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**A SOCIOECONOMIC ASSESSMENT AND RISK PERCEPTION OF STAKEHOLDERS ON THE IMPACT OF THE CITRUS GREENING DISEASE / HUANGLONGBING (HLB) IN BELIZE**

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**ABSTRACT:** Citrus Greening Disease is a deadly bacterial disease that affects all citrus varieties. It is rated by most national and international research institutions as the most destructive disease in citrus and to date has led to drastic reductions in production in Asia and Africa and now threatens citrus industries in the western hemisphere. Citrus Greening has been known internationally from its first description in China, as Huanglongbing (HLB), translated as “yellow shoot disease”. The disease was confirmed in the Americas in Brazil in 2004. Since then, its presence has been verified in several other major citrus producing countries including: Florida / United States (2005), Cuba (2007), Mexico, Jamaica and Belize (2009). The economic cost implications of HLB have been estimated to far exceed other citrus diseases that have affected the industry in previous years. This study focused on two aspects of the Belize citrus industry: (i) the socioeconomic impact of the disease and (ii) the producers’ response to the disease. The convenient sampling technique was used to enumerate stakeholders across the value chain to ascertain their experiences with the impact of the disease on the industry up to December 2011. The risk attitude and risk perception of primary (fruit) producers in the industry was evaluated by using a psychometric test. The results of the study found that the demise of the citrus industry would have negative socioeconomic impact on Belize specifically, citrus producers, agriculture workers, rural citrus producing communities and stakeholders within the citrus industry value chain. Analysis of the logistic regression focused on the significance of three variables: risk attitude (ra), risk perception (rp), and a combination of the two (risk attitude and risk perception) (rarp) on the behavioural outcome of farmers (whether to remain or exit the citrus industry). The results indicated that the variable (rp) (farmers risk perception) has a p-value of 0.030. Farmers risk perception was the only variable with a p-value below the chosen level of significance (0.05). Hence, only risk perception influenced the behavioural outcome.

Despite this threat, an estimated 76% of the farmers were willing to remain in the citrus industry and deal with the challenges presented by HLB. The results also show that 49% of the farmers enumerated were risk-seeking and 66% had employed some form of management for the disease. Overall, HLB was perceived by primary stakeholders as the disease which poses the greatest risk to the citrus industry of Belize.

Keywords: Citrus Greening Disease, Huanglongbing (HLB), Belize Citrus Industry, Risk, Socioeconomic Impact

**BACKGROUND TO STUDY**

Citrus Greening Disease is a deadly bacterial disease that affects all citrus varieties. It is rated by most national and international research institutions as the most destructive disease in citrus and to date has led to drastic reductions in production across Asia and Africa, and has now been impacting the citrus industries in the western hemisphere. Citrus Greening has been known internationally from its first description in China as Huanglongbing (HLB), translated as “yellow

shoot disease”. The disease was confirmed in the Americas in Brazil in 2004. Since then, its presence has been verified in several other major citrus producing countries, including Florida / United States (2005), Cuba (2007) and Mexico (2009).

Within the CARICOM group of countries, HLB was confirmed in Belize and Jamaica in 2009. Belize is the largest producer of citrus in CARICOM, and Jamaica ranks second. The economic cost implications of HLB have been estimated to far exceed those of other citrus diseases that have plagued the industry in the past. In this regard, this study focused on two aspects of the industry in Belize: (i) the socioeconomic impact of the disease, and (ii) the producers’ response to the disease. The study employed the convenient sample technique, enumerating stakeholders across the value chain to get their experiences on the impact of the disease up to December 2011. The risk perception of primary (fruit) producers in the industry was done by using a psychometric test.

