

Consumers' willingness to pay for greenhouse-hydroponic tomatoes in Trinidad, W.I.

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Trinidad tomatoes are differentiated only by their physical size. Farmers in many countries have been adopting agronomic differentiation strategies by utilizing various production systems. This project seeks to determine consumers' willingness to pay (WTP) for greenhouse-hydroponic (GH) tomatoes when marketed in a hypothetical scenario as a differentiated commodity. A total of 405 consumers were surveyed in Trinidad. A logistic regression and ANOVA were used to determine the factors affecting consumers' WTP for GH tomatoes. Consumers' knowledge and perception towards the health benefits of GH tomatoes were influential factors. In the current state, the differentiation may not be a feasible undertaking for farmers without the accommodation of any supporting public educational programmes. These programmes must aim to highlight the differences between conventional open field tomatoes and GH tomatoes.

Keywords: Greenhouse-hydroponics, contingent valuation, utility, willingness to pay, premiums

The on-going development of agriculture is driven by ever evolving consumer demands. Consumers are becoming increasingly sophisticated in their taste and preferences, as well as their perceptions of food risks and environmental issues. As a result, predicting long term consumer demand for food is challenging. Issues surrounding pesticide residue levels, genetic engineering, organically produced foods, labeling and packaging, as well as environmentally sustainable farm practices have significantly influenced consumers demand for food. Production systems must respond to meet changing demand patterns. As a result of changing consumer preferences, new contemporary food trends have been emerging.

Given the complexity of consumer demand in the global marketplace and the need for agricultural growth in developing countries, successful farmers must be able to maximize production, minimize costs and be competitive. The need for innovation in agriculture cannot be ignored.

Trinidad Tomato Market

Global production values of tomatoes have increased while the gross value of domestic tomato production has declined (FAOSTAT 2012). Trinidad and Tobago's tomato production has decreased from three million kilograms in 1999 to less than two million kilograms in 2008 (Seepersad et al. 2009, 32-38). According to the Trinidad and Tobago Tropical Greenhouse Operators Association (TTTGOA), imported tomatoes are often sold at lower prices, pulling the domestic market prices for tomatoes downwards (Gopie, pers. com). Local producers must compete with imported produce by selling fresh tomatoes at comparable prices, which results in lower profits.

A major problem faced by local tomato farmers is changing weather patterns (IICA 2012, 37). This led to the adoption of greenhouse technology and its cheaper alternative; shade houses. Nonetheless, utilization of greenhouse technology to produce tomatoes has resulted in a higher cost of production

(Seepersad et al. 2009, 32-38). Greenhouse establishments and hydroponic systems have not been widely adopted by farmers in the region because of high investment costs. Regional agriculture continues to be dominated by small subsistence farming and in most cases investments in modern technologies can be very risky to these small farmers. Greenhouse technologies and protected agriculture introduces a wide range of benefits to tropical farmers. However, given the low adoption rate of the technologies, opportunities of greenhouse farming are not fully realized. Greenhouse operators in the USA have adopted hydroponic production systems and have benefited from price premiums by using innovative marketing strategies. However, regional farmers have little knowledge of the premiums they can receive for tomatoes produced under such systems.

While tomatoes are produced under various agronomic conditions employing different agronomic models and varieties, the differentiation that takes place in the local marketplace only classifies the product on the basis of size (small, medium and large). With little product differentiation in the domestic market, tomato farmers are viewing investment in modern agricultural technologies as uneconomical.

As a result of the limited differentiation in the Trinidad tomato market, consumers regard almost all tomatoes as "regular" and make purchasing decisions based on this fact. According to the Trinidad and Tobago Tropical Greenhouse Operators Association, there are approximately forty to fifty (40-50) greenhouse operators in Trinidad and Tobago and most crops produced under greenhouses are sold to major restaurants and hotels seeking large tomatoes (Gopie pers. com.).

Given the current structure and

functioning of the tomato marketing system in Trinidad and Tobago, there is the need to boost the income of local tomato farmers and drive the technological process further while improving agricultural marketing. This project therefore seeks to determine consumers' willingness to pay for greenhouse-hydroponic (GH) tomatoes when marketed as a differentiated commodity. If consumers are willing to pay different prices for GH tomatoes, it implies that local consumers are sophisticated enough to recognize differences in product quality attributes and there may be potential for further differentiation in Trinidad's tomato market. The introduction of a differentiated tomato market has implications for consumers and farmers. Consumers will be given more purchasing choices and thereby have ability to maximize their utility with alternative bundles of goods. Conversely, farmers will be forced to compete in a differentiated market; such competition will require greater production efficiency. Efficiency in production may allow farmers to boost their incomes in the long run.

Consumers are aware of open field tomatoes and for this reason, open field tomatoes will be used as a benchmark standard in this study. Consumers will be required to identify their preferences and willingness to pay for GH tomatoes in comparison to open field tomatoes.

