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Pesticide Usage in Pest Management by Vegetable Producers in the Foumbot Production Basin of the Western Highlands (Cameroon)

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Abstract

Purpose: Cameroon is the food basket of the Central African Region in terms of food production and a significant proportion of her population depends on the production of fruits and vegetables for livelihood. The Western Highlands of Cameroon is known for its high agricultural output, especially in the domain of market gardening. The Foumbot Production Basin in the Western Highlands of Cameroon is noted for its high agricultural output, especially in the domain of market gardening. Produce originating from this area is consumed throughout the nation, especially in the Southern Regions of Cameroon and also exported to neighbouring countries like Gabon, Equatorial Guinea and Central African Republic. This study therefore sought to find out how pesticides are being employed in the production of these crops (mostly fruits and leafy vegetables, of short growing cycles) in the Foumbot Production Basin of the Western Highlands of Cameroon.

Methodology: A survey was conducted in which a well-developed questionnaire containing both closed multiple-choice and open-ended questions, was established to collect important information related to the topic from the market gardeners in the Foumbot Production Basin. A total of 100 market gardeners were interviewed. Data was analyzed using descriptive statistics. The data allowed us to assess the pesticide use practices of tomato growers by having a clear idea on demographic social characteristics (sex, level of education, age, and marital status), agronomic practices (cropping season and cropping system), application of pesticides (types of pesticides used, source of information's relating to the use of pesticides, the moment of application, reaction following the ineffectiveness of the product, respect pre-harvest intervals, knowledge of the presence of residues in the fruits, health effects, wearing of PPE and disposal of empty packaging).

Findings: It was observed that a majority of the gardeners were males with mostly secondary education. Many of the gardeners did not disposed their empty pesticide containers properly while a majority did not use personal protective equipment during application. Up to 93% of producers do not respect or ignore the pre-harvest interval. Harvest was determined by the availability of buyers of the crop, irrespective of the last time it was sprayed. This is attributed to the complete absence of extension services and training.

Unique Contribution to Theory, Practice and Policy: This information can be used to develop a training programme on pest management especially on pesticide use in the Foumbot Production Basin.

Keywords: *Pesticides, Market Gardening, Pests, Foumbot, Western Highlands*

1.0. INTRODUCTION

Agriculture is undoubtedly the backbone of the economy of Cameroon, and other economic activities thrive only if production is this sector is assured. The western highland of Cameroon is actively involved in this agricultural activity most especially in the Foumbot production basin. Market gardening is a very important farming type in this area as it is a major livelihood activity of the people in terms of income, employment and subsistence. This basin is well known for its contribution in the domain of market gardening as produce originating from here is sold in many towns in Cameroon especially in the southern part, and even exported to neighbouring Countries like Gabon, Equatorial Guinea and Chad. Ofoka *et al.*, (2013), market gardening is the growing, processing and marketing of fruits, vegetables and ornamental plants.

Many market gardeners in this zone make their living from the cultivation and selling these vegetables. Among various economic and social benefits, market gardening has a vital and multifaceted role in providing food security, meeting the demands of consumer markets, utilising labour and generating income. Many people derive great satisfaction from seeing plants grow and produce nutritious food for themselves and their communities. Vegetables play a significant role in human nutrition, especially as a source of dietary fibre, minerals and vitamins – C (ascorbic acid), A, thiamine (B1), niacin (B3), pyridoxine (B6), folacin, B9 and E (Wargovich, 2000; Tarla *et al.*, 2015). Other important nutrients supplied by fruits and vegetables cultivate include riboflavin (B2), zinc, calcium and phosphorous. These Fruits and vegetables remain an important source of nutrients in many parts of the world and offer advantages over dietary supplements because of the low cost and wide variety (Tarla *et al.*, 2015). The main vegetable crops cultivated are green beans (*Phaseolus vulgaris* L.), tomato (*Solanum lycopersicum* L.) green pepper (*Capsicum annuum* L.), watermelon (*Citrillus lanatus* L.), leeks (*Allium porrum* L.), lettuce (*Lactuca sativa* L.), amaranth (*Amaranthus cruentu* L.), huckleberry (*Solanum scabrum* Mill.), carrot (*Daucus carota* L.), pepper (*Capsicum frutenscens* L.) and cabbage (*Brassica oleraceae* var. *Capitata* L.) (Abdulai *et al*., 2019).

As urban centres expand, the demand for fresh garden produce increases and the land devoted to market gardening also expands, usually in the periphery and this is particularly true in developing countries where rapid urbanisation is prevalent (Friesen, 1998; Abdulai *et al*., 2019). The immediate benefits are a source of income, livelihood assurance and food security for the market gardener, their household, as well as the wider community. The income generated from market gardening also provides indirect socio-economic benefits for market gardeners, such as greater access to household items (televisions, chairs) and greater mobility from the purchase of motor vehicles, motorbikes or bicycles.

Market Gardening in this basin still encounters a lot of problems, which lead to low yields. Some of these problems include insufficient land, lack of irrigation systems, lack of properly channeled markets, and high cost of inputs, dwindling soil fertility, and the pertinent problem of pests. Successful market gardening in the Foumbot production basin is greatly hindered by these pests and diseases which has greatly affected output. For yields to increase, farmers have in recent years relied mostly on the use of pesticides and fertilizers commonly referred to as agrochemicals. Agrochemical use has increased over the past 20 years, the highest identified in low-income countries starting from a low base such as Cameroon, Ethiopia, and Burkina Faso with an 8- to 50-fold increase (Pretty and Bharucha, 2015).

The Foumbot production basin is mostly focused on vegetables which they supply within and out of this area. To increase production and to meet the high demands, the use of pesticides has been highly practiced in vegetables farming in the area (Sonchieu *et al*., 2017; Abdulai *et al*., 2019). However, according to standards set by World Health Organization, only pesticides that are safe to farmers and farm-workers, other non-target species and the consumers should be used in production of vegetables

(WHO, 1986). But, the safer pesticides are often either more expensive as many of the gardeners cannot afford them. Farmers and pesticide users are required, to handle, apply and discard leftover pesticides safely in order to reduce the hazards they pose to non-target animals, themselves and plant species. This is not always the case as many markets gardners practice indiscriminate use of these chemicals, applying whenever they want and with dosages not in conformity with that of manufacturers' dosages (Abdulai *et al*., 2019). This therefore requires reinforcements by training farmer on safe use, respect of dosages, storage and disposal of pesticides and followed via close monitoring.