Citrus is the second largest agricultural industry in Belize, after sugarcane, with an area of approximately 27,977 hectares under cultivation. Belize is ranked 29<sup>th</sup> and 19<sup>th</sup> in the world in orange and grapefruit production, respectively, and produced 237,200 tonnes of oranges and 36,000 tonnes of grapefruits in 2010. Exports of citrus and citrus products comprise 13 percent of agricultural GDP and 30 percent of manufacturing GDP. The leading value added export - Frozen Concentrate Orange Juice (FCOJ) totalled 29,369 tonnes (US\$ 46,465,000) in 2008 and 20,428 tonnes (US \$15,945,000) in 2009. Growth in citrus exports over the last ten years averaged 24% per annum, making it the fastest growing agricultural industry in Belize (FAOSTAT, 2012).

## STUDY OBJECTIVE

This study specifically sought to:

1. Assess the risk attitude and risk perception of farmers regarding HLB and the significance of risk attitude and risk perception in influencing farmers’ decisions to remain or exit the Belize citrus industry, and
2. Determine the socioeconomic impact of the HLB disease on the Belizean citrus industry.

## INTRODUCTION

**Citrus Greening Disease / Huanglongbing (HLB):** Citrus Greening is a deadly bacterial disease that affects all citrus varieties. It has been known internationally, from its first description in China, as Huanglongbing (HLB, translated as “yellow shoot disease”). It was presumed to originate in China during the 1890s (A. Batool et al., 2007). According to Lin (1956), the first epiphytotic conditions of HLB were noticed in Chaoshan and Yuenchung districts of Fukien province in 1925. The disease was later reported in South Africa in 1929 as “yellow branch disease”, and later called “greening”, which refers to Stylar end greening on fruits infected with HLB. Lafleche and Bove established that a bacterium-like organism was associated with HLB in 1970.

The bacterium, ‘*Candidatus Liberibacter asiaticus*’ (Las) is vectored by an insect called the Asian citrus psyllid, *Diaphorina citri* Kuwayama. The Candidatus part of the bacterium's name indicates that it cannot be cultured. Two other related forms of the disease are known of African and South American origin, ‘*Candidatus L. africanus*’ (Laf) and ‘*Candidatus L. americanus*’ (Lam), respectively, all of which are also vectored by the Citrus Psyllid.

HLB reduces the quantity and quality of citrus fruits, eventually rendering infected trees unproductive. In areas of the world affected by HLB, the average productive lifespan of citrus trees has dropped from 50 or more years to 15 years or less. Citrus trees in established orchards usually decline within three to five years after becoming infected. In addition, experiments by national and international research institutions to date have found no cure for HLB (Centro de Citricultura Sylvio Moreira, 2007).

## **RISK AND PSYCHOMETRIC TESTING**

Risks are defined as the potential that a chosen action or activity (including the choice of inaction) will lead to an undesirable outcome. The notion implies that a choice of having an influence on the outcome exists (or existed). Psychometric testing is concerned with the theory and technique of psychological measurement, which includes the measurement of attitude and perceptions of individuals with regards to incidents of risk. During the literature review, researchers found no studies documenting farmers' risk attitudes or perceptions towards the risk posed by HLB in the citrus industry of Belize or any other CARICOM country.

## **METHODOLOGY**

### **MEASURING SOCIOECONOMIC IMPLICATIONS**

Measuring the socioeconomic implications of HLB on Belize places specific focus on those characteristics that seem to be highly significant or classified as vital roles which the industry performs in the national economy, i.e. contributions to foreign exchange earnings, GDP, employment, and the rural economies of the citrus-producing districts of Belize. In order to determine the socioeconomic impact of the HLB disease on the Belizean citrus industry, two strategies were employed. Guide questions were used to facilitate consultations with industry personnel throughout the value chain. Secondary data was obtained from the Belize Citrus Growers Association.

### **MEASURING THE CITRUS FARMERS' RESPONSE TO RISKS**

The study utilized a structured questionnaire to determine the influence of farmer risk attitude and risk perception on the behavioural outcome.