Literature Review

Mexico, USA and Canada are the major producers of greenhouse tomatoes in the western hemisphere (Cook and Calvin 2005, 9). Greenhouse technologies allow these countries to maintain steady supplies year-round, with minimal fluctuations in cost of production. Tomato farmers share

a common problem of very high risks. Greenhouse technology significantly minimizes such risks by growing the plants in closed, protected environments. Cook and Calvin (2005, 9) stated that with the absence of pests and other nutrient-competing plants, a greenhouse produced crop tends to be naturally bigger and have a more attractive exterior.

Cook and Calvin (2005, 9) stated that the greenhouse tomato market has grown significantly since the 1930s in North America. In addition, they stated that greenhouse tomatoes made up 37% of the fresh tomato market and accounted for 50% of household consumption. The number of greenhouse operators in the US has increased significantly over this time period, which resulted in an increase in the supply of greenhouse tomatoes, causing prices to decrease. As a result of this, operators began investigating alternative methods to create "differentiated fresh tomatoes".

Greenhouses require significant capital investment, however, steady year round supplies and lower risks permit stable cost of production. In the USA, greenhouse producers compete with conventional producers in the marketplace and fetch comparable prices. Due to this, small to medium size operators are starting to exit the market, citing the inability to cover investment costs (Abate 2006, 4-5). The most notable differentiation strategy of greenhouse operators in recent years is the use of hydroponic systems to produce vegetables.

According to Murali et al. (2011, 286-296) the term "hydroponics" was created by Dr. W. F. Gericke, which he used to describe the method of cultivating crops and plants in water and dissolved nutrients. In most applications, the term "hydroponics" is used in agriculture when produce is grown in a fully controlled

environment (temperature, light, water, humidity and nutrients). Plants grown hydroponically attain all their nourishments via nutrient-enriched water and are not dependent on natural precipitation or soil. Hydroponic systems are considered more "environmentally friendly" because the nutrient enriched water is re-used thus, there are no surface run-offs. Ilaslan, White and Langhans (2002, 9) stated that controlled systems can help conserve and preserve the environment.

According to Murali et al. (2011, 286), the first agricultural crops produced under a fully implemented hydroponic system were tomatoes and peppers. They claimed that hydroponic systems have proven to be a better alternative than traditional systems, such as open field production and stand-alone greenhouse systems. As a result, they are used extensively in countries such as Israel, Netherlands, England, Australia and New Zealand and North America. Due to the increased interest in hydroponics by North American farmers, the North American Greenhouse/Hothouse Vegetable Growers (NAGHVG) was developed to promote greenhouse-hydroponics crops.

American greenhouse operators have acknowledged the potential of a greenhouse-hydroponics differentiation strategy and the number of new farmers has increased in several states in the USA (Abate 2006). Crops produced under hydroponics systems are considered high-end and in most cases, are targeted toward high-income markets (Abate 2006, 5). These crops are said to be healthier, larger and generally more physically appealing to consumers. Consumers claim that hydroponic tomatoes are sweeter and firmer than soil-grown tomatoes. Due to limited research done in the area, these claims are yet to be scientifically proven. An increasing number of supermarkets in

the USA are carrying products labeled “*hydroponically produced*”, with consumers believing that these vegetables are more costly (Abate 2006, 5).

The USA greenhouse tomato market is now differentiated based on size, shape, degree of ripeness, color and variety. (Abate 2006, 3). Most commercial greenhouse operators in North America utilize hydroponics and climatic control systems (Controlled Environment Agriculture) (Abate 2006, 3).

There are limited studies that specifically focused on consumer preferences and willingness to pay for hydroponic vegetables. However, Ilaşlan, White and Langhans (2002, 286) stated that when buying fresh produce, consumers are mostly concerned about freshness, price, appearance and convenience. Pena (1985, 77) stated that consumers would pay 100% more for an attractive tomato in comparison to an unattractive tomato. USA greenhouse operators strive to produce vegetables that are most appealing to consumers by using controlled environments and mixing cultivars. Arias et al. (2000, 545-548) stated that hydroponics tomatoes that were ripened on-vine contained higher levels of lycopene. They were firmer and had a more intense color than hydroponics tomatoes that were ripened off vine. In addition, a panel of one hundred judges had expressed greater satisfaction (textural, flavor and color) with on-vine ripened hydroponics tomatoes.

In a study conducted in Taiwan, Huang et al. (1999, 76-91) reported that family health status and household income was the most significant factors affecting consumers WTP more for hydroponics vegetables. In the USA, Huang et al. (2002, 15) stated that there was a demand for hydroponic cucumbers and tomatoes in Nashville, USA. They stated that if stakeholders wish to market hydroponics

vegetables, the superior nutritional and physical qualities can be highlighted.