Pesticides are intensively used in Cameroon by farmers and traders to protect their plants and products during production and postharvest storage (Galani *et al*., 2018; Kenko *et al*., 2017). They are a major technological tool used worldwide to boost agricultural production. The Foumbot Production Basin in the Western Highlands of Cameroon is noted for its high agricultural output, especially in the domain of market gardening. Produce originating from this area is consumed throughout the nation, especially in the Southern Regions of Cameroon. The produce from this area is also exported to neighbouring countries like Gabon, Equatorial Guinea and Central African Republic. However, their adverse consequences, which may stem from misuse (as farmers, especially the less educated ones, will not follow the basic rules governing their application) and environmental persistence, could lead to many undesirable effects (Pouokam *et al*., 2017). The public health effects of these pesticides have long been known and the undesired effects have been recognized as a serious public health concern during the past decades.This study therefore sought to find out how pesticides are being employed in the production of these crops (mostly fruits and leafy vegetables, of short growing cycles) in the Foumbot Production Basin of the Western Highlands of Cameroon and to ascertain the threats they pose (or not) to human health and the environment. Tarla *et al*., 2015; Kenko *et al*., 2017 and Abdulai *et al*., (2019) in their different studies found out that a majority of market gardeners do not use pesticides correctly so this also acted as a booster for this work to be carriedout.

2.0 METHODOLOGY

Description of Study Site

Foumbot is a sub-division situated in the Noun Division of the West Region of Cameroon. Its geographical coordinates fall under 5° 16′ to 5° 35′ N; 10° 30′ to 10° 45′ E; 1100-1300 masl with 120 m (390 ft) elevation for a total surface area of 579 Km2 (PNDP, 2014). The annual rainfall varies between 2500 and 5000mm (Kimengsi & Muluh, 2013). It is found at an average altitude between 1100 and 1300 m above sea level. There are two seasons: the rainy season which runs from mid-March to mid–November and the dry season which takes place between mid-November and mid–March. More than half of the people live in the rural area where farming is the main activity. Ethnic groups are the Bamouns, Bamilekes, Bansos and Mbororos (PNDP, 2014). Foumbot subdivision, unlike other towns of the Noun Division, is situated on a vast plain, slightly inclined towards the West. Mostly of volcanic origin, Foumbot's soils are essentially made up of tropical ferruginous soils with little leaching and black with a high agronomic value given its richness in nitrogen, phosphorus and potassium.

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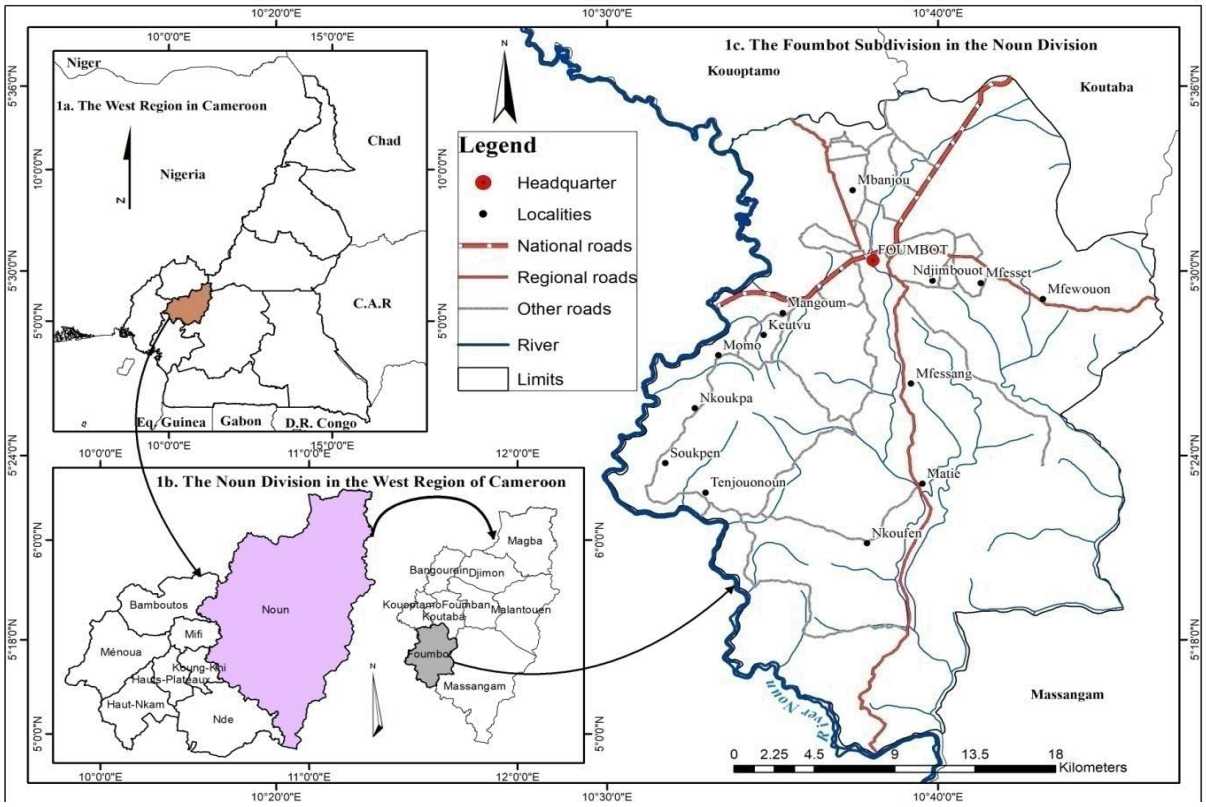

Figure 1: Map Of Foumbot Showing the Different Study Zones

Methodology

Identification of Market Gardeners in the Foumbot Production Basin

In order to identify market gardeners in the study area, database from the Sub Divisional office of the Cameroon Ministry of Agriculture and Rural Development (MINADER) was used. The database was well-established, identifying all agricultural groups in the subdivision showing the intensive market gardening areas. These groups are classified according to the main crops cultivated. Using this database, all the farmers who participated in market gardening were sorted and classified according to the different villages in the sub-division. Out of the many villages that make up the Foumbot Sub-division, four were found to have a greater proportion of farmers involved in vegetable production. These included Baigom, Mfessang and Mfesset, Mangoum.

