a number of parishes (US$1 million)
August 2004	Extensive damage to crops across Jamaica from Hurricane Charley (US$1.3 million)
September 2004	Extensive damage to the agricultural sector by Hurricane Ivan (US$121.4 million)
January-April 2005	Prolong drought conditions
July 2005	Damaged suffered from Hurricane Dennis (US$31.7 million)
July 2005	Severe damages to all sectors caused by tropical storm/ Hurricane Emily
October 2005	Extensive damage mostly to southern parishes (US$1 million)
August 2007	Island-wide damage to agriculture from Hurricane Dean (US$128.6 million)
October 2007	North-eastern section of Jamaica affected by tropical storm Noel
December 2007-March 2008	Extensive drought across a number of parishes
August 2008	Island-wide damage to all sectors from tropical storm/ Hurricane Gustav (US$22.5 million)
November 2009-April 2010	Extensive drought across Jamaica which affected the agricultural sector
September-October 2010	Flood rains from tropical storm Nicole affect all parishes (JA$763 million to agriculture)
May/June 2011	Extensive flooding across Jamaica (JA135.7 million)

Modified from Spence 2009; Campbell et al. 2010; PIOJ 2005: 2010: 2011.

Appendix 3: Losses/Damages due to Hurricanes/Tropical Storms/Drought/Fire

HURRICANE Update 24-4-2011	FARMERS AFFECTED	CROPS (HA)	CROPS (VALUE $)	LIVESTOCK VALUE $	GREENHOUSE	TOTAL ESTIMATED (VALUE $)
Charley August 2004	986	792	88,644,500	1,828,000		90,472,500
IVAN September 2004	117,698	11,130	2,433,638,540	677,749,950		3,111,388,500
Dennis July 2005	6,700	610	126,700,000	29,598,000		156,798,000
Wilma October 2005	19,973	1,572	197,108,000	40,326,000		237,434,000
Emily August 2007	1,499	656	39,205,000	420,000		39,625,000
Dean August 2007	63,707	5,473	904,373,000	52,470,000		1,031,343,000
TOTAL	**210,563**	**20,233**	**3,789,669,040**	**802,391,950**		**4,667,061,000**
Tropical Storm						
Gustav August 2008	24,255	2,777	520,000,000	26,700,000	19,700,000	565,600,000
Nicole September 2010	18,601	3,741	531,632,000	32,415,000	12,451,000	1,151,056,000
TOTAL	**42,856**	**6,518**	**1,051,632,000**	**59,115,000**	**32,151,000**	**1,716,656,000**
FLOOD RAIN					**Others**	
1994		2,250	101,459,500			
1998		210	23,030,175			23,030,175
2000		327	46,363,000	2,604,000		48,967,000
2001	13,350	1,911	375,637,708	28,421,400		404,059,108
November . 2006	811	50	20,282,500	2,770,000	15,300,000	38,352,500
TOTAL	**14,161**	**4,748**	**566,772,883**	**33,795,400**	**15,300,000**	**514,408,783**
BUSH FIRE						
March 1996	60	63	2,500,000			2,500,000
April 2000		46	11,300,000			11,300,000
July 2001	38	41	3,800,000			3,800,000
February2005	100	74	17,450,000	441,000		17,891,000
TOTAL	**198**	**224**	**35,050,000**	**441,000**		**35,491,000**
DRUOGHT						
1999 / 2000	8,278	2,779	248,365,600			248,365,600
1995		1,817	149,027,085			
1997		5,907	254,266,420			
March 2005	14,269	2,058	296,048,100			296,048,100
4-Mar-08	70	79	34,119,000	640,000		34,759,000
Sub Total	**22,617**	**12,640**	**981,826,205**	**640,000**		**579,172,700**
Grand Total	**290,395**	**44,363**	**6,424,950,128**	**896,383,350**	**47,451,000**	**7,512,789,483**

Source: Rada 2011

Appendix 4: Production of Sugar in Jamaica (2000-2009)

