Research & Reviews: Journal of Agriculture and Allied Sciences

e-ISSN:2347-226X
p-ISSN:2319-9857

Social Characteristics Associated with Agrochemical Use and Health Risks among Grenadian Farmers

Lindonne Glasgow[1]*, David Anderson[2] and German Gonzalez[2]

[1]Department of Public Health & Preventive Medicine, St. George's University, Grenada
[2]College of Health Sciences, Walden University, Minneapolis, Minnesota, United States

Research Article

Received date: 27/02/2019
Accepted date: 19/03/2019
Published date: 26/03/2019

***For Correspondence**

Lindonne Glasgow, DrPH, Department of Public Health & Preventive Medicine, St. George's University, P.O. Box 7, True Blue, St. George, Grenada

Tel: 473-439-2000 ext. 3087

E-mail: linglasg@yahoo.com

Keywords: Grenada, Occupational health, Agrochemicals, Pesticides, Environmental health, Chemical exposure, Population-based study, Agriculture, Farmers, Health problems

ABSTRACT

Background: According to the World Health Organization, agrochemical use is globally widespread although hazardous to human health. Few studies were conducted in the Caribbean to assess health problems from exposure to agrochemicals. Studies were not conducted previously in Grenada to investigate factors that may influence the use of agrochemicals. In the United States, farmers experienced health problems that were found to be associated with exposure to specific agrochemicals.

Methods: Algorithms from the Agriculture Health Study in the United States were adopted to conduct a correlational cross sectional study in Grenada to investigate the relationships between the characteristics of 8868 farmers in the 2012 agriculture census and frequency of use of agrochemicals in the census year.

Results: Statistically significant relationships were found between gender, age, education, membership in a farm organization and having ever used agrochemicals. There was also a statistically significant greater odds (OR 1.945, 95 CI: 1.028- 3.679, p=0.041) of having ever used agrochemicals by farmers who completed school at the vocational level compared to farmers who completed school at the primary level. A significant relationship was also found between membership in a farm organization and having used herbicide ≥ 12 times in the year (OR 2.481 95 CI 1.039-5.926, p=0.041) with greater odds for farmers who did not have membership in the organizations.

Conclusion: The results indicate farmers who completed education at vocational institutions were more likely to experience health problems such as allergic and non-allergic wheeze, rheumatoid arthritis, sleep apnea, and decreased DNA methylation associated with the use of agrochemicals. Farmers who did not have membership in farm organizations were more likely to experience Parkinson's disease and end-stage renal disease. There is need to regulate and monitor the use of agrochemicals by Grenadian farmers as a public health measure.

INTRODUCTION

According to the World Health Organization (WHO), agrochemicals are commonly used worldwide and pose threats to human health [1]. The use of agrochemicals —pesticides, herbicides, insecticides, and fungicides —is also becoming more widespread in crop production [2]. Populations in low-income countries are at higher risk of exposure to the chemicals due to a lack of understanding about the hazardous nature of the chemicals, limited absorptive capacity to utilize safer practices, inadequate resources to adopt alternative technologies, and the absence of policies to facilitate monitoring and control of the chemicals [3-5].

Agrochemical use is widespread in the Caribbean region given that the agriculture sector remains critical for the regional economy, with contributions from the sector to GDP ranging from 3% in some countries to 35% in other countries [6]. Grenada

e-ISSN:2347-226X
p-ISSN:2319-9857

is one of the smallest islands in the region with a population of 105,000 residents and is located in the southern part of the Caribbean. The contributions to GDP from the agriculture sector in Grenada was about 8% in 2017 [6]. Among the agrochemicals that were frequently used by Grenadian farmers during and before the period of the 2012 agriculture census, the active ingredients included glyphosate, paraquat, and carbaryl [7]. Paraquat was classified by the WHO as moderately hazardous [8]. Based on the findings of the International Agency for Research on Cancer (IARC), glyphosate was classified as probably carcinogenic to humans [9]. Although carbaryl was not classified as carcinogenic by the IARC, the chemical was reported to be associated with several health problems and recommended for priority review [10].