The questionnaire focused on two main dimensions:

- i. The first dimension addressed risk attitude, looking specifically at the content of the crisis and the impact of the risk (HLB). More specifically, it speaks to a farmer's interpretation of the risk content and how much he dislikes that risk content.
- ii. The second dimension addresses risk perception and reflects the likelihood that the content of the risk actually becomes manifest. Specifically, it deals with farmers' interpretation of the chances of his citrus farm becoming exposed to the content of the risk (HLB).

The dimensions: risk content and the likelihood of exposure are directly related to the two fundamental drivers of decision behavior under uncertainty. The behavioural outcome is driven by farmers risk attitudes, risk perceptions and the interaction between them. Convenient sampling was used to enumerate farmers in the major citrus producing areas of Belize within the following categories: large (> 200 acres), medium-sized (50 – 200 acres) and small (< 50 acres).

### **ANALYTIC MODEL USED IN THE ANALYSIS**

The Logistic Regression model was used for data analysis. This model was used because it allows for prediction of the outcome of a categorical variable (a variable that can take on a limited number of categories) based on one or more predictor variables. With logistic regression, the researcher is predicting a dichotomous outcome, i.e. splitting of a whole into exactly two non-overlapping parts ("yes" vs. "no").

The entire behavioural outcome space, which contains the possible behaviours of farmers was postulated to be driven by farmer risk attitudes, risk perceptions and also the interaction between them. Specifically, the analysis sought to determine whether the decision to remain or exit the citrus industry was influenced by their risk attitude, risk perception and the interaction between the two terms.

The equation took the form of:  $BS=B_i = RA_i + RP_i + RA_i * RP_i$  (1)

Where;

BS is the behavioural outcome space, reflecting the set of farmers' behaviours,

$B_i$  is the behavioural outcome of farmer i.

$RA_i$  is the risk attitude of farmer i.

$RP_i$  is the risk perception of farmer i.

The strengths of logistic regression are as follows:

1. It is robust; the independent variables do not have to be normally distributed or have equal variance in each group.
2. It does not assume a linear relationship between the independent variable and dependant variable; in reality, relationships among variables are not always linear.
3. Explicit interaction and power terms can be added; in reality, there is interaction between independent variables which may not be picked up in other models.



## DATA ANALYSIS

The primary data from questionnaires was collated, coded and analyzed by using the Statistical software package STATA version 12.0.

## RESULTS OF THE STUDY

### SOCIOECONOMIC IMPACT OF THE HLB DISEASE ON THE BELIZEAN CITRUS INDUSTRY

The study found that approximately 3,917 persons were employed by the Belize citrus industry, and overall, the industry contributed US\$ 59 million to the national economy in 2009/2010. At the local level, the citrus directly contributes to the socioeconomic development of the Stann Creek, Toledo, Cayo and Belize districts through employment, infrastructure and sustenance of the local economy. HLB represents a direct threat to the livelihood of farmers and farm families. The demise of the industry can result in the stagnation or reversal in social and economic gains advanced by the Belize citrus industry over many decades. The disease also leads to decimation of citrus trees impacting negatively on the rural landscape.

The contributions of the industry were as follows:

- (i) **Employment:** Approximately 491 farms made up the producer component of the industry. Farm operations employ 2,352 persons, 807 being permanent and 1,545 being temporary or seasonal labor used in cleaning and harvesting of the fruit. Citrus processing factories employ 1,074 persons, 218 in permanent, and 856 as temporary workers.
- (ii) **Capital:** US \$59 million contribution to the national economy with an estimated 10% of citrus earnings injected directly into the rural communities of Stann Creek, Toledo, Cayo and Belize districts.
- (iii) Maintenance of the economic integrity of 36,920 acres of Belize countryside in the Stann Creek, Toledo, Cayo and Belize districts.
- (iv) Employment of a large number of professionals includes, farm and industry managers, processors, engineers, and financial managers.
- (v) Sustaining industries involved in hardware, construction, large scale machinery and other support services.