Data Collection Methods

From January 2021 to March 2021, questionnaires were administered to 100 (One hundred) vegetables farmers who were randomly selected for interview. A well-developed questionnaire containing both closed multiple-choice and open-ended questions, was established to collect important information related to the topic from the market gardeners in the Foumbot Area. Twenty randomly selected market gardeners were interviewed face-to-face in each village of the five villages. Each interview lasted between 20 to 25 minutes depending on the collaboration of the interviewed farmers. In each farm, the owner was targeted first, and if the latter was not available, an employee was interviewed. This was done according to the availability of the farmers.

The data allowed us to assess the pesticide use practices by market gardeners, by having a clear idea on socio-demographic characteristics (sex, level of education, age, and marital status), agronomic practices (cropping season and cropping system), application of pesticides (types of pesticides used,

source of information relating to the use of pesticides, the time of application, respect of pre-harvest intervals, wearing of Personal Protective Equipment (PPE) and disposal of empty packaging, and health effects arising from pesticide application). Data was analysed using descriptive statistics and presented in the form of frequency tables and charts.

3.0 FINDINGS

Analysis of Questionnaire

Socio-Demographic Characteristics of Foumbot Market Gardeners

Analysis of the survey showed that a majority of the market gardeners in the Foumbot Area are men (76%) with women representing only 24%. This result corroborates with the findings of Sonchieu *et al*., (2017) , Tandi *et al*., (2014) ,Tarla *et al.*, (2015) and Tambe *et al*., (2019) which, showed that a majority of farmers in foumbot were males, with women constitution the minority. This can be justified by the fact that market gardening production requires a lot of human labour involving pesticide application and capital, which women may not be able to have. In most cases it was observed that the women assisted their husbands in activities that did not require a lot of energy such as transplanting, fertilizer application and harvesting of the crops.A comparison between the results of the two studies shows that there has been a considerable increase in the number of women and a slight decrease in the number of men involved in market gardening during the last five years. This variation can be considered as the direct consequence of the mass movement of the population from the English-speaking neighbouring North West Region to the closest French-speaking areas following the political crisis in North West and South West (NOSO) of Cameroon with about 530,000 internally displaced persons (Petrigh, 2019).

The results also indicated that most of the market gardeners had a basic level of education at primary (64%) and secondary (24%). Only a few farmers attended higher of education (5%). While the rest (7%) never attended school. This results were are similar to those obtained by Abdulai *et al*., (2019); Tarla *et al.*, (2015) where they found a majority of market gardeners to have the FSLC. The majority (86%) of gardeners are made up of youths aged between 20 and 49 years old [20-29 years (22%), 30-39 years (48%), and 40-49 years (16 %)]. Aged persons from 50years and above constituted just about 14%. In their study, Kenko *et al.*, (2017), also found this age group to be the predominant age group actively involved in Fako Division of South West Cameroon. A greater proportion of the population consisted mainly of married people (76%) while just a few individuals were single (Table1).

Table 1: Sociodemographic Characteristics of Market Gardeners in the Foumbot Area

	Social status of Market Gardeners	**Percentage (%)**
Sex	Men	76
	Women	24
Gardeners age group	20-29	22
	30-39	48
	40-49	16
	50-59	14
Level of education	Non	7
	Primary	64
	Secondary	24
	University	5

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Agronomic Practices and Cropping Systems

The survey indicated that 61% of the market gardeners in this production basin use land areas less than or equal to 1 hectares, while 28% had farm sizes above 1hectare but less than 5hectares. 11% cultivated in area of about 5hectares and above. A greater proportion of the gardeners cultivated during the dry season (52%) while only a few gardeners cultivated during the rainy season (11%). some cultivated their vegetables all year round (Table 2).These findings corroborate with the work of Tarla *et al.*, (2015) who reported that for the growing season, more than half of the farmers (51%) cultivated in the dry season. This choice is justified by the fact that, during this season, markets are more suitable for the selling of garden crops and the plants are less susceptible to diseases. The main source of water supplied to the farms was from streams around that were channeled to these farms with the help of motor pumps in water pipes. The main source of seeds was from registered seed retailers and most of these seed were nursed for at least 4weeks before being transplanted. This is same as the findings of Abdulai et al., (2019).

Table 2: Seasons of Cultivation

Period	Number of farmers	% of farmers
Dry season (mid November to mid-March	52	52.0
Rainy season (mid-march to mid-November)	11	11.0
All Year round	37	37.0