The Agricultural Health Study (AHS) was conducted from 1993 in Iowa and North Carolina in the United States with more than 89,000 private and commercial agrochemical applicators and spouses [11,12]. The study was one of a few large prospective epidemiological studies to investigate health effects from exposure to specific agrochemicals. In the AHS, exposure to carbaryl was found to be associated with farmers experiencing sleep apnea [13], decrease in LINE-I DNA methylation [14], rheumatoid arthritis [15], and allergic wheeze [16]; exposure to paraquat was found to be associated with farmers experiencing a decrease in LINE-I DNA methylation [14]; exposure to glyphosate was found to be associated with farmers experiencing allergic and non-allergic wheeze [16]; and exposure to paraquat was found to be associated with farmers experiencing Parkinson's disease [17] and end-stage renal disease (ESRD) [18].

Specific to the Caribbean region, few studies have been conducted to investigate health risks related to the use of agrochemicals [19,20]. The need for research and agrochemical exposure profiling were emphasized in a publication by Forde and Dewailly, reporting moderate to high levels of metabolites in the urine of pregnant women as an indication of exposure to various agrochemicals [21]. Before this current research, studies were not conducted in Grenada to investigate the factors that may predispose the local farmers to specific health problems as a consequence of exposure to agrochemicals. This research was, therefore, the first of its kind to investigate relationships between the social and economic characteristics of farmers who participated in the 2012 agricultural census in Grenada and the frequency of use of agrochemicals. The relationships between the variables are indicative of the likelihood of Grenadian farmers experiencing the health problems found in the AHS. The results of this study can have implications for agriculture practice, health care, health surveillance, and the legal provisions for procurement and use of agrochemicals.

METHODS

Research question

A correlational cross-sectional study was conducted, using secondary data, to investigate the relationships between the characteristics of farmers who participated in the 2012 agricultural census in Grenada and the use of agrochemicals at frequencies that were found to pose risk to human health. Two research questions were posed in the study. The first research question in this study was: What is the relationship between the characteristics of farmers in the 2012 agricultural census in Grenada and the use of agrochemicals at the frequency that can potentially cause farmers to experience sleep apnea, rheumatoid arthritis, decrease in LINE-I DNA methylation, and allergic and non-allergic wheeze, respectively? The second research question was: What is the relationship between the characteristics of farmers in the 2012 agricultural census in Grenada and the use of herbicide (paraquat) at frequencies that can potentially cause farmers to experience ESRD and Parkinson's diseases?

Target population

The 2012 agriculture census was conducted with farmers in the State of Grenada that met the criteria of having responsibility for farm holdings: 1 or more cattle, 5 or more sheep, goats and pigs (combined), breeding sheep, goats or pigs, 25 or more poultry, 25 or more fruit, nut or spice trees (combined), ¼ acre (10,000 square feet) of land used for garden crops (temporary vegetables, root crops, herbs, melons, pineapples, flowers, etc.), annual sales of agricultural produce of EC$2,500 or more [22].

Data collection

Data from the 2012 agriculture census were used in the analysis. The census was conducted from October–November, 2012 with each household in the State of Grenada – that is, on the mainland and in the two dependency islands, Carriacou and Petite Martinique [23]. Trained enumerators canvassed the 287 enumeration districts and administered a short questionnaire to identify the households with farmers that met the criteria of the target population. In households that met the criteria, the long farm questionnaire was administered to one farmer – the individual that had responsibility for a farm. When more than one individual had responsibility for a farm, the farmer was regarded as the individual who spent the most time working on a farm that was owned, leased, or without legal title. If two or more individuals spent equal time working on the farm, the eldest person was considered as the farmer to answer the questions [22]. The data were collected through face-to-face interviews and responses were filled on the questionnaire. The dataset of the 2012 agricultural census contained responses of 9295 farmers.

Independent and dependent variables

The social independent variables investigated in this study were: age, gender, highest level at which education was completed, size of household, and membership in a farm organization. For the first research question (RQ1), the frequency of use

of agrochemicals was the dependent variable, categorized as *ever used* agrochemicals and *never used* agrochemicals. In the AHS, ever use of the agrochemicals - carbaryl, glyphosate, and paraquat - were found to be associated with the farmers experiencing the health problems in RQ 1 [13-16].