The study also found that the stakeholders in Belize had differing views of the threat posed by HLB and actions that should be employed in its management and control. The intensity of management measures at the production level, and policy initiatives to protect the industry were largely dependent on stakeholder perception of the severity of the risk posed by the disease. Most importantly, the survival of the industry was largely dependent on farmers' decision to remain or exit the industry.

## RISK ANALYSIS

This section presents the results of risk attitude and risk perception of farmers on HLB and the significance of risk attitude and risk perception in influencing farmers' decision to remain or exit the Belize citrus industry. A total of 67 farmers were surveyed and the data obtained from these farmers were used in the analysis. The result of the logistic regression is presented in Table 1.

**Table 1: Results of Logistic Regression–Belizean Citrus Farmers' Attitude toward Risk**

Number of observations = 67

Wald  $\chi^2$  (3) = 16.64

Log likelihood = -34.533092

Prob >  $\chi^2$  = 0.0008

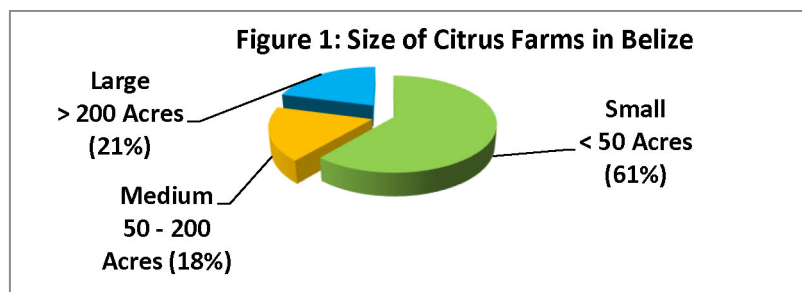
bo   (Behavioral Outcome)	Coef.	Std. Err	z	P> z	Comment
ra   (Risk Attitude)	-0.1434283	0.210536	-0.68	0.496	Not Significant
rp   (Risk Perception)	-1.041263	0.4808818	-2.17	<b>0.030</b>	Significant at the 5% level
rarp   (Interaction Term)	0.1992465	0.1099753	1.81	0.070	Not significant

*The level of significance chosen for the logistic regression was 0.05 (5%).*

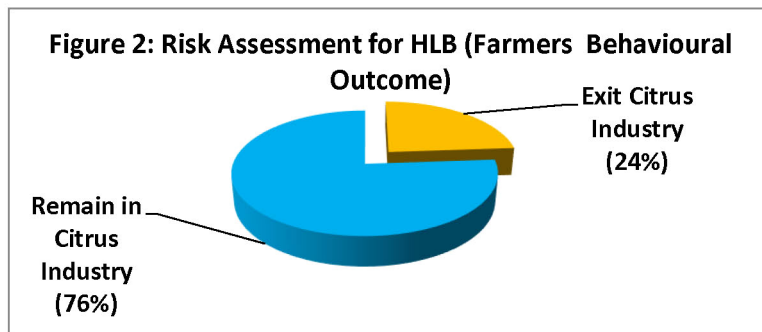
The Wald Chi-Square statistic was used to test whether at least one of the predictor's regression coefficients is not equal to zero. The model has a Wald Chi-Square (3) of 16.64, which indicates that the variables are significant at the 5% level. The number in the parentheses indicates the degrees of freedom of the Chi-Square distribution used to test the Wald Chi-Square statistic and is defined by the number of predictors in the model (3). The p-value of 0.0008 was less than the chosen level of significance of 0.05 (5%).

Three variables were used in the logistic regression: risk attitude (ra), risk perception (rp) and an interaction term [risk attitude (ra) and risk perception (rp)]. The variable (ra) (farmers' risk attitude) has a p-value of  $0.496 > 0.05$ ; hence the variable was not significant and did not influence the behavioural outcome. The variable (rp) (farmers' risk perception) has a p-value of  $0.030 < 0.05$ ; hence the variable was significant and influenced the behavioural outcome. The variable (rarp) (interaction term) has a p-value of  $0.070 > 0.05$ ; hence the variable was not significant and did not influence the behavioural outcome.