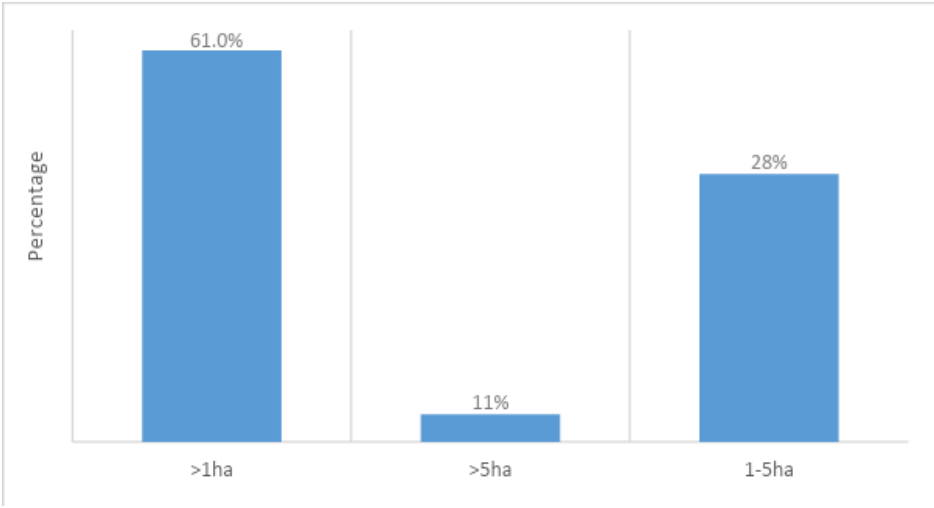

Figure 2: Percentage Distribution of Farm Sizes in the Area of Study

The cropping systems practiced by market gardeners in the Foumbot basin are monoculture (45%), and mixed cropping (55%). Mixed crops make it possible to diversify income, reduce the pressure of diseases and pests. Farmers reported that they used the income from the intercrops to be able to pay certain direct costs such as the purchase of inputs and labor. This same findings were reported by Abdulai *et al*.,(2019) in their study with market gardeners in the Santa Area of Cameroon.

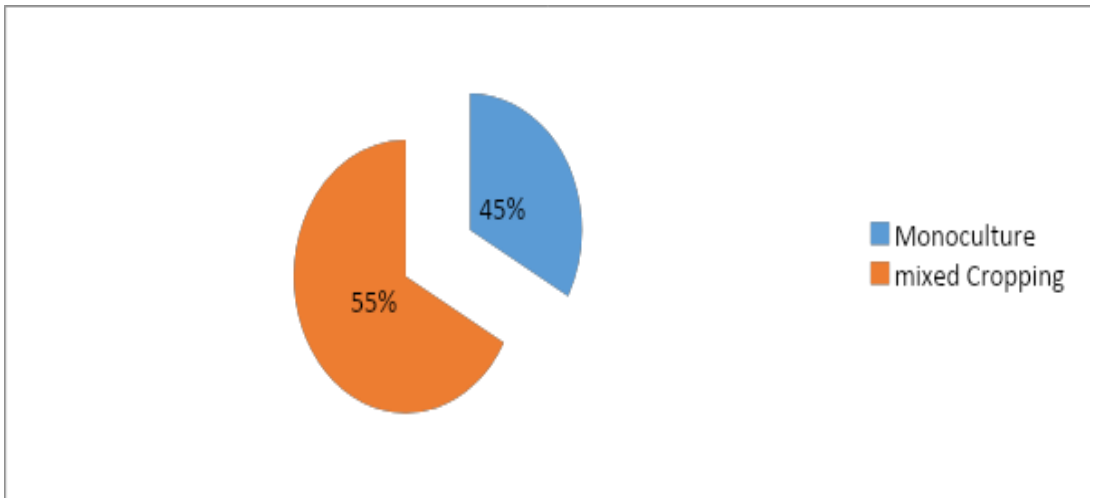

Figure 3: The Main Cropping Systems in the Foumbot Area

Pesticide Use Practices Of Market Gardeners in Foumbot

Source of Advice for Choosing a Pesticide Product

Among the pesticides used by gardeners in Foumbot Area to manage diseases and pest, 57% are recommended by the pesticide vendors, 26% was from personal experience while 11% come from advice from neighbors at the farms, 6% from buyers of crops. When farmers notice that the neighboring farm is in good health, they go there and get information on type of pesticide used and repeat the same in their own farm. Tarla *et al*., (2015) also found a majority of pesticides users to rely on information they obtained from the pesticide sellers regarding recommendation for use. As opposed to these findings, Kenko *et al*., (2017), Kenko and Kamta, (2021) in their studies instead found most of the farmers rely on pesticides labels to make their choice. This might be due to generally increased level of literacy as a majority of farmers in his study area had Secondary school certificates and university education. Sellers in most cases only intervened when the producers complain, generally about the ineffectiveness of the products used.

The measuring of pesticides dosages was not done according to standards or instructions put up by the manufacturers. Market gardeners here used available tools such as tomato tin, spoon, beer corks or table spoon. The gardeners, according to the means at their disposals, will spray a given pesticide preparation.

Concerning new products, the seller decides on the dose of the product to be used for good field efficiency, instead of the recommended dose by the manufacturer. This findings ties with that of Abdulai *et al*., (2019), who found a majority of farmers not to also respect the manufacturer's dosages. The Use of kitchen utensils or cocks and cans will not give right concentration and consequently, the spraying parameters (dosage, spraying materials and time, frequency, etc.) will not cope with the good agricultural practices (GAP) as recommended (Mala *et al*., (2015) and Sonchieu *et al*., (2017).