For the second research question (RQ2), the dependent variable was the frequency of use of herbicide (paraquat). The algorithms used in the AHS were applied in this study to quantify exposure and to determine the potential for farmers in Grenada to experience specific health problems. Parkinson's disease was found to be associated with at least 25 lifetime days of use of paraquat, a herbicide [17]. Farmers who reported use of agrochemicals ≥ 12 times in the census year were likely to use the chemicals for 25 lifetime days over a period of 2.5 years. ESRD was found to be associated with ≥ 2087 intensity-weighted risk exposure to paraquat [18,24,25]. This score is achievable by the use of herbicide ≥ 12 times per year following a lapse period of 11 years. **Tables 1 and 2** show the calculation of cumulative intensity-weighted exposure days and the lapse period, indicating the potential period of exposure that may can lead to the farmer experiencing the health problems stated in RQ2. The score was calculated taking into consideration field activities, use of protective equipment while mixing and applying agrochemicals, and frequency of application/use of the agrochemicals.

Table 1. Calculation of average work-day risk exposure.

Task	Risk for Exposure Value	Exposure Situation
Mix	9	Assumption that the farmer mixed agrochemical more than 50% of the time given that 20% of fewer farmers had paid workers.
Apply	8	Farmer commonly (57%) used knapsack sprayers to apply agrochemicals in Grenada. This data were extracted from the dataset.
Repair	2	An assumption was made that the farmer generally repaired/loaded the knapsack sprayer in the field.
PPE	X .80	Each of 5 PPE item contributed 20% reduction in exposure. Rubber boots were the main PPE used by farmers in Grenada. Therefore, the level of exposure is about 80%.
Intensity risk score	15.2	

Table 2. Calculation of cumulative intensity weighted risk exposure score and lapse period.

Task	Risk for Exposure Value	Exposure Situation
Average work-day exposure intensity Risk Score	15.2	Based on calculations above.
Frequency/days per year of use of pesticides	X 12	The highest frequency reported for use of herbicides is ≥ 12 days per year.
Duration of years	X 1	One year was used in the calculation, given the recall period of 12 months in the census.
Highest cumulative intensity weighted exposure risk score reported in the census year	182.4	

Data analysis

Descriptive and inferential analyses were conducted using IBM SPSS Statistics Software (version 24). The codes in the dataset were screened and, where necessary, the data were categorized and/or re-coded for the analyses. The descriptive analyses included cross tabulation to observe cell counts (not shown in the results). Cells with count <10 were combined to create larger counts that were appropriate for conducting binomial regression analysis [26]. Binomial regression analysis was conducted to investigate whether there were statistically significant relationships between the independent and dependent variables. The regressions analysis also generate odds ratio; that is, the likelihood that an outcome will occur given a particular characteristic. Odds ratio also provides an indication of the strength of association between a characteristic and the outcome. The statistical significance of the effect of each independent variable on the dependent variable was interpreted with alpha 0.05 as the cutoff point. The results of the odds ratio were interpreted with a 95% level of confidence.

Ethical approval for the study

The study was approved by Walden University IRB in the United States and by St. George's University IRB in Grenada.

RESULTS

Descriptive analysis

Responses in the study: Of the 9295 farmers responding in the dataset, 95.4% (N=8868) were involved in crop production only or in both crop production and animal husbandry. These farmers were included in the analysis. Farmers who did not report involvement in crop production were not included. A total of 11.9% (n=1059) farmers also reported they used one or more agrochemicals in the last 12 months (census year).

Gender, age, and education of farmers: A total of 71.5% of the farmers were males (n=6343) and 28.5% were females

e-ISSN:2347-226X
p-ISSN:2319-9857

(n=2525). The majority of farmers were in the middle to older age groups; 35-44 (18.1%, n=1608), 45-54 (26.2%, n=2324), 55-64 (19.1%, n=1694), and 65-74 (12.7%, n=1127). More than half of the farmers completed education at the level of secondary school, (56.9%, n=5044), while a quarter completed at vocational school (25.1%, n=2226). The smallest number of farmers completed their education at primary school (0.8%, n=70) and university (2.6%, n=230). **Table 3** shows the frequency and percent statistics of gender, age, and education of the farmers.

Size of farmers' households: The majority of farmers had household with 1-4 members (74.8%, n=6633). About one quarter of the farmers had larger households with 5-9 members (23.7%, n=2101). Less than 2% of farmers had 10 or more members in the household. **Table 3** shows the frequency and percent statistics of the size of the farmers' households.