Framework

Contingent Valuation

Accent Research Agency (2010, 3) noted that the main objective of a CV questionnaire is to elicit consumers' maximum WTP in monetary terms for a clearly identified product in a hypothetical market scenario. Firstly, the questionnaire presents a scenario or situational change that will affect the respondent in some way or another. The respondent is then asked to consider how such a change might affect them. The defined, hypothetical change should be perceived as realistic, feasible and relevant. The scenario should be described comprehensively before respondents are asked to assign any monetary value.

Traditionally, while CV has mostly been applied in the economic valuation of consumer preferences for non-market goods and services, it is also applicable to small-scale market products that are not usually available in all retail stores (Rodríguez 2008, 4).

According to Roy (2009, 21), the CV method was heavily criticized when it was implemented to estimate the value of compensation required following a massive oil spill caused by the Exxon Valdez oil tanker in 1989. In response to these criticisms, a panel of distinguished economists was formed in order to objectively assess the validity and reliability of the CV method. Conclusively, the method was then formally validated as a proper valuation technique. However, the National Oceanic and Atmospheric Administration (NOAA) provided several recommendations researchers should consider when employing CV surveys. According to

NOAA (1993, 29-32), these are:

1. the CV method should use face to face/personal survey techniques,
2. CV should use WTP to prevent probable future incidents from happening rather than WTA for an incident that already occurred,
3. the survey instrument should provide sufficient description of the commodity being valued,
4. the respondent should be reminded throughout the survey that consumption of the proposed good/service will reduce their disposable income,
5. respondents should be informed of any existing product substitutes or other somewhat comparative products.

In this research, these recommendations were carefully considered when designing the CV questionnaire. For all respondents, the survey instrument was administered via face to face interviews. Consumers were provided with descriptive information on the production process of GH tomatoes and made aware that the GH tomato was a substitute to a conventional, open field tomato. Also, they were made aware that their expressed WTP for GH tomatoes will certainly reduce their current level of disposable income.

Utility and Willingness to Pay

The random utility theory (RUT) posits that an individual will choose a bundle of goods (goods A and B), among a set of known alternatives (goods A, B, C, D...), that generates the highest utility, subject to a known budget constraint (MacFadden 1973, 107). According to Kim et al. (2006, 7), the rational consumer aims at maximizing their utility based on a traditional Marshallian demand curve. The

quantity demanded (Q) of good A and B is a function of market price (P_A , P_B), disposable income (Y) and the quality attributes of good A and B.

This study focuses primarily on willingness to pay. Throughout the study, WTP ideally refers to the maximum amount that an individual states they are willing to pay for a good. Also, the definition takes on a wider meaning, which is, the amount a consumer is willing to pay for a perceived change in quality of the product assuming their utility is constant at some level (George 2010, 9). The study aims to determine the amount an individual is willing to pay for a perceived change in the quality attributes of tomatoes as a result of its differentiation (GH). The amount an individual is willing to pay is primarily a measure of the indirect utility attained through the consumption of a given good.

Methodology

A survey research methodology was used in this study. Sample data were collected via face to face interviews by pre-trained interviewers (five per region). A total of 405 consumers were surveyed (see Table 1). The procedure for selection of the sample was identifying, from a list of national population demographics provided by the Trinidad and Tobago Central Statistical Office (CSO), the five most populated geographical regions of Trinidad. From each region, four (4) supermarkets were randomly selected and the respondents to be surveyed were conveniently chosen using proportionate sampling to reflect area populations, based on town statistics provided by the CSO.

In each supermarket, the first customer encountered was selected and if a successful interview was done, the next third customer to exit the supermarket was

then approached. If the individual agreed to participate, an interview was done. If declined, the next person to exit was approached. This procedure was done in all areas to arrive at the sample size of 405

respondents. The number of respondents surveyed by region (Table 1) was as follows; (North East: n=100, North West: n=92, Central: n= 84, South East: n=49, South West: n=80).

Table 1: Total number of questionnaires collected in each region in Trinidad

Area	% of Sample	No of questionnaires (collected)
South East (Princes Town/Rio Claro/Mayaro)	11	49
South West (San Fernando/Point Fortin/Penal/Debe/Siparia)	20	80
Central (Chaguanas/Couva/Tabaquite)	21	84
North East (Tunapuna/Piarco/Arima/Sangre Grande)	25	100
North West (POS/Diego Martin/San Juan)	23	92
Total	100	405

To acquire a representative sample of the total population, all regions (based on CSO data) were surveyed by pre-trained interviewers possessing a background in agriculture. Tomato consumers (age >18) were the target population. Within this population, the questionnaires were completed by all persons of different socio-economic and demographic background (income, age and education).

The survey instrument aimed at attaining data on several factors that the literature has shown to be associated with consumers' willingness to pay for food products. These were socio-demographic characteristics of the individual, perception of the effects of agrochemicals on human health and the environment as well as the perceived health benefits derived from the consumption of GH tomatoes.

