Food Sec. (2014) 6:61–69
DOI 10.1007/s12571-013-0322-4

ORIGINAL PAPER

# Compliance with Good Agricultural Practices (GAPs) by state-registered and non-registered vegetable farmers in Trinidad, West Indies

**Wayne Ganpat · Neela Badrie · Shivana Walter · Lennon Roberts · James Nandlal · Nyasha Smith**

Received: 3 April 2013 / Accepted: 6 December 2013 / Published online: 22 January 2014


**Abstract** If Trinidad farmers are to meet consumers' demands for safer food and also the requirements for export of produce then they must embrace Good Agricultural Practices (GAPs) on farms. This study assessed the extent of compliance with GAPs among smallholder vegetable farmers ($n=196$) across Trinidad, West Indies. Farmers were randomly selected and surveyed using a structured interview schedule designed to capture personal, demographic and farm related data as well as the extent of compliance with GAPs from the recommended protocols governing production and post production practices. Data were analyzed using ANOVA and categorical regression. Overall, compliance was low among all farmers; farmers registered as exporters with the state owned national marketing company had lower compliance levels than those not registered; the level of compliance with GAPs was different based on gender, education, farming experience, number of extension visits received, size of farm, land tenure status and export status (all at $p\leq0.05$ of level of significance). Categorical regression results showed that the status of land tenure, number of extension visits received and the institution at which farmers were trained were the most important factors determining the extent of compliance with GAPs. Land tenure and number of extension visits were consistently the most important factors among the entire sample and subsamples (registered as exporters and non-registered with the state owned national marketing company). If Trinidad farmers are to produce vegetables of higher quality, which are safe to eat and meet all international safety protocols then urgent actions are needed i) to better educate the extension service in order to improve GAPs compliance and ii) for governmental intervention to improve farmers' land tenancy arrangements.

**Keywords** Good Agricultural Practices (GAPs) · Smallholder farmers · Adoption · Compliance · Vegetables · Food safety

W. Ganpat (✉)
Department of Agricultural Economics and Extension, Faculty of Food and Agriculture, University of the West Indies, St. Augustine, Trinidad and TobagoWI
e-mail: Wayne.Ganpat@sta.uwi.edu

N. Badrie · S. Walter · L. Roberts · J. Nandlal · N. Smith
Department of Food Production, Faculty of Food and Agriculture, University of the West Indies, St. Augustine, Trinidad and TobagoWI

N. Badrie
e-mail: neela.badrie@sta.uwi.edu

## Introduction

Trinidad and Tobago is a relatively small country with approximately 1.3 million people. Its economy is energy based with oil and gas amounting to 40 % of the GDP. The agricultural sector is small, with approximately 20,000 farmers, and it contributes less than 1 % to the country's GDP. Most farmers operate on small areas of predominantly marginal land with little access to irrigation or machinery. Trinidad farmers have, nevertheless, become expert producers for a range of vegetables as nearly half the population is of East Indian descent and vegetables constitute the main part of their daily diet. The country is self sufficient in vegetable production and even exports these commodities to neighboring Caribbean countries. Regionally, Trinidad and Tobago is regarded as the lead country for vegetable production and for this reason it is important and urgent that these crops are produced under conditions that meet food safety standards.

In fruit and vegetable production, one of the major goals is to provide the consumer with safe and wholesome end products (FAO 2007). Good Agricultural Practices (GAPs) is a set of protocols that cover all activities that take place on the farm. They outline the systematic frameworks, which help the

farmer to identify, implement and manage appropriate control measures to minimize contamination of produce at each stage of production and post harvest (Francis 2009). GAPs apply available knowledge to addressing environmental, economic and social sustainability for on-farm production and post-production processing, resulting in safe and healthy food and non-food agricultural products (FAO 2010).

GLOBALGAP is now accepted as a key reference for Good Agricultural Practices (GAPs) in the global market place by translating consumer requirements into agricultural production in over 100 countries worldwide (GLOBAL GAP 2009). GLOBALGAP is the pre-farm gate standard set in place by Europe's leading food retailers to give their customers assurance of food safety. Under this protocol, only certified growers can supply these retailers and therefore many growers see GLOBALGAP certification as a "passport to market" (GLOBAL GAP 2009).

In Trinidad and Tobago, the National Agricultural Marketing Development Corporation (NAMDEVCO) is responsible for certifying farmers. The agency's extension officers monitor farms as part of its mandate to promote compliance with GAPs (NAMDEVCO 2011). It also assists in the identification of new market opportunities, both locally and abroad, for agricultural products.