Factory	Capacity (Tonnes)	Production (Tonnes 96^0)									
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Frome	90,000	59,108	64,078	56,534	53,117	56,978	42,515	46,524	53,729	49,828	37,847
Monymusk	65,000	42,247	32,559	22,666	19,028	27,091	9,322	18,400	16,957	15,421	19,342
Bernard Lodge	50,000	29,325	28,193	19,673	16,798	21,869	14,053	15,124	16,114	15,017	-
Appleton	50,000	23,291	30,706	26,707	20,882	29,267	21,404	26,196	31,332	22,310	31,625
Long Pond	30,000	15,600	8,967	9,873	10,475	10,410	4,654	8,761	9,884	6,399	3,833
St. Thomas Sugar	25,000	13,389	10,615	10,968	9,685	13,492	10,426	10,928	14,151	12,886	11,486
Worthy Park	26,000	25,188	22,339	23,066	22,552	24,566	21,833	20,949	22,220	19,011	21,685
Total	**336,000**	**216,387**	**204,478**	**174,640**	**152,536**	**183,672**	**124,206**	**146,882**	**164,387**	**140,872**	**125,818**

Source: Burrell 2010.

Appendix 5: All-Island Estimates of Crop Production 2001-2010

CROPS	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LEGUMES										
BROAD BEANS	139	118	128	116	130	156	133	125	171	178
SUGAR BEANS	124	100	100	95	127	145	115	111	125	116
COW PEA	275	223	264	213	202	229	245	222	206	199
GUNGO PEA	1348	1186	954	978	584	934	868	668	847	749
RED PEA	1038	836	956	727	686	622	554	506	768	682
PEANUT	4436	3015	3121	2572	3175	3413	3728	2825	2704	2007
SUB-TOTAL	**7360**	**5478**	**5523**	**4701**	**4904**	**5499**	**5644**	**4458**	**4820**	**3930**
VEGETABLES										
BEETROOT	780	745	849	379	1014	1038	1025	1392	1650	1661
BROCCOLI	na	na	na	na	na	na	550	475	688	647
CABBAGE	22475	19297	25859	22366	20222	25676	22110	20648	25896	24515
CALALOO	12964	11342	13668	11535	11845	13708	12192	11184	12938	12886
CARROT	20200	18946	23475	17476	20533	22887	19365	18925	25437	21026
CAULIFLOWER	1698	1587	1533	1209	1141	1545	1490	1204	1279	787
CELERY	79	59	105	84	97	101	48	95	193	160
CHO-CHO	2601	2317	2652	2219	2605	3032	2534	2596	3162	3876
CUCUMBER	15796	13516	16134	13713	13712	12967	11252	11217	11428	11681
EGG PLANT	239	221	202	204	376	317	423	311	404	817
ICEBURG LETTUCE	3587	2845	4040	4363	4325	5723	5682	5364	6125	6234
OTHER LETTUCE	709	729	747	528	452	682	618	647	1200	969
OKRA	2729	2455	3059	2599	3021	3652	3379	3432	4377	4202
PAK CHOI	5884	5671	7022	6246	6958	8337	7099	6803	9101	9197
PUMPKIN	36313	30947	39102	29694	31311	36484	33749	32927	39785	39292
SQUASH	na	na	na	na	na	na	886.4	1192	1016	1538
STRING BEAN	5435	4977	7087	6041	6058	6205	5596	5446	6322	5621
TOMATO	24129	19395	25025	18654	20434	23090	19576	19387	21190	19006
TURNIP	1034	951	1268	1158	1614	1608	1419	1311	1340	1297
OTHER VEGETABLES	na	na	na	na	na	na	180	41	59	44
SUB-TOTAL	**156652**	**136000**	**171827**	**138468**	**145718**	**167050**	**149173**	**144595**	**173589**	**165457**
CONDIMENTS										
ESCALLION	17507	8225	8648	8698	10874	11037	10840	10190	10181	11194
GINGER	250	295	402	361	702	259	241	298	459	486
ONION	788	1050	602	402	311	234	215	455	721	555
HOT PEPPER	4926	4444	5595	4610	5722	7440	6596	5338	10565	11206
SWEET PEPPER	8418	6646	9226	7416	7139	9240	8556	7869	10804	10017
THYME	1641	1347	1700	1194	2334	1878	2423	2131	1584	1249
SUB-TOTAL	**33530**	**22007**	**26173**	**22681**	**27082**	**30089**	**28871**	**26281**	**34313**	**34706**
FRUITS										
CANTELOPE	na	na	na	na	na	na	2743	2520	2337	2333
PAW-PAW	8637	9333	9646	7618	8844	11300	9201	7156	10671	5314
PINEAPPLE	20447	20571	22799	19267	14551	20533	18102	20351	21368	19749
WATERMELON	14857	8068	14134	8350	11266	14056	9573	12230	12393	10606
SUB-TOTAL	**43941**	**37972**	**46579**	**35235**	**34661**	**45889**	**39619**	**42257**	**46768**	**38002**
CEREALS										
HYBRID CORN	360	350	522	432	610	630	587	784	1236	1344
ORDINARY CORN	1682	1393	1501	1156	1314	1259	1080	1107	1114	1017
SWEET CORN	8	2	6	3	2	5	7	6	9	2.16
RICE	33	10	14	10	3	2	0	na		264
SUB-TOTAL	**2083**	**1755**	**2043**	**1601**	**1929**	**1895**	**1673**	**1897**	**2359**	**2626**