Elicitation of Consumers' WTP

According to Boyle (2003, 111-167),

three types of question formats are mainly used; open ended, payment card and dichotomous choice. In general, the dichotomous or referendum format is widely used. Conversely, Green et al. (1996, 85-116) stated that this format may overestimate WTP values due to an "anchoring effect". The binomial response in the dichotomous form question is statistically inefficient compared to the open-ended response format. Carlson and Martinsson (2001, 3) stated that the open ended format avoided the anchoring effect and also, provided more informational content than a closed-ended format. According to Romstad (2012, 10), the statistical properties of open-ended CV formats are also reliable in smaller sample sizes. Greene (1998, 947) recommended that if researchers should adopt the dichotomous format, an open-ended, follow-up question should be used. This technique may have a higher response rate and provides more information on WTP than other formats such as the double

bounded dichotomous choice format. Langford and Bateman (2008, 21-22) also stated that the dichotomous choice format should not be used as a single elicitation format. They stated that the joint use of open-ended and dichotomous choice formats may provide a useful range of contingent welfare measures. In this study, both the dichotomous choice and open ended formats were employed.

To elicit consumers' WTP via the CV method, each respondent was presented with a hypothetical scenario. Consumers were asked to imagine that they were in a supermarket visiting the fruits and vegetables section. Upon arrival to this section, there are two (2) clearly identifiable types of medium-sized, ripened and unpackaged tomatoes that are being sold; Greenhouse-Hydroponic and conventional open field tomatoes. GH tomatoes were described as follows:

A tomato produced under a greenhouse in nutrient-enriched water, without the use of soil. Hydroponic tomatoes are grown in a nutrient solution rather than soil. The tomatoes are grown in a controlled environment without weeds or soil-borne diseases. Hydroponic systems recycle water and agrochemicals. The difference between hydroponic tomatoes and regular tomatoes is the growing medium i.e. soil vs. water. This is in no way to be confused with Organic production systems.

Consumers were made aware that the open field tomato is currently sold in the market at TT\$6.50 per pound (US\$1=TT\$6.44). With respect to the single-bounded dichotomous choice question, respondents were simply asked to state whether or not they would be willing to pay more than TT\$6.50 per pound for GH tomato (1:Yes/0: No).

Following this and irrespective of their previous response, the consumer was then required to state (in dollar values) the maximum amount that they would be willing to pay via an open-ended format question.

Data were collected via face to face interviews. Pre-trained interviewers were required to read questions from the survey instrument and record the responses. Data were analyzed with the use of SPSS V.16.

Data Analysis

A logistic regression model was used to estimate the probability that a consumer would pay more than TT\$6.50 (1 if yes; 0 if no) for GH tomatoes given several independent variables. The basic form of the logistic regression can be stated as:

$$\ln\left(\frac{P_i}{1-P_i}\right) = L_i = \beta_1 + \beta_2 X_{1i} \dots \dots \dots + \beta_k X_{ki} \quad (1)$$

When WTP is elicited via a dichotomous choice question, the response variable is bounded between 0 and 1. The logistic model can be expressed as follows (Gujarati 2003):

Given; $z = \beta + \beta_i X_i$
 $P_i = \text{Pr}(Y=1)$ given X, is stated as:

$$P_i = E(Y = 1 | X_i) = \frac{e^z}{1 + e^z} \quad (2)$$

and $1 - P_i = \text{Pr}(Y=0)$ given X, is stated as;
 $1 - P_i = E(Y = 0 | X_i) = \frac{1}{1 + e^z} \quad (3)$

Given this, the odds ratio can then be written as:

$$\left(\frac{P_i}{1-P_i}\right) = \frac{1 + e^z}{1 + e^{-z}} = e^z \quad (4)$$

The odds ratio (e^z) is non-linear. The logistic regression takes the log linear form of the equation, with the dependent variable being the log odds ratio; creating linearity in β_i and X_i that is,

The logs odds ratio in favor of $Y=1$ is:

$$\ln\left(\frac{P_i}{1-P_i}\right) \quad (5)$$

Hence, the logit (L_i); can be stated as:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_1 + \beta_2 X_i \quad (6)$$

The model follows a logistic cumulative distribution function (CDF) and its parameters are derived from Maximum Likelihood Estimation (MLE), which defines the effect of a marginal change in X on the probability that $Y=1$ (WTP-Yes). According to Gujarati (2003, 586), in a logistic regression model, the coefficient (β) describes the effect of the independent variable on the log-odds ratio, in favor of $Y=1$. Further, the sign of β indicates whether the independent variable (X) has a positive or negative impact on the probability that $Y=1$ (that is, $Pr(Y=1)$). Gujarati (2003, 586) provided an example of estimating the coefficients of a logistic regression with ungrouped data using MLE. Pindyck and Rubinfeld (1998, 330-365) stated that the coefficients estimated from such models are unbiased, consistent, and asymptotically efficient thus, making it a preferred model in this study.