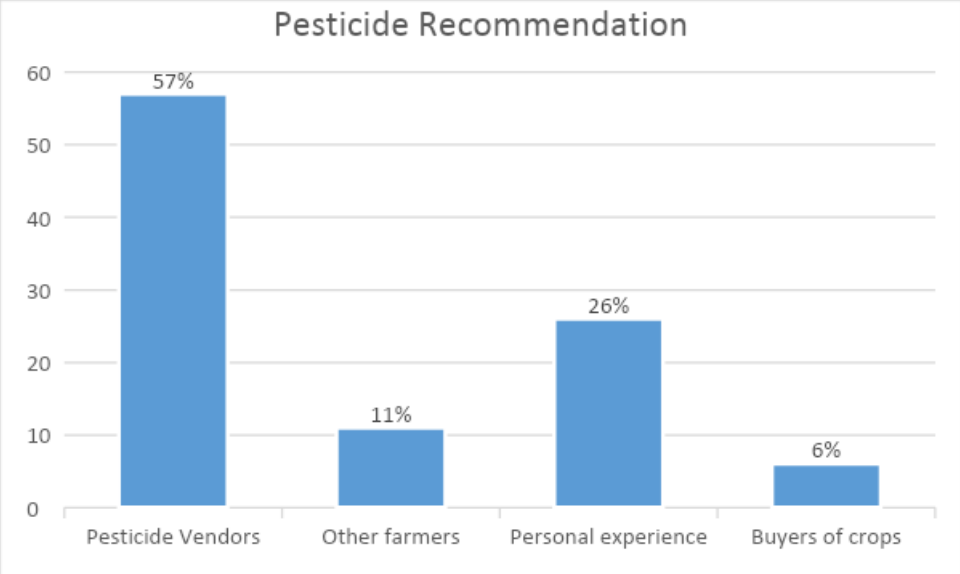

Figure 4: Source of Advice for Using Pesticide Product

Pesticide Compounds Used and Pests

The results showed that insects and diseases were some of the major problems faced by farmers. This confirms the research carried out by Christopher (2010) who found insect pests and diseases to be the major problems of vegetable production in Cameroon. Pests and diseases management in this area is done with the use of different types of synthetic pesticides. The results of the survey showed more than almost four-fifths (79.31%) are insecticides while only 13.79 and 6.90% are fungicides and herbicides respectively. Different active ingredients are used for diseases and pest management (Table 3). Pyrethrynoids and neonicotinoids are the highest groups used in the area, while all farmers use lambda cyhalothrine followed by chlorantraniliprole (98%), which is a pesticide not registered in Cameroon Sonchieu *et al*.,(2017) in their reseach in Santa also found a majority of the market gardeners to use lambda cyhalothrine as the main insecticide to control insect pests.

The predominant insect pest that caused damage above the economic injury level was the leaf miners (*Tuta absoluta)* locally called "Boko Haram" in this area. This pest affected mainly tomato as a majority of farmers here were engaged in tomato production. All the respondents in our study area recognized it as the most dangerous pest especially during the dry season. While farmers here recognize leaf miners as a serious pest,Abdulai *et al*., (2019) found cutworms(*Agrotis ipsilon*) to be the main insect pest that retarded successful gardening in the Santa Area. Essentially chemical control, is based on the use of chlorantraniliprole 200g/l but the cost is really high (estimated at 80,000 frs CFA per litre). As the cost of the product is high, many gardeners prefer to buy it in small quantities.

Gardeners did not leave pesticide mixtures on the farm. Generally, the farmer finished the mixture and returned home both with the pesticide and the Knapsack sprayer because there are a lot of thieves in the area. Returning home with the sprayer and pesticides constitute a serious health hazard to the farmer's household especially when the containers have been opened. Chronic illnesses and poisonings have been reported in the Foumbot Area and the local population generally attributes them to witchcraft but we can understand the role of pesticide storage as a major factor

Table 3: The Most Commonly Pesticides in the Foumbot Area

N°	Commercial Names	Active Ingredients	Categories	Mode of action	Application	CLASS
1	CORAGEN 20 SC	Chlorantraniliprole 200g/L	Insecticide	-	cotton	I
2	CAIMAN B	Emamectine Benzoate 50g/Kg	Insecticide	Contact	cotton	I
3	MORAN 30 DF	Indoxacarbe 300g/Kg	Insecticide	Contact	cotton	-
4	DIAMANT 35 EC	Lambda-Cyhalothrine 15g/L Acetamipride 20g/L	Insecticide	Systemic contact	vegetables	II
5	GREMEC 50 WG	Emamectine Benzoate 50g/Kg	Insecticide	Contact	-	I
6	EMACOT 050 WG	Emamectine Benzoate 50g/Kg	Insecticide	Contact	vegetables	I
7	CYPERCOT	Cyperméthrine 100 EC	Insecticide	Contact	Cocoa, vegetables	II
8	COLIBRI 30 SL	Imidaclopride 30 G/L	Insecticide	Systemic	Cocoa	II
9	PLUSFORT 45 SC	Thiamethoxam 30g/L Lambda-Cyhalothrin 15 G/L	Insecticide	Systemic Contact	Cocoa, vegetables	II
10	LYNX EC	Lambda-Cyhalothrin 15 G/L Acetamipride 20g/L	Insecticide	Systemic	vegetables	II
11	PACHA 25 EC	Lambda-Cyhalothrin 15 G/L Acetamipride 10g/L	Insecticide	Systemic	vegetables	II
12	FIXE 50 EC	Fipronil 50 G/L	Insecticide	Contact	Cocoa	II
13	BOMEC 18 EC	Abamectine 18g/L	Insecticide	Contact	vegetables, fruits	
14	ALPHACYGA 180 EC	Alphamethrine 180 G/L	Insecticide	Contact	vegetables	-
15	KANNON 90 EC	Imidaclopride 30 G/L Lambda-Cyhalothrin 60 G/L	Insecticide	Systemic	Cocoa, vegetables	II
16	CICAPSIDS 50 SC	Fipronil 50 G/L	Insecticide	Contact	cocoa	II
17	SAVAHALER 250 WP	METHOMIL 250 G/Kg	Insecticide	Systemic	vegetables	-
18	GALAXY 80 EC	Imidaclopride 40 G/L Lambda-Cyhalothrin 40 G/L	Insecticide	Systemic Contact	Cocoa,cotton, vegetables, coffee	II
19	CYPER 50 EC	Cypermethrine 50 EC	Insecticide	Contact	vegetables and cocoa	II
20	ONEX SUPER 40 EC	Acetamipride 20g/L Cypermethrine 20 G/L	Insecticide	Translaminaire and Systemic	cocoa	II
21	EPERVIER 220EC	Cypermethrine 20 G/L Chlorpyriphos-Ethyl 200 G/L	Insecticide	Systemic Contact	Coffee	II

22	COFRESH GOLD 90 EC	Imidaclopride 30 G/L Lambda-Cyhalothrin 60 G/L	Insecticide	Systemic Contact	Cocoa,cotton, vegetables, coffee	II
23	AREA 50 EC	Emamectine Benzoate 10g/Kg Lambda-Cyhalothrin 40 G/L	Insecticide	Systemic contact	vegetables	II
24	PLANTINNEB	Manebe 80g/kg	Fungicide		vegetables, fruits	
25	PENNCOZEB 80 WP	Mancozebe 80g/kg	Fungicide	contact	vegetables	
26	COTZEB 80 WP	Mancozebe800g/kg	Fungicide	contact	vegetables	III
27	MANCOSTAR 80 WP	Mancozebe	Fungicide	contact	vegetables	
28	GLYPHOSATE	Glyphosate	herbicide	Systemic	-	

Timing of Pesticide Application

The market gardeners in this production basin applied pesticides at different times of the day. Some applicators do this at any time of the day, but in the majority of cases, pesticides are sprayed in the morning between 6a.m and 9a.m. In fact, of the 100 farmers interviewed, 54% carry out their applications in the morning (6 to 9 a.m.), 30% carry them out at any time, while 16% in the afternoon (3 to 5 p.m.)(Table 11). This result corroborates with the findings of Sonchieu *et al*., (2017); Abdulai *et al*., (2019) who found out their different studies that market gardeners in the Santa area apply their pesticides mostly in the mornings.