As Trinidad vegetable farmers seek to enter the global marketing arena, meeting the demands for quality and food safety will require them to observe GAPs in order to ensure safety of produce from farm to table. Small farm systems in the Caribbean have been encouraged over the years to adopt such measures in order to take advantage of export markets. The implementation of GAPs is costly, however, and farmers are hesitant to adopt them, often taking their time to go through the necessary psychological stages before making a decision. Because of the cost, a positive decision is not always made, especially among resource-limited smallholders, who constitute the bulk of farmers in the Caribbean.

There are, however, several benefits to farmers and consumers when GAPs are observed. Farmers can achieve added value for their produce and better access to markets while consumers will be assured of better quality and safer foods. The appropriate adoption and monitoring of GAPs therefore help improve the safety and quality of food and other agricultural products. Moreover, participation in a GAPs program reduces the risk of non-compliance with national and international regulations, standards and guidelines regarding permitted pesticides, maximum levels of contaminants and other hazards (FAO 2010).

In Trinidad and most other Caribbean countries, GAPs are not mandatory requirements for farmers. Consequently, production continues to be heavily dependent on fertilizer and pesticide use (Simpson 2003). Any threat to the food supply, whether by intentional or unintentional contamination, could result in danger to health, considerable cost to food chain suppliers and could also affect trade (Badrie et al. 2007). An additional consequence of insufficient compliance with GAP protocols is that farmers would not be able to take advantage of export market opportunities. For farmers to enter the export market there is a critical need for them to be adequately informed, technically prepared and organized to meet this new challenge and governments and public agencies must play a facilitating role (FAO 2008).

An understanding of the safety practices employed in local food production and the level of success of the government supported programme to improve GAPs on farms could inform actions to improve compliance with GAPs in the vegetable sector.

The objectives of this study were to (i) assess the extent of compliance of selected GAP protocols among farmers, (ii) identify differences between farmers registered to participate in the national GAPs program and non-registered farmers and (iii) determine the factors which are associated with compliance with GAP protocols.

This study uses the traditional adoption and diffusion of innovations model (Rogers 1985) and the Farming Systems model (Shaner et al. 1982) to construct a framework to understand and explain the adoption of GAPs by resource-limited smallholder farmers. The basic premise of the traditional adoption model is that behavior is influenced by factors which include, but are not limited to, personal characteristics such as gender, experience, age, and level of education; and technology associated factors such as cost, associated information, ease of understanding as well as attitudes to new practices and risk taking behavior.

The Farming Systems model posits that factors beyond the farm and farmer also play important roles and it is the interaction of these factors that ultimately determines the extent of technology adoption. Issues related to government policies such as credit and incentives as well as marketing factors are also important. Farming Systems theory holds that adoption of practices is also related to the circumstances of farmers (Shaner et al. 1982). These include resources, both financial and otherwise, type of farming system practised, whether farming is a full time or part time occupation, whether cropping is single or mixed and, importantly, whether livestock is part of the farming system. Other issues, such as the location of the land, access to water for irrigation and labour also impact the decision-making process of smallholder farmers. These could all be very relevant issues in determining GAP adoption by farmers.

The literature is sparse on the factors related to the adoption of GAPs so this study uses sustainable practices as a nexus for understanding farmers' compliance with GAPs. Tilman et al. (2002) defined Sustainable Agricultural Practices as "practices that meet current and future societal needs for food and fibre, for ecosystem services and for healthy lives, and which do so by maximizing the net benefit to society when all costs and benefits of the practices are considered".

From this perspective several research results are relevant. Drost et al. (1996) have found that, although farmers adopt

some sustainable practices, the majority stated that economic factors, availability of information, and Federal farm programs were the primary constraints limiting higher adoption rates. Lack of concern and reluctance to give up traditional farming practices were also barriers to adoption of sustainable techniques. Sadighi (2002) found that some 49.3 % of the variance in the adoption of Sustainable Agricultural Practice Needs could be explained by farmers' age, their access to information sources and their level of technical knowledge. Jayaratne and Acker (2003) found that Extension educators in Sri Lanka believed that inadequacies in training materials, research based information, and resources to conduct farmer demonstrations were the major barriers to the diffusion of sustainable agriculture technologies.

## Methods

### Survey questionnaire

The survey questionnaire consisted of 65 open ended and closed questions. Questions were asked to assess the extent of compliance with 42 GAP control points in the areas of sanitation ($n=6$), site selection ($n=4$), planting materials ($n=5$), water quality ($n=6$), fertilizer and pesticide use ($n=6$), record keeping ($n=3$) and harvesting and post harvest handling ($n=12$) (Table 1).