PLANTAINS										
HORSE PLANTAIN	16508	15962	15370	14010	6920	17219	14900	11345	18792	23519
OTHER PLANTAIN	5041	4922	4819	3750	2033	4768	4187	3690	5829	6307
SUB-TOTAL	**21549**	**20884**	**20189**	**17760**	**8953**	**21986**	**19087**	**15035**	**24621**	**29826**
POTATOES										
IRISH POTATO	6711	5394	6710	6504	7729	8559	7477	4929	8708	11222
SWEET POTATO	24870	20012	23595	18639	25237	27468	26055	25797	34229	34512
SUB-TOTAL	**31581**	**25406**	**30305**	**25143**	**32966**	**36027**	**33531**	**30725**	**42937**	**45734**
YAMS										
LUCEA	16479	16157	15021	12896	10241	9831	10306	10542	9609	10744
NEGRO	15385	14163	14947	12152	11633	12654	11217	11075	15289	15163
RENTA	11825	10909	11200	11380	6444	7956	8006	6662	8253	9444
ST. VINCENT	5766	4428	4489	3524	2243	2717	2323	2026	2443	2902
SWEET	15130	13487	13535	11760	6313	6275	5186	3765	4411	3907
TAU	4041	3614	3672	3478	2696	2913	2588	2150	2245	2442
YELLOW	86542	83153	86831	78887	66243	78571	71863	64374	80531	89944
OTHER	2389	2241	2543	2090	1482	2088	1636	1689	1735	2240
SUB-TOTAL	**157557**	**148152**	**152238**	**136167**	**107295**	**123005**	**113124**	**102284**	**124516**	**136785**
OTHER TUBERS										
BITTER CASSAVA	6960	6681	8551	8452	5929	7710	8299	6741	5764	6426
SWEET CASSAVA	7767	6953	8697	8306	7295	10001	10220	8250	8231	12064
COCO	7548	6712	6885	5929	5695	6921	6485	5464	6635	7494
DASHEEN	12927	12787	11469	9750	8656	10993	10830	11416	14305	16196
SUB-TOTAL	35202	33133	35602	32436	27575	35625	35834	31871	34936	42181
SORREL	841	792	994	598	624	738	749	708	811	1057
GRAND TOTAL	**490296**	**431579**	**491473**	**414790**	**391707**	**467802**	**427305**	**400110**	**489672**	**500304**

Source: RADA 2011.