The equation employed to determine the probability of a person paying more than TT\$6.50 for GH tomatoes was specified as:

$$WTP_i = \alpha + \beta_1 Y_i + \beta_2 R_i + \beta_3 S_i + \beta_4 H_{id} + \mu_i \quad (7)$$

- WTP_i is the log odds ratio of person i that is willing to pay more than TT\$6.50 for GH tomatoes
- Y_i is the income level of that person.

- R_i is perceptions and risks of the impact of agrochemicals on the environment and human health.
- S_i is a vector of socio-demographic variables.
- H_i is a perception of health benefits of GH tomatoes.
- μ_i is the random disturbance term.

In addition to logistic regression, an ANOVA model was employed to identify the differences in the mean (μ_i) maximum WTP based on key socio-demographic variables. This analysis provided further insight into the socio-demographics characteristics of a consumer that is likely to pay more for hydroponic tomatoes. An ANOVA model is well-designed to handle situations where the dependent variable is quantitative and the independent variables are qualitative (nominal) in nature (Gujarati 2003). Given this, the dependent variable in the ANOVA model employed is the "Maximum WTP" that is, the monetary maximum amount an individual states he/she is WTP for GH tomatoes.

The F statistic of the ANOVA test allows conclusions to be drawn about the differences between all means. However, a post comparison test is needed to pinpoint exactly where these differences exist (between each mean). In this study, the Tukey's b post hoc test was used to identify differences between means.

The ANOVA test assumes homogeneity of variance. Hence, the Levene's Test of Equality was used to ensure this assumption was satisfied. In instances where inequality of variances existed, the F value of the one way ANOVA test was not regarded as reliable and was not discussed further.

The logistic regression model was used to estimate the probability that consumers were willing to pay more than TT\$6.50 for GH tomatoes. Conversely, the ANOVA model was used to determine

the mean maximum WTP (more or less than TT\$6.50) for GH tomatoes based on key independent factors. In this study, the ANOVA results were used to complement

the results of the logistic regression models. Table 2 provides a definition of each variable used in the data analysis.

Table 2: Measurements and Coding of Variables

Variable name	Categories	Input format
Gender	Female Male	1= Female, 0 otherwise
Age 1	18-24	1= 18-24, 0 otherwise
Age 2	25-40	1= 25-40, 0 otherwise
Age 3	41-55	1= 41-55, 0 otherwise
Ref.	>55	
Location 1	North	1=North, 0 otherwise
Location 2	Central	1=Central, 0 otherwise
Ref.	South	
Marital Status	Married	1= Married, 0 otherwise
Ref.	Single	
Education 1	None	1= None, 0 otherwise
Education 2	Primary	1= Primary, 0 otherwise
Education 3	Secondary	1= Secondary, 0 otherwise
Ref.	Tertiary	
Income 1	<\$3,000TT	1= <3,000, 0 otherwise
Income 2	\$3,001-6,000TT	1= 3,001-6,000, 0 otherwise
Income 3	\$6,001-10,000TT	1= 6,001-10,000, 0 otherwise
Ref.	>\$10,000	
Perception of Agrochemicals	Score 4-16	
Not Concerned (NC)	4-8	1 if NC, 0 otherwise
Somewhat Concerned (SC)	9-12	1 if SC, 0 otherwise
(Ref.) Very Concerned	13-16	
Perception of health benefits	Score 0-5	
Not Healthy	0-2	1 if "not healthy", 0 other
Somewhat Healthy	3-4	1 if "somewhat healthy", 0 other
(Ref.) Very Healthy	5	
WTP for GH	Yes/No	1= Yes, 0 otherwise
Maximum WTP for GH	TT\$	Interval Variable

Results

From Table 3, the majority of the respondents were females (60%). With respect to age, 44% of respondents belonged to the 25-40 age group, 23% belonged to the 41-55 age group, 20% belonged to the 18-24 age group and 13% were 55 years and over. Additionally, 47% of the respondents resided in the northern areas whilst 32% lived in south

and 21% in central Trinidad. The majority of respondents, 52% were married while 48% were single. Majority of individuals (53%) held tertiary level education, 33% had secondary level, 11% possessed primary level and 3% reported no educational background. With respect to monthly average income earnings, 36% of respondents earned TT\$3,001 to TT\$6,000, 24% earned within the range TT\$6,001 to TT\$10,000, whilst 24%

earned less than TT\$3,000 with 16% earning more than TT\$10,000 monthly.