Total scores for each area varied according to the number of GAP protocols assessed. Scores were assigned to each respondent based on the number of practices carried out under each area (compliance = 1; non-compliance = 0) and summed to give an overall compliance score. Total score possible was 42. The GAP score attained by each farmer would then indicate their level of compliance and this score was used as the dependent variable. Personal and demographic data were also collected. Content validity of the instrument was assessed by four GAP experts; two working at the University of the West Indies and two at the NAMDEVCO. A pre-test was conducted among a small group ($n=5$) of farmers in the main market in central Trinidad to test the practicality of the questionnaire. Based on feedback, adjustments were made to all the areas studied to include questions that conveyed the critical indicators of GAP compliance and omit questions that were deemed not applicable by the farmers with respect to the management practices in Trinidad.

### Sample selection

Lists of farmers who grew vegetables as their main crops were obtained from the national Agricultural Extension offices in the main vegetable growing districts as well as from the NAMDEVCO head office. To adequately reflect the spread of the farmers across the country, the final sample consisted of 196 farmers proportionately selected from the Northern,

**Table 1** Control points assessed by areas

| Control points # | GAP questions ($n=42$) |
|---|---|
| Sanitation | |
| 1 | Is potable water available to all workers? |
| 2 | Have your workers received training on proper sanitation and hygiene practices? |
| 3 | Are there toilets, restrooms and field sanitation facilities? |
| 4 | Are smoking and eating confined to designated areas separate from where product is handled? |
| 5 | Is the farm sewage treatment system or septic system functioning properly with no evidence of leaking or runoff? |
| 6 | Are there municipal or commercial sewage treatment facilities or waste material landfills adjacent to the farm? |
| Site selection | |
| 7 | Has the site ever been used for animal production? |
| 8 | Has the site ever been used for garbage disposal or been a dump site? |
| 9 | Is the site adjacent to or near livestock production? |
| 10 | Did you experience any flooding last year? |
| Planting materials | |
| 11 | Where do you source seeds or seedlings? (Produce your own or purchase) |
| 12 | If you produce your own, are they propagated in a seedling house/shed? |
| 13 | Do you sterilize soil media? |
| 14 | Do you sterilize trays? |
| 15 | If you purchase seeds, how do you store them? |
| Water quality | |
| 16 | What is your source of irrigation water? |
| 17 | Which irrigation method do you use? |
| 18 | Do you test for microorganisms or heavy metals? |
| 19 | Do you have documents that show your water quality is adequate for the crop irrigation method and crop being irrigated? |
| 20 | Is your water quality known to be adequate for chemical application or fertigation? |
| 21 | If necessary, are steps taken to protect irrigation water from potential direct and non-point source contamination? |
| Fertilizer/Pesticide usage | |
| 22 | Is the manure used fresh or composted? |
| 23 | Fertilization method? |
| 24 | How often is fertilizer applied? |
| 25 | How is fertilizer or manure applied? |
| 26 | Do you comply with the directions given? |
| 27 | Is protective equipment used? |
| Record keeping | |
| 28 | Are records of farm activities kept? |
| 29 | How often are records updated? |
| 30 | What types of records are kept? |

**Table 1** (continued)

| Control points # | GAP questions ($n$=42) |
|---|---|
| Harvest and postharvest handling | |
| 31 | Is there a separate area to store produce? |
| 32 | At what time of day is harvesting done? |
| 33 | Are harvesting implements sanitized? |
| 34 | If yes, how often do you sanitize? |
| 35 | During harvesting how is the produce stored? |
| 36 | How long after harvest is produce removed from the temporary store? |
| 37 | Where is the produce cleaned or trimmed? |
| 38 | How is harvested produce packed? |
| 39 | At what time of day do you transport harvested produce? |
| 40 | How is the harvested produce transported? |
| 41 | Is the vehicle cleaned before transporting produce? |
| 42 | Do you sort your produce before sale? |

Central and Southern regions. Farmers were interviewed face to face either on their farms or at their homes.

### Statistical procedures

The questionnaires were coded numerically and analysed using the Statistical Package for Social Sciences (SPSS version 17) and results reported based on frequencies and ANOVA tests with associated post-hoc test (Tukey's b) to show significant differences among means. Multiple categorical regression was also done. The factors that differentiated GAP compliance were examined for the total sample, and then for NAMDEVCO-registered farmers and non-NAMDEVCO-registered farmers separately.