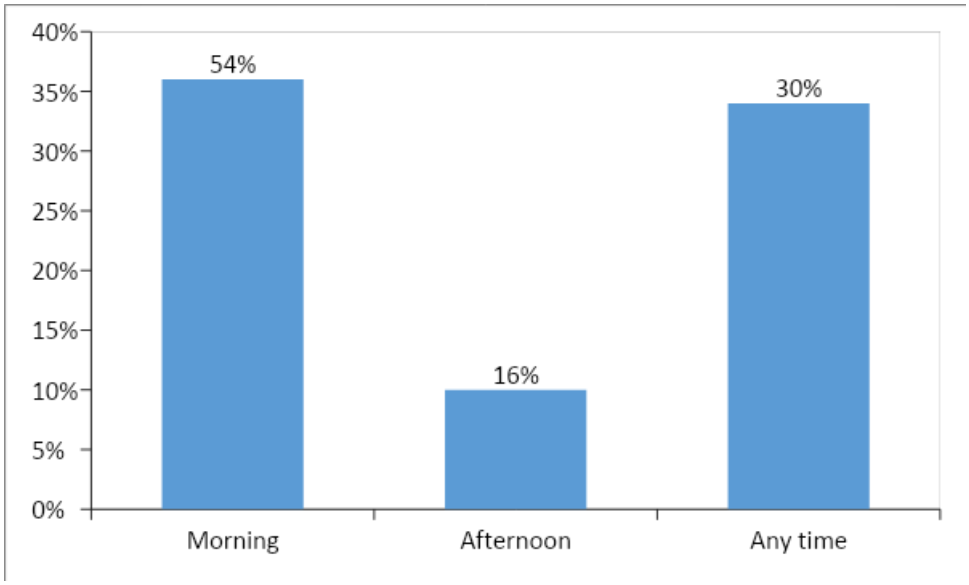

Figure 5: Timing of Pesticides Application

Naturally, the majority of producers do not respect the time allocated between the last treatment and harvest. Up to 93% of producers do not respect or ignore the pre-harvest interval. Harvest was determined by the availability of buyers of the crop, irrespective of the last time it was sprayed. Sonchieu *et al*.,(2017 also found this in their study in Santa. Of the formulations used, 98% are essentially liquid and 2% are powder. The application of pesticide products is accelerated at the time

of fruiting: 77% of farmers affirmed that they increased the treatment as well as the frequencies at the time of fruiting until maturity. One fifth (20%) of farmers stated that they achieve maximum application of the products at flowering and only 3% say that they maintain the same spray rate throughout the plant cycle. On the other hand, the notion of pesticide residues present in fruits is very surprising for most market gardeners: 91% declared having no idea about the presence of residues of pesticides used for treatment in the fruits. In a study by Sonchieu *et al.*, (2019), farmers in Mount-Bamboutos Agricultural Area, did not know the existence of residues after application.

In order to preserve the health of final consumers, it must be ensured that the pesticide residues present in the fruits and vegetables treated do not exceed the MRL (Sonchieu *et al.*, 2017). The survey shows that the market gardeners stop spraying the fruits not according to the manufacturer recommendations, but according to their own perception of the presence of pests and diseases in their plots (especially when the fruits are already present). Several reasons can explain this behavior: (i) wrong timing of treatment, (ii) desire to save on products, (iii) pressure of work. Similar trend was also observed by Ahouangninou *et al.*, (2011) and Kanda *et al.*, (2013), although the percentages of compliance and non-compliance with acceptable daily intake are different.

Similar results were obtained in Brazil by Römbke *et al.*, (2007) in their study where they found that farmers do not understand pesticide label information (Römbke *et al.*, 2007). With the same idea, Waichman *et al.*,(2006) indicated in their study (that farmers do not read the instructions on the labels of plant protection products, claiming that the font is very small but also that these instructions are long enough to read and remember. This can also justify the fact that only 9% of the producers surveyed in Foumbot take into consideration the instructions mentioned on the product labels before use.

Knowledge of Impact of Pesticides on Health

Only 9% of farmers mentioned that the products used may be present in the fruit and therefore harm the health of consumers. This lack of knowledge on the socio-environmental impacts linked to the misuse of pesticides, justified by the high rate of the uninformed population (81%), directly results in non-wearing of personal protective equipment (PPE) in the field by all of the producers when handling plant protection products.

Disposal of Empty Pesticide Containers

Most market gardeners in this basin did not take any specific environmental protection measure after using pesticide products: empty packages are usually thrown on the farms (68%). Some burnt the empty pesticide containers at the farm (20). In some cases, farmers use them for domestic purposes (8%)as they are therefore cleaned and used as a drinking water bottle (most encountered case) or to keep oil. In addition, these empty packages have essential functions for traders, especially for those with a volume of one liter. They are most often used as measuring containers when selling palm oil, palm wine and traditional maize beverage.