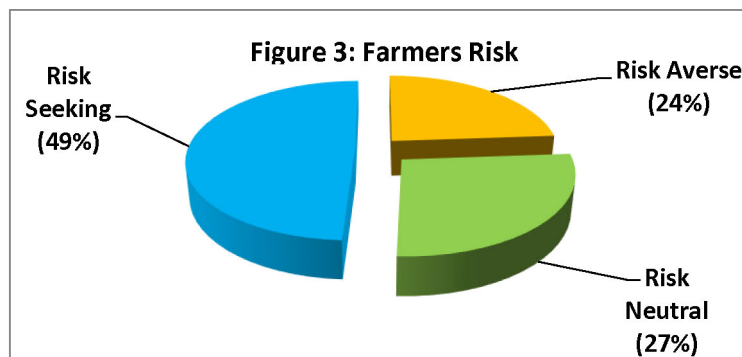
**Farm Size:** The study solicited the opinions of small, medium and large farmers. Overall 61% of the farmers surveyed were small farmers; 18% were medium sized; and 21% were large farmers (Figure 1).



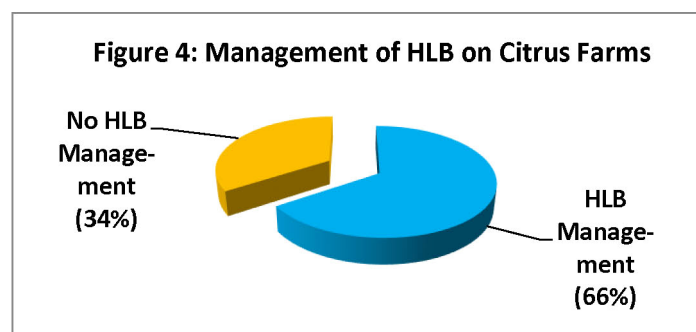
**The Behavioural Outcome of Farmers Surveyed:** With respect to the farmers' response to the risk posed by HLB, a total of 24% of the farmers surveyed indicated that they would exit the citrus industry and 76% of the farmers indicated that they would remain in the citrus industry regardless of the HLB infestation (Figure 2).



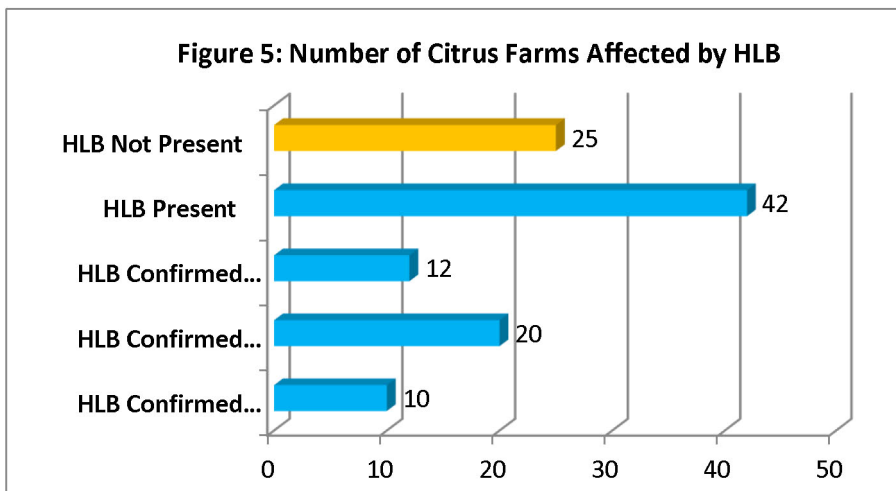
**Farmers' Risk Attitude:** The study utilized a series of questions which assessed farmers' attitude towards risk. The results indicate that 49% of the farmers surveyed were risk-seeking, 27% risk neutral, and 24% risk averse (Figure 3).