## Results

### Personal and demographics factors

The sample population consisted of 196 farmers: 49 (25 %) were National Agricultural Marketing Development Corporation (NAMDEVCO) registered and 147 (75 %) were non-NAMDEVCO registered farmers. The majority of farmers (86.7 %) were males. Over half the sampled farmers (58.2 %) were between the ages of 32 and 50, 25.5 % were over 50 years old, and 16.3 % were 19 to 31 years old. As regards education, 44.9 % had primary level education, 40.8 % had secondary level education, 8.7 % tertiary education, and 5.6 % less than primary level. The majority of the farmers (66.8 %) had some level of formal training in agriculture while 33.2 % did not. Most of the formal training was acquired through the Extension services of the Government (73.1 %) and to a lesser extent from the Farmers' Training Center (21.3 %), the ECIAF/Farm School (2.6 %) and the UWI (3 %). Farmers reported obtaining most of their farming information from other farmers (30.6 %); 29.1 % received information mainly from extension officers; 29.1 % mainly from agro shops; and 5.6 % stated that they accessed information via the internet and there was no response from 5.6 % of the farmers. Some 70.9 % reported either no visits or only one visit by extension officers per month, 25 % indicated 2–4 times in a month and 4.1 % reported 5-7 visits per month. The highest percentage of the sample (45.9 %) had 11–20 years experience in farming; 23 % had between 5 and 10 years experience; 20.4 % had 21–30 years farming experience; and some (10.7 %) had less than 5 years experience. The majority of farmers (59.2 %) operated farm sizes of between 1 and 5 acres, some 22.4 % worked on more than 5 acres, while 18.4 % farmed on less than 1 acre of land. Lands owned were 36.2 %; 34.7 % were leased; 9.7 % rented and 19.4 % were occupied illegally. Some 18.4 % of farmers exported their produce.

### Compliance with good agricultural practices

With a maximum possible GAP compliance score of 42, the mean score for the entire sample was 14.4 (SD=4.6): the mean for registered farmers was 12.2 (SD=3.3) and for non- registered farmers 15.2 (SD=4.8). Means were significantly different at $P<0.01$ level.

The factors that differentiated farmers were examined for the total sample, and then separately for NAMDEVCO-registered farmers and non-NAMDEVCO-registered farmers.

#### *Entire sample*

ANOVA results (Table 2) show that overall mean scores attained by all farmers sampled were significantly different based on: gender, education level, number of extension visits, years of experience as a farmer, size of farm, tenure status of the farm lands, whether the farmer is an exporter or not and whether the farmer is NAMDEVCO-registered or not. Tukey's *b* post-hoc test indicated that; female farmers ($M$=16.3) had a higher mean compliance score than male farmers ($M$=14.1); those with primary ($M$=14.2), secondary ($M$=14.8) and tertiary ($M$=15.6) level education had higher scores than those with other education ($M$=10.9); farmers who had 0–1 ($M$=18.3) and 2–4 ($M$=17.5) visits by an extension officer had higher compliance scores than those who were visited 5–7 times per month ($M$=15.1); farmers with 21–30 years of experience had higher scores ($M$=16.1) than farmers with 11–20 ($M$=14.2), 5–10 ($M$=13.1) and <5 ($M$=12.9) years experience; persons with <1 acre ($M$=18.4) and 1–5 ($M$=17.2) acres had higher scores than farmers with 6–10 acres ($M$=13.5) and >10 acres ($M$=14.2); farmers who rented land had higher scores (18.2) than others who owned ($M$=14.9), leased ($M$=14.3), or

**Table 2** Results of ANOVA of variables and mean compliance score for all farmers (*AF*), NAMDEVCO Registered farmers (*NAM*) and non-NAMDEVCO Registered farmers (*NN*)