Table 3. Frequency and percent statistics for gender, age, and education.

Demographic	Frequency (n)	Percentage (%)
Gender		
Male	6343	71.5
Female	2525	28.5
Total	8868	100
Age		
15-24	242	2.7
25-34	917	10.3
35-44	1608	18.1
45-54	2324	26.2
55-64	1694	19.1
65-74	1127	12.7
≥ 75	701	7.9
No response	255	2.9
Total	8868	100
Education		
Primary	70	0.8
Secondary	5044	56.9
Vocational	2226	25.1
University	230	2.6
Tertiary	1272	14.3
No response	26	0.3
Total	8868	100
Size of Household		
1-4 members	6633	74.8
5-9 members	2102	23.7
≥ 10 members	123	1.4
No response	10	0.1
Total	8868	100

Membership in farm organizations: The farmers were asked whether they belonged to any farm organization, including Fair Trade, Grenada Cocoa Association (GCA), Grenada Cooperative Nutmeg Association (GCNA), Farm Watch, Carriacou Farmers Associations, or other farm organizations. The majority of the farmers did not have membership in a farm organization (67.8%, n=6013).

Statistical analysis

RQ1: Four independent variables - gender, age, education, and membership in a farm organization were found to have statistically significant relationship ($p<0.05$) with the dependent variable in RQ1 (frequency of use of agrochemical in the census year). The size of the farmers' households were not found to have statistically significant relationship with the dependent variable ($p=0.168$).

Compared to the farmers who completed education at the primary school level, the odds of having ever used agrochemical was >1 for all farmers who completed education at higher level institutions. The differences in odds between the education categories were not statistically significant except for the difference in the odds for farmers who completed education at primary school compared with the farmers who completed at vocational school (OR 1.945, 95 CI: 1.028-3.679, $p=0.041$). Farmers who completed education at vocational school were more likely to have ever used agrochemicals in the census year and potentially experience the health problems stated in RQ1 compared to farmers who completed education at primary school. **Table 4** shows the results of binomial regression analysis with level at which education was completed and the frequency of use of agrochemical.

e-ISSN:2347-226X
p-ISSN:2319-9857

Table 4. Logistic regression analysis with frequency of use of agrochemical in the census year and education.

	95% C.I. for EXP(B)							
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Primary			22.45	4	0			
Secondary	0.399	0.32	1.553	1	0.213	1.49	0.796	2.79
Vocational	0.665	0.325	4.187	1	0.041	1.945	1.028	3.679
University	0.142	0.366	0.15	1	0.698	1.153	0.562	2.364
Tertiary	0.214	0.327	0.43	1	0.512	1.239	0.653	2.352
Constant	1.576	0.317	24.681	1	0	4.833		

RQ2: Membership in a farm organization was the only independent variable that was found to have a statistically significant relationship with the dependent variable in RQ2 ($p<0.05$).

The odds of use of herbicide ≥ 12 times in the census year was at least twice times greater for farmers who did not belong to a farm organization and statistically significant (OR 2.481, 95%CI: 1.039-5.926, p=0.041). The farmers with membership in farm organizations were, therefore, more likely to experience ESRD after 11 years and Parkinson's disease after 2.5 years. **Table 5** shows the variables in the equation for logistic regression analysis with membership in farm organization and use of herbicide ≥ 12 times per year.

Table 5. Logistic regression analysis with use of herbicide ≥ 12 Times in the census year and membership in farm organization.

	95% C.I. for EXP(B)							
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Does not belong to farm organization	0.909	0.444	4.187	1	0.041	2.481	1.039	5.926
Constant	-3.645	0.383	90.639	1	0	0.026		

DISCUSSION

This study was the first in Grenada to investigate the relationship between the characteristics of farmers and the use of agrochemicals at levels that that were found in previous research to pose risk to human health. The study is unique for two main reasons. First, the study draws on the technical features of a large prospective cohort study in the United States to generate results about potential public health risk in a small Caribbean state. The algorithms used in the AHS were applied to calculate exposure to hazardous chemicals by farmers in Grenada. Second, while publications of the findings in the AHS and other studies frequently included information on the relationships between age, gender, education and health outcomes, this study investigated two additional social variables - membership in farm organizations and household size. The findings related to the two variables provide insights into the effects of factors that may be investigated in future studies in Grenada and in other countries.