Q. # ___ **LOCATION ID #: ____________**

Appendix 6: Agricultural Questionnaire for Small-scale Farmers

(All the information gathered will be treated with confidentiality)

Section 1: Demographic and household characteristics

1. Sex: i.) □ Male ii.) □ Female
2. How old are you? ____________
3. How long have you been a small-scale farmer in this community? ________ years.
4. Are you the head of your household? i.) □ Yes ii.) □ No
5. What is the size of your household? ___________ persons
6. Do you consider yourself to be a
   i.) □ Full-time farmer
   ii.) □ Part-time farmer

b) If **part-time**, why is this so?
   i.) □ Insufficient income from farm
   ii.) □ Farm size too small
   iii.) □ Off-farm work pays more
   iv.) □ Other (specify) _______________________________

c) Please state the type of part-time employment
   ____

7. What is your highest level of education?
   i.) □ Primary/All Age ii.) □ Secondary/High School iii.) □ Tertiary

Section 2: Farm characteristics

8. Complete the table below with the relevant information.

8a	8b	8c	8d	8e	8f	8g
Number of plots	**Size of plot**	**Land tenure of plot**	**Topography of plot**	**Distance from (*miles*)**		**Crop(s) grown**
				House	**Main Road**	
Plot 1						
Plot 2						
Plot 3						
Plot 4						
Plot 5						

* *Land maybe Leased, Rented, Owned, Family land or Squatted Land.*

9. Are you engaged in livestock rearing for commercial purposes?
   i.) ☐ Yes
   ii.) ☐ No

Section 3: Crop production

10. Which year was your best year in farming?
    ____

11. What would you say accounted for this?
    ____
    ____
    ____
    ____

12. Which year was your worst year in farming?
    ____

13. What would you say accounted for this?
    ____
    ____
    ____
    ____

14. How many times have you experienced major production failure in the last 10 years?
    ____

15. Which year was your last experience of a major production failure? ________________

16. What was the cause for the production failure?
    ____
    ____
    ____
    ____

17. What is your annual income from crop production now? $_________________

18. What was your annual income from crop production five years ago? $_________________

19. What accounted for the change in your annual income over past five (5) years?
    ____
    ____
    ____

20. What are the most profitable crops you cultivate?
    (1)_____________________________________
    (2)_____________________________________
    (3)_____________________________________

21. In the last 10 years, how has the output of the main cash crops you produce changed?
    i.) ☐ Increased
    ii.) ☐ Decreased
    iii.) ☐ Unchanged

22. What would you say is responsible for this change in your crop production?
    ____
    ____
    ____
    ____

23. Describe your method of irrigation
    ____
    ____
    ____
    ____

24. Which month, do you normally prefer to plant crops? _____________________________________

25. Why?
    ____
    ____
    ____
    ____

26. Do farmers help out each other on their farms?
    i.) ☐ Yes
    ii.) ☐ No

    b) If **yes**, please describe the arrangement/s
    ____
    ____
    ____
    ____

NB. (Labour arrangement can be hired labour, day-for-day labour, family labour or hire & day-for-day labour.)

27. Who/where do you market your produce?
    i.) ☐ Local Market
    ii.) ☐ Restaurant
    iii.) ☐ Shop
    iv.) ☐ Hotel
    v.) ☐ Higgler
    vi.) ☐ Residents of the community
    vii.) ☐ Other _______________________

Section 4: Hurricanes/storms and agriculture

28. In the past, which hurricane or storm would you say has affected you worst?

____
____

b) Approximately, what proportion of your crops did you lose?
   i.) ☐ < 50%
   ii.) ☐ 50%
   iii.) ☐ > 50%
   iv.) ☐ 100%

29. How did this affect your crop production?
____
____
____

30. How did this affect routine operation at the household level?
____
____
____

31. How did you manage to cope with the hurricanes?
____
____
____

32. Did you receive any help from family members of friends to cope with your losses?
   i.) ☐ Yes
   ii.) ☐ No

33. If question 32 is **yes**, how did they help?
____
____
____

34. Did you receive any assistance from the government to cope with your losses?
   i.) ☐ Yes, please state____________________
   ii.) ☐ No