| Variables and category % | *F* values and significance | | | | | |
|---|---|---|---|---|---|---|
| | *F* value (AF) | Means* (AF) | *F* value (NA*M*=49) | Means* (NAM) | *F* value (NN=147) | Means* (NN) |
| Age (years): | 0.76 | | 1.17 | | 1.20 | |
| 19–31 (16.3 %) | | | | | | |
| 32–50 (58.2 %) | | | | | | |
| >50 years (25.5 %) | | | | | | |
| Gender | 5.32 ** | | 0.43 | | 3.55 | |
| Male (86.7 %) | | 14.1 | | | | |
| Female (13.3 %) | | 16.3 | | | | |
| Education Level | 2.84 ** | | 3.73 ** | | 1.82 | |
| Primary (44.9 %) | | 14.2[a] | | 12.2[a] | | |
| Secondary (40.8 %) | | 14.8[a] | | 13.2[b] | | |
| Tertiary (8.7 %) | | 15.6[a] | | 12.1[a] | | |
| Other (5.6 %) | | 10.9[b] | | 8.5[b] | | |
| Received Ag. training | 0.01 | | 0.06 | | 0.83 | |
| Yes (66.8 %) | | | | | | |
| No (33.2 %) | | | | | | |
| Training institution | 1.91 | | 0.64 | | 1.56 | |
| Extension (73.1 %) | | | | | | |
| UWI (3.0 %) | | | | | | |
| ECIAF/Farm School (2.6 %) | | | | | | |
| FTC and Other (21.3 %) | | | | | | |
| Source of information | 1.03 | | 0.20 | | 1.79 | |
| Extension (29.1 %) | | | | | | |
| Agroshop (29.1 %) | | | | | | |
| Farmer to Farmer (30.6 %) | | | | | | |
| Internet (5.6 %) | | | | | | |
| No response (5.6 %) | | | | | | |
| No. of extension visits | 17.57 *** | | 2.90 * | | 11.68 *** | |
| 0–1 per month (70.9 %) | | 18.3[a] | | 11.7[b] | | 18.4[a] |
| 2–4 (25 %) | | 17.5[a] | | 12.7[b] | | 17.1[a] |
| 5–7 (4.1 %) | | 15.1[b] | | 20.1[a] | | 15.9[b] |
| Farming experience | 4.25 *** | | 1.51 | | 3.42 ** | |
| <5 years (10.7 %) | | 12.9[b] | | | | 13.0[b] |
| 5–10 (23 %) | | 13.1[b] | | | | 13.9[b] |
| 11–20 (45.9) | | 14.2[c] | | | | 15.5[a] |
| 21–30 (20.4 %) | | 16.1[a] | | | | 16.8[a] |
| Size of farm (ac) | 9.12*** | | 3.90 * | | 5.82 *** | |
| <1 (18.4 %) | | 18.4[a] | | 9.1[b] | | 18.4[a] |
| 1–5 (59.2 %) | | 17.2[a] | | 10.3[b] | | 17.6[a] |
| 6–10 (12.4 %) | | 13.5[b] | | 13.1[a] | | 14.1[b] |
| >10 (10 %) | | 14.2[b] | | 13.2[a] | | 15.3[b] |
| Land tenure status | 10.24 *** | | 6.75 *** | | 6.97*** | |
| Owned (36.2 %) | | 14.9[b] | | 14.1[a] | | 15.1[a] |
| Leased (34.7 %) | | 14.3[b] | | 10.2[b] | | 15.5[a] |
| Rented (9.7 %) | | 18.2[a] | | 14.3[a] | | 16.0[a] |
| Illegally Occupied (19.4 %) | | 11.7[c] | | 8.6[b] | | 12.5[b] |
| Exporter status | 7.38 *** | | 0.12 | | 0.85 | |
| Exporter (18.4 %) | | 12.5 | | | | |
| Not an exporter (81.6 %) | | 14.8 | | | | |

**Table 2** (continued)

| Variables and category % | *F* values and significance | | | | | |
|---|---|---|---|---|---|---|
| | *F* value (AF) | Means* (AF) | *F* value (NA*M*=49) | Means* (NAM) | *F* value (NN=147) | Means* (NN) |
| NAM Registered | 16.11*** | | – | | – | |
| Yes (25 %) | | 12.2 | | | | |
| No (75 %) | | 15.2 | | | | |

KEY: *AF* All farmers; *NAM* NAMDEVCO registered farmers; *NN* Non-NAMDEVCO farmers

**$p<0.05$; ***$p<0.01$

*Means followed by the same letter are not significantly different at the 0.05 level based on Tukey's *b* test

occupied land illegally (*M*=11.7); non-NAMDEVCO registered farmers had higher compliance scores (*M*=15.2) than NAMDEVCO-registered farmers (*M*=12.2); and farmers who did not export produce had higher scores (*M*=14.8) than farmers who exported (*M*=12.5) produce.

*NAMDEVCO registered farmers*

The mean score for farmers registered with NAMDEVCO was significantly different based on education level, number of visits by extension officers, size of farm and land tenure status. Tukey's *b* post-hoc test indicated that: farmers who possessed primary (*M*=12.2), secondary (*M*=13.2) or tertiary (*M*=12.1) level education had higher mean scores than those with other education (*M*=8.5); those who reported 5–7 visits per month by extension officers had higher mean scores (20.1) than those reporting 0–1 (*M*=11.7) and 2–4 (*M*=12.7) visits; farmers operating <1 acres (*M*=9.1) and 1–5 acres (*M*=10.3) of land had lower scores than farmers with 6-10 (*M*=13.1) and >10 (*M*=13.2) acres of land; farmers who either rented (*M*=14.3) or owned (*M*=14.1) land had higher mean scores than others who leased (*M*=10.2) or occupied land illegally (*M*=8.6).