Table 3: Socio Demographic Characteristics of the Sample

Characteristics		n	Frequencies (%)	Confidence Interval	
				<i>Lower</i>	<i>Upper</i>
Gender	Female	245	60	.35	.44
	Male	160	40		
Age	18-24	82	20	.31	.41
	25-40	178	44		
	41-55	91	23		
	>55	54	13		
Location	South	129	32		
	Central	84	21		
	North	192	47		
Marital Status	Married	210	52	.47	.56
	Single	195	48		
Education	None	10	3	.83	.89
	Primary	47	11		
	Secondary	133	33		
	Tertiary	215	53		
Income Range	<TT\$3,000	97	24	.35	.44
	TT\$3,001 - TT\$6,000	148	36		
	TT\$6,001 - TT\$10,000	95	24		
	>TT\$10,000	65	16		

Factors Affecting the WTP for GH Tomatoes

Table 4 presents summary statistics of the logistic model of consumers' WTP for GH tomatoes. Firstly, the model log likelihood test (measure of fit) had a value of 485.14 after five (5) iterations. The model fitted the data well with an overall accuracy rate of 66% at step one, resulting in a chi-square value of 76.28 ($df=17$), which was significant at $p<0.01$. In addition, the Hosmer-Lemeshow (H/L) chi-squared statistic was 13.66 with a p-value of 0.10, which confirmed a well fitted model. The Variance Inflation Factor (VIF) of each independent variable

was used to detect multicollinearity. The VIF for all variables were less than 10, indicating no multicollinearity among independent variables.

The Wald test revealed that independent factors; location, education, income and health benefits were significant to the model ($p<0.05$). Results indicated that the odds of paying more for GH tomatoes increased by 99% for persons residing in central Trinidad ($\chi^2 (1, N=405) = 4.64, p=0.03$). According to the results, the odds of paying more for GH tomatoes decreased by 89% for individuals with no education ($\chi^2 (1, N=405) = 4.17, p=0.04$). Also, the odds of paying more for GH tomatoes decreased

by 82% for individuals with only primary level education ($\chi^2 (1, N=405) = 10.5, p=0.00$). With respect to income, the odds of paying more for GH tomatoes decreased by 60% for persons earning less than TT\$3,000 monthly ($\chi^2 (1, N=405)$

$= 4.03, p=0.05$). Finally, results indicated that the odds of paying more for GH tomatoes decreased by 74% for persons who believed GH tomatoes were not healthy ($\chi^2 (1, N=405) = 10.8, p=0.00$).

Table 4: Results of the Logit Model of Selected Variables on WTP for GH Tomatoes

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	Exp (B) - 1
Gender (1=Female)	0.31	0.24	1.71	1	0.19	1.36	0.36
Age							
Age (18-24)	0.67	0.48	1.93	1	0.17	1.95	0.95
Age (25-40)	0.37	0.39	0.93	1	0.33	1.45	0.45
Age (41-55)	-0.26	0.40	0.44	1	0.51	0.77	-0.23
Location							
Location (North)	0.03	0.26	0.01	1	0.92	1.03	0.03
Location (Central)	0.69	0.32	4.64	1	0.03	1.99	0.99
Marital Status (1=Married)	0.16	0.27	0.33	1	0.56	1.17	0.17
Education							
Education (None)	-2.25	1.10	4.17	1	0.04	0.11	-0.89
Education (Primary)	-1.73	0.53	10.51	1	0.00	0.18	-0.82
Education (Secondary)	-0.08	0.28	0.08	1	0.78	0.93	-0.06
Income							
Income (<TT\$3,000)	-0.92	0.46	4.03	1	0.05	0.40	-0.60
Income (TT\$3,001- TT\$6,000)	-0.43	0.38	1.29	1	0.26	0.65	-0.35
Income (TT\$6,001- TT\$10,000)	-0.67	0.37	2.28	1	0.17	0.51	-0.49
Concern of agrochemicals							
Low Concern	-0.04	0.49	0.01	1	0.94	0.97	-0.03
Medium Concern	-0.05	0.24	0.05	1	0.83	0.95	-0.05
Perception of health benefits							
Little health	-1.33	0.41	10.78	1	0.00	0.26	-0.74
Medium health	-0.38	0.28	1.91	1	0.17	0.68	-0.32
Constant	0.56	0.55	1.01	1	0.31	1.75	0.75
Step 1	Overall %	Chi Square	df	-2 Log likelihood	H/L Chi Square		
	66	76.28***	17	485.14	13.66		

The Mean Maximum WTP for GH Tomatoes

Results of the ANOVA model (Table 5) showed that there were significant differences in the mean maximum WTP for GH tomatoes based on the independent factors; education, income and health benefits. With respect to the educational background, there was a significant difference in the mean maximum WTP for GH tomatoes ($F=8.45^{***}$). Tukey's *b* post-hoc test indicated that there was a significant difference in the mean maximum WTP of those with primary level or no education and those with tertiary and secondary level education. Individuals who possessed tertiary or secondary level education were willing to pay up to TT\$2.54 more for GH tomatoes than those with primary education or no educational background. With respect to income level, there was a significant difference in the mean maximum WTP for GH tomatoes ($F=2.70^{**}$). Results from Tukey's *b* post-hoc test indicated that there was a significant difference in the mean maximum WTP between persons who earned more than TT\$10,000 and those who earned TT\$6,001-TT\$10,000, TT\$3,001-TT\$6,000 or less than TT\$3,000. Figures revealed that persons earning more than TT\$10,000 were, on average, willing to pay up to TT\$1.15 more for GH tomatoes than those earning less than TT\$10,000. Finally, results showed that there was a significant difference in the mean maximum WTP