35. How long does it take you to restart production after the hurricane/storm?
   i.) ☐ < 6 months
   ii.) ☐ 6-12 months
   iii.) ☐ > 12 months

36. Do you believe there is (have you experienced) an increase in the frequency of hurricanes/storms?
   i.) ☐ Yes
   ii.) ☐ No

37. If **yes**, does the frequent occurrence of hurricane/tropical storms affect your crop production?
   i.) ☐ Yes
   ii.) ☐ No

38. How regularly is your crop production affected by hurricanes/tropical storms?
   i.) ☐ Always
   ii.) ☐ Very Often
   iii.) ☐ Sometimes
   iv.) ☐ Rarely
   v.) ☐ Never

Section 5: Drought and agriculture

39. Which year did you experience your worst drought?
____

b) Approximately, what proportion of your crops did you lose?
   i.) ☐ < 50%
   ii.) ☐ 50%
   iii.) ☐ > 50%
   iv.) ☐ 100%

40. How did this affect your crop production?
____
____
____

41. How did this affect routine operation at the household level?
____
____
____

42. How did you manage to cope with the drought?
____
____
____
____

43. Did you receive any help from family members of friends to cope with your losses?
   i.) ☐ Yes
   ii.)☐ No

44. If question 43 is **yes**, how did they help?
____
____
____

45. Did you receive any assistance from the government to cope with your losses?
   i.) ☐ Yes, please state____________________
   ii.) ☐ No

Q. # ___ **LOCATION ID #: ___________**

46. How long did it take you to restart production after the drought event?
    i.) ☐ < 6 months
    ii.) ☐ 6-12 months
    iii.) ☐ > 12 months

47. What are some of the things you do during a drought to reduce its impact?
    ____
    ____
    ____
    ____
    ____

48. Do you believe there is (have you experienced) an increase in the frequency of droughts?
    i.) ☐ Yes
    ii.) ☐ No

49. If **yes**, does the frequent occurrence of droughts affect your crop production?
    i.) ☐ Yes
    ii.) ☐ No

50. How regularly is your crop production affected by droughts?
    i.) ☐ Always
    ii.) ☐ Very Often
    iii.) ☐ Sometimes
    iv.) ☐ Rarely
    v.) ☐ Never

Section 6: Recommendation to increase crop production

On a scale of 1 to 5, rate the extent to which the following types of government assistance can increase your crop production before and/or after a major hazard event:

*(With 1 being the lowest and 5 being the highest, **circle your choice**).*

i.	Access to cheaper loans………………..	1	2	3	4	5
ii.	Financial assistance……………………..	1	2	3	4	5
iii.	Provision of farm supplies……………….	1	2	3	4	5
iv.	Market access…………………………….	1	2	3	4	5
v.	Crop insurance…………………………….	1	2	3	4	5
vi.	Ploughing of farm plot after a hazard………	1	2	3	4	5
vii.	Hazard forecasting and communication…….	1	2	3	4	5

52. Rank the top three (3) factors and explain how they would help to increase your crop production before and/or after a hazard event?
    (1)_____________________________________
    ____
    ____
    ____
    (2)_____________________________________
    ____
    ____
    ____
    (3)_____________________________________
    ____
    ____
    ____

53. Do you think you can increase your current level of crop production?
    i.) ☐ Yes
    ii.) ☐ No

54. If **yes**, explain how you would go about achieving this goal/task?
    ____
    ____
    ____
    ____

55. Do you see a future for you in crop production?
    i.) ☐ Yes
    ii.) ☐ No

56. Explain your answer given for question 54?
    ____
    ____
    ____
    ____

57. Do you know of anyone within this district that has gone completely out of crop production because of hydro-meteorological hazards (storms, droughts, etc.?
    i.) ☐ Yes
    ii.) ☐ No
    iii.) ☐ Not sure

Additional Notes

____
____
____
____
____
____
____
____