*Non-NAMDEVCO registered farmers*

Mean compliance scores by this subset of farmers was significantly different based on: the number of visits by extension officers, years of farming experience, size of farm and land tenure status. Tukey's *b* post-hoc test indicated that; non-registered farmers who had 0–1 (*M*=18.4) and 2–4 (*M*=17.1) visits by an extension officer had a higher mean GAP compliance scores than those who were visited 5–7 times per month (15.9); farmers with 21–30 (*M*=16.8) and 11–20 (*M*=15.5) years of farming experience had higher mean scores than farmers with 5-10 (*M*=13.9) and <5 (*M*=13.0) years experience; farmers with <1 (*M*=18.4) and 1–5 acres (*M*=17.6) of land had higher mean scores than farmers with 6–10 (*M*=14.1) and >10 acres (15.3) of land; farmers who owned (*M*=15.1), leased (*M*=15.5) or rented (*M*=16.0) land had higher mean scores than those who illegally occupied land (*M*=12.5).

Determinants of GAP compliance

*Entire sample*

Results of the categorical regression for the entire sample (Table 3) showed that age of the farmer, gender, education, type of training institution attended, source of information, the number of visits received by extension officers, farming experience, size of farm and land tenure status were the significant variables determining the total GAP compliance score. Together, these variables accounted for 43.6 % in the variation of compliance scores with number of extension visits, land tenure status and where farmers received training being the most important variables in the model.

*Analysis based on NAMDEVCO registration status*

For *registered farmers* the results showed that age, education, type of institution where farmers received training and land tenure status were the significant factors determining the extent of compliance among NAMDEVCO registered farmers, with land tenure status and education being the most important. All the significant variables explained 76.1 % in the variation of adoption scores for this set of farmers.

For *non-registered farmers*, age, gender, type of institution trained at, information source, number of extension visits, years of farming experience, farm size and land tenure status were the significant factors determining GAP compliance, with the number of extension visits, farm size and land tenure being the most important factors. The significant variables in this model explained 41.7 % of the total variation.

## Discussion

The overall low compliance by farmers may be related to the characteristics of the protocols that are recommended under the GAPs regime and the system of farming practised by Trinidad farmers. One would have expected that such an

**Table 3** Categorical Regression analysis of the entire sample, NAMDEVCO farmers and non-NAMDEVCO farmers

| Variables | All farmers | | NAMDEVCO registered | | Non-registered | |
|---|---|---|---|---|---|---|
| | *F* value | Importance | *F* value | Importance | *F* value | Importance |
| Age | 9.64*** | 0.05 | 2.73* | 0.11 | 7.53*** | 0.07 |
| Gender | 4.32** | 0.03 | 1.87 | 0.04 | 4.79** | 0.04 |
| Education level | 3.38** | 0.04 | 8.04** | 0.37 | 1.90 | 0.03 |
| Received Ag. Training | 0.56 | 0.00 | 2.0 | 0.04 | 1.02 | 0.03 |
| Training Institution | 8.08*** | 0.12 | 6.11** | 0.06 | 6.05*** | 0.09 |
| Source of Information | 7.77*** | 0.02 | 1.26 | 0.05 | 7.26*** | 0.06 |
| No. of Extension visits | 15.73*** | 0.24 | 1.69 | 0.05 | 15.33*** | 0.28 |
| Farming Experience | 6.13** | 0.10 | 1.24 | 0.06 | 4.40** | 0.11 |
| Size of farm | 8.69*** | 0.09 | 0.029 | 0.01 | 11.74*** | 0.17 |
| Land tenure status | 10.10*** | 0.22 | 5.15** | 0.35 | 4.94** | 0.15 |
| Exporter status | 1.21 | 0.03 | 2.55 | 0.07 | 1.0 | 0.01 |
| Registration status | 1.45 | 0.04 | – | – | – | – |
| Model Statistics | F- 5.43*** | | F- 6.27*** | | F- 4.26*** | |
| | $R^2$- 53.4 %; | | $R^2$- 90.5 % | | $R^2$- 54.5 % | |
| | Adj. $R^2$- 43.6 % | | Adj. $R^2$- 76.1 % | | Adj. $R^2$- 41.7 % | |

Level of significance: *$P$<0.10, **$P$<0.05, ***$P$<0.01

important set of protocols with all the benefits that could be accrued would have had a much higher compliance level.