based on the perceived health benefits derived from the consumption of GH tomatoes ($F=18.9^{***}$). Tukey's *b* post-hoc test indicated that there were differences between the three means of this variable. Consumers who believed that GH tomatoes were very healthy were willing to pay up to TT\$2.62 more for it than those who believed that it was not healthy. Also, they were willing to pay approximately TT\$1 more than those who believed it was somewhat healthy. The *p*-value of the ANOVA test for the factor age showed that there was a significant difference in the mean maximum WTP. However, the null hypothesis of the Levene's test was rejected ($p=4.22^{***}$), implying that the variances was not equal.

Overall, consumers were willing to pay an average price of TT\$6.74 per pound for GH tomatoes (Table 6). Therefore, farmers can receive an approximated minimum premium of 4% for GH tomatoes over conventional open field tomatoes. In addition, results indicated that 49% were not willing to pay more than TT\$6.50 for GH tomatoes while 51% were willing to pay more. Of the fraction that was not willing to pay more, individuals were willing to pay an average price of TT\$4.95 for GH tomatoes (approx. 24% discounted price). Regarding those that were willing to pay more, individuals were willing to pay an average price of TT\$8.45 for GH tomatoes (30% premium price).

Table 5: ANOVA Model Showing Differences in the Mean Maximum WTP for GH Tomatoes

Variables	<i>n</i>	Max WTP (TT\$) (S.D.)	<i>F</i>	Levene's Test (<i>F</i>)
Gender			1.30	0.60
Male	153	6.55 (0.17) ^a		
Female	237	6.85 (0.21) ^a		
Age			6.72**	4.22***
18-24	79	6.95 (0.28) ^a		
25-40	169	7.23 (0.19) ^a		
41-55	89	5.92 (0.26) ^b		
>55	53	6.16 (0.34) ^b		
Location			0.86	4.81***
South	186	6.69 (0.19) ^a		
Central	79	6.49 (0.29) ^a		
North	125	6.96 (0.23) ^a		
Marital Status			2.42	8.93***
Married	202	6.54 (0.18) ^a		
Single	188	6.94 (0.19) ^a		
Education			8.45***	1.88
None	9	4.67 (0.86) ^a		
Primary	45	5.54 (0.37) ^a		
Secondary	127	6.52 (0.22) ^b		
Tertiary	209	7.21 (0.17) ^b		
Income			2.70**	1.89
<TT\$3,000	93	6.34 (0.26) ^a		
TT\$3,001-TT\$6,000	142	6.66 (0.21) ^a		
TT\$6,000-	92	6.74 (0.26) ^a		
TT\$10,000	63	7.49 (0.32) ^b		
>TT\$10,000				
Health Benefits			18.90***	2.38
Not healthy	52	5.06 (0.34) ^a		
Somewhat healthy	250	6.75 (0.15) ^b		
Very healthy	88	7.68 (0.26) ^c		

*** $P < 0.01$; ** $P < 0.05$ Notation for Tukey's *b* post hoc tests: $a \neq b \neq c$

Table 6: Mean Maximum Willingness to Pay for Greenhouse Hydroponics Tomatoes (Statistics of the OE WTP question)

Statistics	Value
Mean (Whole Sample)	6.74
Lower C.I.	6.48
Upper C.I.	6.98
Standard Deviation	2.55
Median	7.00
Minimum	1.00
Maximum	15.00
Skewness	-0.15
Ex. Kurtosis	0.60
Mean (persons not willing to pay more)	4.95
(n=193)	1.93
Standard Deviation	
Mean (persons willing to pay more) (n=197)	8.45
Standard Deviation	1.74

Discussion

Findings revealed that location, education, income and consumers' perception of health benefits derived from the consumption of GH tomatoes were significant factors influencing consumers' WTP for GH tomatoes. In addition, roughly half the sample was willing to pay more for GH tomatoes.

It appears that the benefits derived from the use of GH systems lie on the supply side (production) rather than the price at which the vegetable fetches on the consumer market. The literature indicated that farmers can benefit from stable cost of production, increased yields, stable year round production and decreased risks. These were the major factors that drove the adoption of GH systems for tomato production in developed countries, regardless of the fact that these farmers fetch similar or slightly higher prices than open field tomatoes (Huang et al. 2002, 76-91). Considering that this will not suffice in Trinidad given the limited scale of production, effective marketing

strategies and educational campaigns should be used in the local GH tomato industry to reduce consumers' level of uncertainty of GH systems. Results indicate that this will influence higher price premiums. With the introduction of these techniques, farmers can benefit from the advantages stated above and also, receive premiums for their produce.