Alexander et al. found that paraquat and carbaryl were significantly associated with decreased LINE-1 DNA methylation and certain cancer risk in participants with the highest lifetime exposure [14]. Tanner et al. found a relationship between use of paraquat for at least 25 lifetime days and Parkinson's disease [17]. Hoppin et al. also found a relationship between the use of glyphosate and allergic and non-allergic wheeze, especially in younger farmers under 50 years [16]. Interestingly, the differences for having ever used agrochemicals between categories of farmers were not statistically significant except for the difference between the farmers who completed school at primary and vocational institutions. This finding may indicate there were differences between the groups in awareness, decision, and access to information related to the use of agrochemicals.

O'Donnell et al. reported pesticide exposure was positively associated with being a case of low glomerular filtration rate in farmers in Nicaragua [28]. Although O'Donnell et al. did not indicate the specific chemical to which the participants were exposed, the results provided a useful insight into education - as a determinant of exposure to agrochemicals. In the Nicaraguan study, cases of low glomerular filtration rate, an indicator of renal problems, were less likely among individuals who attended school [28]. The findings in Grenada, with regard to the effect of education on exposure to agrochemicals, is consistent with the findings of O'Donnell et al. in cases where the farmer did not attend or complete primary education before attending a vocational institution. Therefore, at the vocational level, the individual may still be considered to have the lowest level of education. On the other hand, individuals who completed secondary school may also, thereafter, attend vocational institutions to pursue skills training. In the latter cases, the results in Grenada may not indicate greater odds of having ever used agrochemicals by farmers with the lowest level of education but, instead, by those who completed school at a slightly higher level (vocational level). Further research is, however, needed to determine how vocational education may influence agricultural practices in Grenada. Although the findings in Grenada and Nicaragua suggest differences in exposure to agrochemicals and health risks by farmers with different levels of education, Semple [29] and Henry and Feola [19] found that education was not a determinant of the use of PPE. Further studies are, therefore, also needed to determine whether there was a change in the relationship between education and the use of PPE over the years.

The results of the study in Grenada also show statistically significant differences in having used herbicide, such as paraquat, ≥ 12 times in the census year by farmers who did and did not have membership in farm organizations. Membership in farm

e-ISSN:2347-226X
p-ISSN:2319-9857

organizations may contribute to increased access to information about the hazardous nature of specific chemicals. Members of the farmers' organizations in Grenada may also have greater access to farm labor programs for land clearing, reducing the need for the use of herbicides. The results show farmers who do not have membership in farm organizations were at least twice likely to have used herbicide, presumingly prarquat, ≥ 12 times in the census year. Consequently, these farmers may also be at greater risk of experiencing end stage renal disease and Parkinson's disease. Membership in farm organization may be an important determinant of farming practices and an avenue through which education and services may be provided to reduce exposure to hazardous agrochemicals.

The Constitution of Grenada provides for protection of all citizens. As such, the Government has a responsibility to ensure that the Constitution is upheld to protect the health and wellbeing of citizens. In 1975, Grenada became a signatory of the Universal Declaration of Human Rights which provides for "just and favorable conditions of work" [30]. In 1991, Grenada also became a signatory of the International Covenant on Economic, Social and Cultural Rights: 1976 which states in Article 12, "The States Parties to the present Covenant recognize the right of everyone to the enjoyment of the highest attainable standard of physical and mental health" [31]. Data is not collected for epidemiological surveillance in the agriculture sector in Grenada. Although this information would be useful to estimate disease burden in the sector, there is no policy or legal obligation for compiling the information. Another challenge lies in documenting occupational history of patients. Commonly, physicians do not seek to explore linkage between occupation and disease and, consequently, occupational history is not documented. Without interventions to minimize farmers and other residents' exposure to hazardous chemicals, Grenada is in contradiction with these conventions.