The relatively recent introduction of GAPs as part of the production practices for farmers may also be a factor. In classical adoption theory, there is a lag period between the introduction of a technology and its eventual uptake by farmers. The length of this period varies according to the type of technology introduced. From the low levels of compliance determined, it appears that farmers in Trinidad are in this lag period. Adoption theory also holds that farmers are cautious, usually taking their time and watching other farmers, making internal assessments, maybe testing the technology before adopting.

The finding that non-NAMDEVCO-registered farmers showed significantly higher compliance than registered farmers, at first glance, may appear surprising. However, the registered farmers would be new entrants to the sector with the intention of taking advantage of export markets, which require GAP compliance. They are probably 'sitting on the fence', while the non-registered farmers are more than likely to be the traditional farmers who, having been longer in the industry, had already adopted some of the GAP protocols. The finding that farmers with tertiary level education have higher scores than those with less formal education is consistent with the findings of classical adoption studies.

Female farmers tended to comply with GAP protocols more than male farmers. Many of the practices in the set of protocols have to do with sanitation on farms and concern for health of end-users of the products. It may be that the nurturing and caring attributes, associated more with females than males, are contributing factors.

Regardless of registration with NAMDEVCO, numbers of visits by extension staff, size of farms and land tenure status were the common factors, which affected compliance with GAPs. Experience in farming, however, set the two groups apart. More experienced farmers had higher scores, tending to suggest that after many years of farming, they have better knowledge of market requirements and more knowledge of appropriate practices than less experienced farmers. Therefore they may have adopted, over time, some of the good agricultural practices that have been offered in an effort to produce higher quality and safer products for consumers, even before the increased promotion of the formal GAP protocols.

Results of the categorical regression suggest that land tenure, number of extension officers' visits and age were the most important factors consistently across the entire sample and sub-samples that impacted the decisions to engage in GAPs. Smallholder farmers in Trinidad and the entire Caribbean, because of historical events, do not have secure titles to land and this is therefore the most likely reason for the low compliance with GAPs. If producers are not sure that the land will be theirs in the future, they are unlikely to invest in practices, many of which require significant infrastructure investments e.g. irrigation equipment, on-farm toilet facilities etc. all of which have significant costs. The issue of extension visits is also important. Although increasing the number of visits will impact positively on compliance, this is hardly likely to occur, given the few staff available. Other methods of extension have to be explored by extension staff such as group work with clusters of vegetable farmers, group training seminars, increased use of supporting materials in print or sent via short messaging service (SMS), as most farmers have access to cellular phones, and result demonstrations.

Generally, farmers are fairly old in the region but very experienced in farming. Therefore modern information and communication methods are unlikely to have much impact on them. Improving the quality and quantity of extension education service is critical to influencing compliance levels, as determined by this study, but unfortunately the extension service is short-staffed, resulting in few visits to farmers.

## Conclusion and implications

The low level of compliance with GAP protocols is a cause for concern. Not only will farmers be unable to take advantage of export opportunities to increase incomes, but local consumers are at risk of eating fruits and vegetables produced in circumstances that are below acceptable standards. The move by the government to promote and facilitate the development of the export-marketing sector may be at risk because of the quality of the education services provided to farmers. More experienced staff are needed. The findings that age, land tenure status, experience and extension visits were the main determinants of compliance suggest that there are opportunities to increase the present levels of compliance through i) improving the quality of extension staff ii) encouraging a new cadre of vegetable farmers, i.e. younger farmers to enter the industry for the main purpose of exporting fruits and vegetables, iii) reorganizing and modernizing the courses being offered at farmer training institutions to reflect more modern practices in line with world standards for the production and export of vegetables and iv) regulating land tenure in order to give farmers security of property.

## References


Badrie, N., DeLeon, S., Talukder, R. A. (2007). *Food safety management systems: Initiatives of Trinidad and Tobago, West Indies, Philippines and Bangladesh.* Proceedings of the 26th West Indies Agricultural Economics Conference, Puerto Rico, July, 2006: 84–93.

Drost, L., Long, G., Wilson, M., Miller, B., & Campbell, W. (1996). Barriers to adopting sustainable agricultural practices. *Journal of Extension, 34*, 6.

FAO. (2007). *Safety and quality of fresh fruit and vegetables. A training manual for trainers. Food and Agricultural Organization of the United Nations.* New York: FAO.