Persons in central Trinidad were 100% more likely willing to pay a premium for GH tomatoes. Many local consumers were unaware of GH technology and were unsure if the output from such a system was worth any additional premiums. Central Trinidad consists of many farming communities and there are many farmers residing in central Trinidad. As a result, central consumers may be more aware and knowledgeable about greenhouse agriculture and the related protected agriculture technology. Consumers' knowledge seems to be the major factor affecting consumers' WTP for GH tomatoes. Arias et al. (2000, 545) performed an experiment with one hundred judges and all expressed a greater

preference for vine-ripened hydroponic tomatoes with respect to flavor, texture and color.

Results also indicated that education was a significant factor affecting consumers' WTP for GH tomatoes. Persons with no formal education and primary level education were less likely willing to pay more for GH tomatoes. ANOVA results showed that as individual's level of education increased their WTP for GH tomatoes also increased. With the price of regular tomatoes set at TT\$6.50 per pound, individuals with primary level and no education were WTP less than TT\$6.50 for GH tomatoes. Consumers with lower levels of education as well as secondary level education may not be aware of GH systems. As a result, these individuals were willing to pay the same price for GH and open field tomatoes. On average, only consumers with tertiary education were willing to pay an 11% premium for GH tomatoes since, it can be assumed that individuals with tertiary level education understand the functioning and more importantly, the benefits of these systems. Therefore, it is possible again to link the importance of consumers' knowledge to their WTP for GH tomatoes.

According to Huang et al. (1999, 90), household income was significant to the WTP for GH vegetables. Individuals earning less than TT\$3,000 per month were less likely willing to pay more than TT\$6.50 for GH tomatoes. As individuals' income increased, the probability of them paying more for GH tomatoes also increased. Therefore, their mean maximum WTP for GH increased. Individuals earning more than TT\$10,000 per month were willing to pay about a 15% premium for GH tomatoes. Abate (2006, 4-6) stated that US consumers perceived hydroponic vegetables to be high end and were closely related with

quality products. It appeared that such perception may be extended to local consumers. As mentioned, individuals with high incomes can afford a more comfortable lifestyle and may opt for premium products such as GH tomatoes. Local consumers earning higher incomes were clearly willing to pay more for GH tomatoes and therefore they will serve as a very profitable market segment for GH tomato farmers.

As expected, consumers' perception toward the health benefits derived from the consumption of GH tomatoes was a significant factor affecting their WTP. As consumers' perception toward the health benefits of GH tomatoes increased positively, the probability of them paying more for it also increased. Additionally, results of the ANOVA model confirmed this and persons who believed that it was not healthy were not likely to pay more and were, on average, willing to pay a maximum of TT\$5.06 or TT\$1.44 less for GH tomatoes. Those who believed that it was somewhat healthy and very healthy were likely to pay more, stating premiums of 4% and 18%, respectively. It is easily seen that Trinidad consumers place a high value on their health and were very willing to pay more for foods they believe to be more nutritious. Consumers' perception of GH tomatoes may be formed by unsubstantiated information. While most consumers are well aware of the vitamin C properties of a tomato, it is also probable that consumers are aware of the cancer-fighting claims associated with lycopene. Arias et al. (2000, 545) indicated that vine-ripened GH tomatoes contained higher levels of lycopene than open field tomatoes. Results such as these may be very important to the possible strategies that can be employed to market GH tomatoes at a premium price.

Conclusion and Implications

On average, consumers were willing to pay an average price of TT\$6.74 and this represented a price premium of approximately 4%. Also, younger persons, those with tertiary level education, high income earners and persons who perceived GH tomatoes to be very healthy may already perceive GH tomato as a quality product as they were willing to pay significantly more for GH tomatoes (11%, 11%, 15%, 18% respectively). It appears that other consumers are either unaware of the attributes of such a product or are simply, not willing to pay more for it. Consumers' knowledge and perception toward the health benefits of GH tomatoes were influential factors. If these factors are heavily focused on marketing strategy, it is very likely that farmers can gain price premiums of 4% to 18% for GH tomatoes. On the demand side, Abate (2008) stated that farmers of developed countries are using GH systems to produce differentiated tomatoes by experimenting with various varieties to create an attractive produce. These technologies allow farmers the flexibility to experiment with different varieties and produce highly attractive tomatoes.

By marketing GH tomatoes in Trinidad as more healthy and aesthetically appealing than conventional tomatoes, a premium market for the product can certainly be established. However, it appears that consumers are simply not aware of the product. Therefore, given the overall WTP premium of 4%, the differentiation (GH tomato) may not be a feasible undertaking for farmers without the accommodation of any supporting education programmes. Consumers must be provided with sufficient information via public education to make well informed purchasing decisions. If such programmes are effectively introduced,

local consumers will be able to recognize the differences between conventional open field tomatoes and GH tomatoes. In this instance, results indicated that those consumers may be willing to pay a premium of up to 30% more for GH tomatoes. Arguably, Trinidad consumers will sacrifice more of their income to attain vegetables of perceived higher quality.

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