From as early as 1973, Grenada passed The Act to Provide for the Control, Sale, Storage, and Use of Pesticides [32]. The Act and its regulations comprise the main legal framework to address pesticides use, providing for the development of regulations; establishment of a Pesticides Control Board to regulate and monitor importation and use of pesticides; inspection of land and premises believed to be involved in sale, storage, manufacturing and use of pesticides; inspection of documents to ensure compliance; and seizing of illegal samples. Since then, almost every subsequent government contributed to the revision of the Act to improve the provisions for protection of the health of residents. Currently, the Act is being reviewed and the draft Pesticides and Toxic Chemical Control Bill is being further revised before submission to the Parliament for approval and enactment. The current draft Bill addresses, inter alia, importation, manufacture, storage, sale, licensing, record keeping, inspection, medical examination and penalties related to use of toxic chemicals and pesticides. The Bill, however, does make provisions for knowledge enhancement about safety in pesticide use. As such, based on evidence of the cost effectiveness of training, research and knowledge development may be incorporated as a legal responsibility of the Pesticides Control Board or the Ministry of Agriculture. The history of attempts by governments to revise and enact the law in Grenada may be regarded as an indication of willingness to address the public health issue.

The health of farmers has implications for production, food security, and nutrition both for households and at the national level. Despite an aging farming population, the proposal of the WHO is pivotal for the sustainability of the local agriculture sector. The WHO urged public health practitioners and health care authorities to identify and address upstream determinants of health as one of three critical steps to achieve equity in health and to improve the social conditions in communities. As such, based on the results of this study, the following should be considered by public health practitioners:

1. Whether there is a need to address the type of agrochemicals that are used in Grenada;
2. Whether there is a need to address agricultural practices related to personal protection;
3. Whether there is a need to modify the surveillance system to monitor occupational-related diseases.

An affirmative approach is needed to address the higher odds of experiencing health problems by farmers in Grenada. The outcome of the Dewayne Johnson case in California in August, 2018, may be an example of the health consequences that workers may face stemming either from a lack of information or failing to act on information to protect public health. An increase in the incidences of the health problems stated in this study can be serious negative implications for farmers, household members and the local health care system.

Two measures may be most critical to respond to the findings in this study. First, the underpinning principle of public health practice, prevention, should be promoted in the farming population. Preventing health problems should be the main goal of any policy or intervention related to the use of agrochemicals in Grenada. Second, the precautionary principle should be adopted. Farmers should be made aware of the risk and encouraged to be cautious and take responsibility for their health. Prevention and precaution can effective strategies in the short term while other long-term interventions are developed.

There were limitations in conducting the study. The specific agrochemicals that were used by the farmers were not reported in the census. As such, the results in this study provide a general indication of potential health problems from exposure to specific agrochemicals at the frequencies reported by farmers in Grenada. Other studies should be conducted to provide specific information to answer the research questions. The results of this study may be used as baseline to compare the results of future studies and to provide some direction for the need for additional studies.

Another limitation of the study was gaps in the collection of data on the use of personal protective equipment (PPE). These

data were essential for calculating the cumulative intensity risk exposure score. In one study, there was an indication of sparse use of PPE in Grenada, except rubber boots [29]. Mention was not made of the use of chemical resistant gloves, respirators, overalls, and other personal protective equipment for protection against exposure to agrochemicals.

Most of the AHS studies were conducted with White male applicators while the census in Grenada was conducted with Black male and female farmers. The differences in how agrochemicals may affect racial and gender groups were not considered in this study. This study did not focus on the pathways in the development of health problems. The study was limited to investigating the association between the health problem and socioeconomic factors. However, geographical, social, economic contexts may account for differences in the findings in the AHS and the study in Grenada. This study may be used as baseline against which the finding of other studies may be compared and to provide a foundation for more comprehensive studies.

ACKNOWLEDGMENT

The authors are grateful to the Permanent Secretaries in the Ministry of Agriculture in Grenada for making the dataset available for this study. Special thanks to Ms. Lavern Mapp and Mr. Imi Chitterman for their consistent support to me in conducting this study. Thanks to Dr. Ronald Hudak and Dr. Timothy McIndoo for their contributions and guidance to conduct this study.