FAO. (2008). *Good agricultural practices. Food and Agriculture Organization of the United Nations.* New York: FAO.

FAO. (2010). In W. L. Mushobozi & P. Santacoloma (Eds.), *Good Agricultural Practices (GAP) on horticultural production for extension staff in Tanzania training manual. FAO Gap working paper series 13. Food and Agriculture Organization of the United Nations.* Rome: FAO.

Francis, D. E. (2009). *The agriculture, food and health challenge; critical issues, perspectives and options.* Morton Publishing Inter-American Institute for cooperation on Agriculture (IICA).

GlobalGAP (2009) *GLOBALG.A.P: Annual report 2009. The global partnership for good agricultural practices.* Issue: September 2009.

Jayaratne, K. S. U., Acker, D. G. (2003). *Going forward in agricultural extension: Problems and alternatives in diffusing sustainable agricultural practices in Sri Lanka.* AIAEE 2003 Proceedings of the 19th Annual Conference Raleigh, North Carolina, USA.

NAMDEVCO. (2011). *Good agricultural practices starts with You.* Trinidad: The National Agricultural Marketing and Development Corporation, Debe.

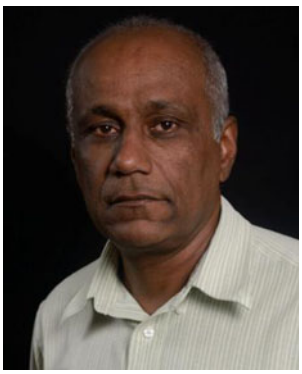
Rogers, E. (1985). *Diffusion of innovation-innovation diffusion theory* (3rd ed.). New York: Free Press.

Sadighi, H. (2002). *Assessing farmers' sustainable agricultural practice needs: Implication for a sustainable farming system.* (AIAEE) Proceedings of the 18th Annual Conference Durban, South Africa.

Shaner, W. W., Philipp, P. F., & Schmehl, W. R. (1982). *Farming systems research and development: Guidelines for developing countries.* Westview: Boulder.

Simpson, L. (2003). *Review of soil management and farming practices, including the use of Agro-Chemicals in the Caribbean, with particular reference to St Lucia and Jamaica. Caribbean Agriculture and Research Development Institute (CARDI) Project report No 2.* Jamaica: CARDI.

Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature, 418*, 671–677. doi:10.1038/nature01014.

**Dr Wayne Ganpat** is a lecturer in Agricultural Extension and Communications at the University of the West Indies. He had long experience in the public sector as a director of extension services before his career at the UWI. Good Agricultural Practices is a special interest for him and he actively promotes compliance of GAP among smallholder farmers across the Caribbean.

**Professor Neela Badrie** is the Head of the Department of Food Production, Faculty of Food and Agriculture, The University of the West Indies, St. Augustine, Trinidad and Tobago. She is a lecturer and researcher in microbiology, food microbiology, food processing, food safety and quality assurance, risk analysis, international trade and food legislation, public health, epidemiology and food-borne diseases and nutrition at the Department of Food Production. In 2012, she received the top award (gold medal), Rudranath Capildeo prize for applied science and technology from the National Institute of Higher Education Research in Science and Technology.

**Shivana Walter** holds a Bachelors in General Agriculture from the University of the West Indies St. Augustine where upon graduating, received 3 academic awards for her final year project. Ms. Walter also holds a Masters degree in Agri Food Safety and Quality Assurance form the UWI, which she attained in 2013. Ms. Walter is currently employed as a Project Assistant at the Seafood Industry Development Company, Ministry of Food Production, Trinidad and Tobago.

**James Nandlal** has an Associate Degree Institute of Agriculture and Forestry, a Bachelors degree (honors) in General Agriculture from the University of the West Indies and is currently pursuing an Msc in Food Safety and Quality Assurance. He worked as a Field Officer in Agriculture for three years promoting GAPs and monitoring local farmers around Trinidad. Currently he is an Agricultural Science/Technology Education teacher in a secondary level school.

**Lennon Roberts** holds a Bachelors in General Agriculture from the University of the West Indies St. Augustine. Mr. Roberts is currently reading for a Masters Degree in Tropical Animal Production at UWI St. Augustine. He is currently employed as an Agricultural and Research Officer at the Sugarcane Feeds Centre, Ministry of Food Production, Trinidad and Tobago.

**Nyasha Smith** graduated from the University of the West Indies with a degree in Agriculture in 2010. Presently, she teaches Agricultural Mason Hall Secondary School on the island of Tobago. She expects to pursue a Diploma in Education in the next academic year.