Some gardeners indicated that they sold the empty containers to the pesticide sellers (14%). Abdulai *et al.*, (2019) found a majority of gardeners in the Santa area to throw the empty pesticide containers in the farms. This result is further confirmed by the findings of Tarla et al., (2015), Tambe *et al.*, (2019) and Sonhafouo-Chiana *et al.*, (2022). Sonchieu *et al.*,(2017) found a majority of the gardeners in their study in Santa to burn empty pesticide containers while just a few burnt theirs in the farms. This practice of indiscriminate disposal of pesticide containers in the fields have been reported in Tanzania (Lekei and Ngowi 2014)

The indiscriminate disposal of these containers in the field could cause the accumulation of pesticide in soil and water sources, as was previously detected in a sample of irrigation water (Damalas and Koutroubas, 2016). Some pesticides' active ingredients might not decompose in the soils or water and can therefore be attributed to as the cause for pesticide residues in vegetables. Indeed, (Gomgnimbou

et al., 2009) have shown that the use of empty pesticide containers, after or without washing, for the packaging of consumable goods such as water, palm wine and red oil is a source of health danger for the population. On the other hand, abandoned in nature, they contribute to the pollution of the soil, water by runoff and infiltration and then of the air by evaporation. Lehmann, (2016) underlines the pollution of certain waterways by pesticide residues in market garden areas. Certain water reservoirs constituting the supply points for wild animals, but also being able to serve as fish farming, it follows an indirect transfer of pesticide residues to humans through the food chain as approved (Agbohessi *et al.*, 2012).

Figure 6: Disposal of Empty Pesticide Containers around Farms

Use of Personal Protective Equipment

Pesticides application equipment most commonly used in this production basin is the hand carried lever operated knapsack sprayer. It is easy to operate, although some gardeners have experienced various problems with this equipment during spraying. The most common problems identified were replacement of the piston and clogging of the nozzles. The use of personal protective equipment (PPE) is a far fresh idea amongst gardeners in this production basin (figure 7). Eighty-seven percent (87%) of the farmers did not use protective clothing in the course of spraying. Their main reasons were that they cannot afford them (24%), think it is not necessary (17%), they are not available (2%), and they are time consuming (2%). Those who used protective clothing indicated the different clothing as respirators, hand gloves, long trousers, boots and long sleeve shirts. The usage of Personal Protective Equipment during pesticides application constitutes a great issue. In their study in the Santa Area, Sonchieu *et al.*,(2017) found a majority of the market gardeners not to put on any protective clothing while spraying pesticides in the farms. This results are also confirmed by the works of Abdulai *et al.*, (2019) and Tambe *et al.*, (2019)

Figure 7: Pesticide Mixtures and Use of Personal Protective Equipment

4.0 CONCLUSION AND RECOMMENDATIONS

Conclusion

The present study focused on evaluation of pesticide use practices by market gardeners in the Foumbot production basin of the Western Highlands-Cameroon, and provides valuable information on the pesticides used in pests and diseases control in market gardening, farmers' perceptions on pesticide usage, and health symptoms experienced by gardeners.

From this study it can be seen that Farmers in the Foumbot production basin do not practice cultural or biological methods of pest control and they cultivate a variety of garden vegetables. This may account for the persistence of Leaf miners (*Tuta absoluta)* commonly called 'Boko Haram' in the area, which has not had pesticides to effectively control it .The bulk of the survey respondents indicated that they start applying pesticides on their crops from the nursery which suggest that these chemicals are deployed solely against insects and fungi .

It is observed that Foumbot gardeners lack appropriate knowledge on safe handling and use of pesticides. This is attributed to the complete absence of extension services and training. This information can be used to develop a training programme on pest management especially on pesticide use in the Foumbot area. Farmers here face problems with insect pests and diseases.

Farmers in the Foumbot Area do not respect the dosages of pesticides recommended by the manufacturer, with the belief that the manufacturers' quantities were inefficient. This could probably lead to pests developing resistance and crops being burnt by over dosages. The improvement of phytosanitary practices in Foumbot, Western Highlands requires training and extensive monitoring of market gardeners by the Cameroonian regulatory authorities.

Recommendations

In this regard, there is an urgent need to educate the Foumbot market gardeners on good agricultural practices through Integrated Crop and Pest Management (ICPM) practices which will include both cultural, physical or mechanical, biological and chemical pests control methods. This can easily be obtained by organizing the farmers into small farming groups where the farmers are trained and are able to exchange their knowledge and experiences with each other.

Training on safety standards which are primarily aimed at promoting practices that encourage farmers and pesticide users to adopt simple practices that protect them and the environment from hazards caused by pesticide exposure, will be beneficial to users and to the consumers. These include:

- wearing of protective clothing, eye protection goggles and nose mask,
- ensuring safety for themselves and other farm workers; pesticides should be handled carefully,
- thorough cleaning up (bathing) immediately after spraying or when pesticides accidentally come into contact with the skin,
- Pesticide containers and leftover pesticides, obsolete stocks must be disposed in ways that do not threaten the health of humans or animals.
- Pesticides should only be applied when needed (taking note of threshold level of attack) and after judging if it is profitable to spray.

REFERENCES

Abdulai, A.N., Konje, C.N., Achiri, D.T., Tarla, D.N. and Nsobinnenyui, D.(2019): Pesticide use practices by market gardeners in the Santa area of the North West Region of Cameroon.. *International journal of plant and soil science, 26(6):1-11.*

Agbohessi, T.P., Toko, II., Kestemont, P. (2012): State of play of the contamination of aquatic ecosystems by organochlorine pesticides in the Beninois cotton basin. *Cahiers Agricultures* 21: 46-56

Ahouangninou, C., Fayomi, B.E., Martin, T. (2011): Health and environmental risk assessment of the phytosanitary practices of market gardeners in the rural municipality of Tori-Bossito (South-Benin). *Cahiers Agricultures* 20 (3): 216–222. DOI: 10.1684 / agr.2011.0485.

Christopher NA (2010): A case study of health risk estimate for pesticide-users of fruits and vegetable farmers in Cameroon. 34pp.

Damalas CA, Koutroubas SD (2016): Farmers' exposure to pesticides: toxicity types and ways of prevention. *Toxics*. ;4(1). https://doi.org/10.3390/ toxics4010001.