**HLB Management:** All farmers were asked whether they practiced any form of management for HLB or were part of the Citrus Growers Association (CGA) HLB management programme. Overall, 34% of the farmers surveyed indicated that they employed no management measures for HLB and 66% indicated that they employed management's programmes or were part of the CGA's HLB management programme (Figure 4).



**Citrus Farms Affected by HLB:** Farmers were asked to indicate whether their farms were affected by HLB. The results show that HLB was present on 42 of the 67 farms involved in the survey. There were 10 confirmations in 2009. In the case of 2010, there were 20 confirmations, while in subsequent year 2011, there were 12 confirmations of HLB present on farmer holdings (Figure 5).



## DISCUSSION AND CONCLUSION

Farmers of the citrus industry of Belize were fully informed of the destructive nature of HLB at the production level and its effects throughout the industry value chain through educational programmes primarily facilitated by the CGA. At the production level, infected orchards experience increased fruit drop, lopsided fruits and increased tree mortality within three to five years, especially in younger groves. Fruits affected by HLB were of a reduced quality, i.e. lower brix content. Fruits also affect citrus juice processing activities because they lack uniformity in shape. This lack of uniformity reduces the output efficiency at the processing plant which translates into reduced export of FCOJ, the primary contributor to agricultural exports, agriculture GDP in Belize. Stated succinctly, HLB may result in reduced earnings for all stakeholders throughout the value chain and may negatively affect the livelihoods of farm owners, workers and the rural economy in general.

Analysis of the logistic regression model indicated that the variable risk perception (the likelihood of farmers getting the disease) was the only significant variable contributing to the behavioural outcome, i.e. farmers' decision to remain or exit the citrus industry. Despite the information communicated to farmers about the disease and early signs of its effects on farmers' holdings, the study found that 76% of the farmers were willing to remain in the citrus industry regardless of prevailing and anticipated circumstances.

The evaluation of farmers' attitude towards risk indicated that almost half (49%) of the farmers were risk-seeking. This finding is reflected in the high percentage of farmers who decided to remain in the industry regardless of the challenges presented by HLB. With regards to HLB management, 66% of the farmers surveyed indicated that they employed management measures either individually or as participants in the CGA's HLB management programme. However, 34%

of the farmers did not implement measures to control HLB, and among the 66% of farmers who implemented a HLB management programme, the required frequency of application of insecticides and fertilizers were less than optimal. A significant number of farmers indicated that the lapse in their HLB management programme was because of financial constraints.

At present, HLB threatens the livelihood of farmers, agriculture workers, the rural and national economy of Belize, and results in reduced earnings for all stakeholders along the citrus industry value chain.

## **RECOMMENDATIONS**

The management of HLB in Belize requires policy initiatives which facilitate the inclusion and effective involvement of all industry stakeholders. Specifically, policies should provide support to the HLB management programmes implemented by the CGA and the Citrus Greening Task Force of the Belize Agriculture Health Authority (BAHA).

Consultations with industry stakeholders revealed that budgetary allocations from government and the private sector were inadequate to fund an effective HLB management programme. Hence, efforts should be made to seek additional funding, combine available resources, and continue collaborations with international partners to increase the effectiveness of national programmes.

At the production level, educational programmes on HLB should continue to increase farmers' overall awareness of the disease and further address the issues of risk attitude and perception. In addition, every effort should be made to encourage the participation of all farmers in the national HLB management programme. Most importantly, researchers and industry professionals should develop cost effective strategies for HLM management that can be utilized by resource-poor farmers.

In the immediate future, focus should be placed on vector control, farmer awareness, and training of technical staff. Overall, focus should be placed on research and development of an Integrated Pest Management (IPM) solution for HLB.

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