REFERENCES

1. WHO. Highly hazardous pesticides. World Health Organization, 2018.
2. Lewis KA, et al. An international database for pesticide risk assessments and management. Hum Ecol Risk Assess. 2016;22:1050-1064.
3. Jallow MFA, et al. Pesticide knowledge and safety practices among farm workers in Kuwait: results of a survey. Int J Environ Res Public Health. 2017;14:340.
4. Mamane A, et al. Occupational exposure to pesticides and respiratory health. Eur Respir Rev. 2015;24:306-319.
5. Remoundou K, et al. Pesticide risk perceptions, knowledge, and attitudes of operators, workers, and residents: A review of the literature. Hum Ecol Risk Assess. 2013;20:1113-1138.
6. Campo KRK, et al. Connecting small farmers in the Caribbean to knowledge, networks, and institutions through ICTs. J Agric Food Inf. 2017;18:81-95.
7. Government of Grenada. Census on agriculture, 2012.
8. WHO. The WHO recommended classification of pesticides by hazard and guidelines to classification 2009. Geneva, Switzerland. 2010;p:81.
9. WHO. IARC monographs volume 112: evaluation of five organophosphate insecticides and herbicides. 2015;p:2.
10. WHO. IARC monographs on the evaluation of carcinogenic risks to humans. Lyon, France. 2014;p:60.
11. Alavanja MCR, et al. The agricultural health study. Environ Health Perspect. 1996;104:362-369.
12. NIEHS. Agricultural Health Study. National Institute of Environmental Health Sciences, 2017.
13. Baumert BO, et al. Sleep apnea and pesticide exposure in a study of US farmers. Sleep Heal. 2018;4:20-26.
14. Alexander M, et al. Pesticide use and LINE-1 methylation among male private pesticide applicators in the Agricultural Health Study. Environ Epigenetics. 2017;3:1-9.
15. Meyer A, et al. Pesticide exposure and risk of rheumatoid arthritis among licensed male pesticide applicators in the Agricultural Health Study. Environ Health Perspect. 2017;125:077010.
16. Hoppin J, et al. Pesticides are associated with allergic and non-allergic wheeze among male farmers. Environ Health Perspect. 2017;125:535-543.
17. Tanner CM, et al. Rotenone, paraquat, and parkinson's disease. Environ Health Perspect. 2011;119:866-872.
18. Lebov JF, et al. Pesticide use and risk of end-stage renal disease among licensed pesticide applicators in the Agricultural Health Study. Occup Environ Med. 2016;73:3-12.
19. Henry D and Feola G. Pesticide-handling practices of smallholder coffee farmers in Eastern Jamaica. J Agric Rural Dev Trop Subtrop. 2013;114:59-67.
20. Ragin C, et al. Farming, reported pesticide use, and prostate cancer. Am J Mens Health. 2013;7:102-109.
21. Forde MS and Dewailly E. What is in the Caribbean baby? Assessing prenatal exposures and potential health outcomes to environmental contaminants in 10 Caribbean countries. West Indian Med J. 2015;64:23-28.
22. Government of Grenada. Agriculture census: Field team manual. St. George's, Grenada. 2012;p:35.
23. Government of Grenada. Grenada agricultural census 2012 - Explanatory notes. St. George's, Grenada. 2012;Pp:1-2.

e-ISSN:2347-226X
p-ISSN:2319-9857

24. Storm J, et al. Understanding the agricultural health study - Part 2: Pesticide exposure. 2004;p:2.

25. De Roos AJ, et al. Cancer incidence among glyphosate-exposed pesticide applicators in the Agricultural Health Study. Environ Health Perspect. 2005;113:49-54.

26. Vittinghoff E and McCulloch CE. Relaxing the rule of ten events per variable in logistic and Cox Regression. Am J Epidemiol. 2007;165:710-718.

27. Ministry of Agriculture. Grenada pesticide control board imports. St. George's, Grenada, 2012.

28. O 'donnell JK, et al. Prevalence of and risk factors for chronic kidney disease in rural Nicaragua. Nephrol Dial Transpl. 2011;26:2798-805.

29. Semple H, et al. Agrochemicals usage and protective clothing among small farmers in Jamaica and Grenada. Caribb Geogr. 2005;14:15-30.

30. United Nations. Universal declaration of human ruights. 2017;p:8.

31. United Nations. International covenant on economic, social and cultural rights: Adopted and opened for signature, ratification and accession by General Assembly resolution 2200A (XXI) of 16 December 1966.

32. Government of Grenada. Pesticides Control Act, 1973. Act No: 28, Grenada. 1973;Pp:238-251.