Friesen, L.G. (1998). Toward a market economy: fruit and vegetable production by the peasants of New Russia, 1850-1900', *Canadian Slavonic Papers*. 40(1/2):27-4218

Galani, J. H. Y., Houbraken, M., Wumbei, A., Djeugap, F. J., Fotio, D. and Spanoghe, P. (2018): Evaluation of 99 pesticide residues in major agricultural products from the western highlands zone of Cameroon using QuEChERS method extraction and LC-MS/MS and GC-ECD analyses. *Foods*, *7*(11), 184–201. https://doi.org/10.3390/foods7110184

Gomgnimbou, A.P.K., Savadogo, P.W., Nianogo, A.J., Millogo-Rasolo-dimby, J. (2009): Use of chemical inputs in a tropical agrosystem: diagnosis of the risk of environmental pollution in the cotton region of eastern Burkina Faso. *Biotechnology, Agronomy, Society and Environment* 13 (4): 499-507

Kenko D. B. N and Kamta P N.(2021): Human and Environmental Health Implications of Pesticide Utilization by Market Gardeners in the Western Highlands of Cameroon. *Asian Journal of Environment & Ecology 14(3): 44-56, 2021; Article no.AJEE.67362 ISSN: 2456-690X*

Kenko, N. D. B., Asanga, B. F. P., Tchamadeu, N. N., & Mpoame, M. (2017): Environmental and human health assessment in relation to pesticide use by local farmers and the Cameroon development corporation (CDC), Fako division, South-West Cameroon. *European Scientific Journal*, *13*(21), 454–473. https://doi.org/10.19044/esj.2017.v13n21p454

Lehmann, E., Morgan F., M., Congo, N., Konaté, Y., De Alencastro, L.F. (2016b): Pesticide application in gardening: assessment of resulting impact on water resources quality using grab sampled and pocis, case study of Loumbila lake, Burkina Faso. In: 9th European Conference on Pesticides and Relatd organic Micropolluants in the Environment (Santiago de Compostela).Accessed on October2,2020.Availableat: https://www.researchgate.net/publication/317647132_PESTICIDE_APPLICATION_IN_GARDENING_ASSESSMENT_OF_RESULTING_IMPACT_ON_WATER_RESOURCES_QUALITY_USING_GRAB_SAMPLES_AND_POCIS_CASE_STUDY_OF_LOUMBILA_LAKE_BURKINA_FASO

Lekei EE and Ngowi AV(2014): Farmers' knowledge, practices and injuries associated with pesticide exposure in rural farming villages in Tanzania. *BMC Public Health*. ; 14:1–13.

Mala Abubakar, M.,, M.A., Mumin, A., Zainab, T. & Fatima, A.A(2015): Perceptions of Environmental Effects of Pesticides use in Vegetable Production by Farmers along River Ngadda of Maiduguri, Nigeria. *Journal of Agriculture and Environmental Sciences, Vol*. 4, No. 1, pp. 212-215

Ofoka C. I., Chah J. M. and Madukwe M. C. (2013): Characteristics of market garden in Anambra State, Nigeria. *African Journal of Agricultural Research.Vol*. 8(29), pp. 3950-3957

Petrigh, C. (2019): Le conflit Anglophone au Cameroun un dialogue an partenaire. *Note de ifri*, ifri octobre 2019. Accessed on October 15, 2020. Available at: https://www.ifri.org/fr/publications/notes-de-lifri/conflit-anglophone-cameroun-un-dialogue-partenaires

Pouokam Guy Bertrand, William Lemnyuy Album , Alice S. Ndikontar and Mohamed El Hady SIDATT (2017): A Pilot Study in Cameroon to Understand Safe Uses of Pesticides in Agriculture, Risk Factors for Farmers' Exposure and Management of Accidental Cases. *Toxics*, *5*, (30); doi: 10.3390/toxics5040030 www.mdpi.com/journal/toxics

Römbke, J., Waichman, A.V., Gracias, V.B.M. (2007): Risk assessment of pesticides for soil of the central amazon, Brazil: comparing outcomes with temperate and tropical data. *Integrated Environmental Assessment Management*, 4 (1): 94-104

Sonchieu J., Ngassoum M. B, Nantia A.E, Laxman P.S.(2017)***:*** Pesticide Applications on Some Vegetables Cultivated and Health Implications in Santa, North West-Cameroon *SSRG International Journal of Agriculture & Environmental Science (SSRG – IJAES) – Volume 4 Issue 2* ISSN: 2394-2568 www.internationaljournalssrg.org Page 39

Sonchieu J, Gracile B.M. and Benoit, N.M. (2019): Characterization of Personal Clothing Worn by Pesticide Sprayers in Foumbot Agricultural area (Cameroon). *Agricultural Sciences*, **10**, 1056-1072. https://doi.org/10.4236/as.2019.108080

Sonhafouo-Chiana N, Leslie D.N, Edmond K., Parfait H.A , Wanji S, Charles S.W and Christophe A.N(2022): Rapid evolution of insecticide resistance and patterns of pesticides usage in agriculture in the city of Yaoundé, Cameroon. *.15:186* https://doi.org/10.1186/s13071-022-05321-8

Tambe AB. , Baleba M. R., Dapi L.N and Medoua G.N (2019): Pesticide usage and occupational hazards among farmers working in small-scale tomato farms in Cameroon. *Journal of the Egyptian Public Health Association*. 94:20 https://doi.org/10.1186/s42506-019-0021-x

Tandi TE, Wook CJ, Shendeh TT, Eko EA, Afoh CO. (2014): Small-scale tomato cultivators' perception on pesticides Usage and Practices in Buea Cameroon. Health. 6:2945-2958. Available:http://dx.doi.org/10.4236/health..621333

Tarla, D. N., Manu, I. N., Tamedjouong, Z. T., Kamga, A. & Fontem, D. A., (2015): Plight of Pesticide Applicators in Cameroon:Case of Tomato (*Lycopersicun esculentum* Mill.)Farmers in Foumbot. *Journal of Agriculture and Environmental Sciences, 4(2): 87-98.*

Waichman, A.V., Eve, E., Nina da Celso N. (2006): Do farmers understand the information displayed on pesticide product lebels? a key question to reduce pesticides exposure and risk of poisoning in the Brazilian Amazon. *Crop protection* 26: 576-583