Pesticide Applications on Some Vegetables Cultivated and Health Implications in Santa, North West-Cameroon

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Abstract

Nationwide surveys conducted on pesticide application in Cameroon raises growing concern of exposure to pesticide uses. This study is aimed at evaluating the use and effects of pesticides in Santa agricultural area, and to estimate the health implications amongst 372 farmers, randomly selected using questionnaires from March 2015 to April 2016. As results: fourteen major vegetables are cultivated; fifteen active ingredients (fixed into twenty six formulations) are used to spray vegetables; 69.8% of pesticide applicators have low educational level (First School Leaving Certificate); spraying parameters (doses, spraying frequency and period, pre-harvesting time; safety measures) are poorly practiced; pesticide wastes and used containers are abandoned in the environment, burned or reuse at home; ailments found are abdominal pain dizziness, headaches, nausea, vomiting, skin irritation, cancers, eye problems, frequent cough/catarrh and reproductive problems; measurement instruments are table spoon, cock of bottle, cans; two to five formulations are frequently mixed, applicators smoke, eat, talk or drink while spraying and 85% of workers are not trained nor assisted. This study raised concern for misuse of pesticides in Santa agricultural area. It calls for pesticide residue analysis in vegetables and water as well as the evaluation of the deep health conditions of the farmers.

Keywords: *pesticides, use, vegetables, health*

I. INTRODUCTION

In Cameroon, the economy is still fundamentally based on agriculture. The traditional food crop is part of an integrated household-farming system. Agricultural production is mainly based on small scale farms which generally depend on household labor. Then, priority is given to sufficient production of food for household and domestic consumption .The part of produce is exported to neighboring countries such as Gabon, Equatorial Guinea and Nigeria. The production is mostly focused on vegetables. To increase production and to meet the high demands, the use of pesticides has been highly used in vegetables farming. However, according to standards set by World Health Organization [1], only pesticides that are safe to farmers and farm-workers, other non-target species and the consumers should be used in production of vegetables. But, the safer pesticides are often either more expensive or less efficacious. 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 [2]. These requirements can be reinforced by training farmer on safe use, storage and disposal of pesticides and followed via close monitoring for [3].

Unfortunately during application, the exposure of non-target organisms, including humans is not well controlled in developing countries [4], pointed out that pesticide use can have unintended effects on the environment, air, water, soil, plants, animals, birds, amphibians, aquatic life and humans. Approximately 98% of all insecticides and 95% of herbicides that are sprayed do not reach the target destination [5]. They reach non-target specie by pesticide drift which occurs when pesticides suspended in air as particles are carried by wind to other areas potentially polluting them, water pollution, bottom sediments, and food.

Much of the problem came from the toxicity of the pesticides used by many small-scale farmers, without adequate knowledge and failing to adequately protect themselves during pesticide applications. Pesticide application causes serious health problems but blames are usually laid on pesticides without considering the way the pesticides are applied. A survey of pesticide application in Cameroon conducted by [6] and [7], raises growing concern about various reports of illnesses associated with

pesticide users. Pesticide known as substance intended to kill pests: in common usage, any substance used for controlling, preventing, or destroying animal, microbiological or plant pests (fungicide, herbicide, insecticide) [8]. After uses, residues will remain and can be toxic as the parent product [9]. They are substances which are not deliberately added to a foodstuff but are present in it as a direct consequence of treatments during production. As a result of poor usage, their amount in food will depend on many factors: the rate of spraying, pre-harvesting period, doses, spraying methods applied, etc. In the Santa production area, it has been observed that pesticides applicators are ignorant of: pesticide toxicity, manufacturer instructions, applications techniques, safety measures and dosages [10]

The objective of this study is to evaluate the conditions pesticides are used in the Santa agricultural area and to estimate the health implications.

II. MATERIALS AND METHODS

A. *Study Area*

Santa is one of the 32 sub divisions of the North West Region which is located between latitudes 5° 42´and 5° 53´ North of the Equator and longitudes 9° 58´ and 10° 18´ East of the Greenwich Meridian (Santa Rural Council Monographic Study, 2003). It covers ten villages that were all investigated: Mbei, Njong, Akum, Mbu, Alatening, Baba II, Awing, Baligham and Pinyin. It covers a surface area of about 532.67 km². It is bordered to the North by Bamenda Sub Division, to the West by Bali and Batibo Sub-Divisions, to the South by Wabane, Babadjou and Mbouda and to the East by Galim.

B. *Data Collection Methods*

From March 2015 to April 2016, questionnaires were administered to 372 (Three hundred and seven two) vegetables farmers who were randomly selected for interview. The following areas were chosen because of their intense cropping activities: Moforbe, akum, Pinyin, Mbei, Awing, Alatening, Baligham, Njong. Matazem. Questionnaires focused on the farmers demographic data (gender, age, level of education), pesticide used (source, choice, applicator, rate, frequency, days to harvest), the applicator (plant protection equipment, personal hygiene and health, training), waste management practices (spray leftover, empty containers) and the role of pesticide distributors and agricultural extension agents. Descriptive (frequency and percentage) and analytical statistics were used for data analysis with Statistical Package for Social Sciences, 17th edition.

III. RESULTS

A. *Identification of Farmers*

This deals with sex, age, educational level, marital status and the role of farmers. The table 1 presented below shows the characteristics of the studied population.

Table I: Characteristics of Pesticide users in Santa Area

Considerations	characteristics	Number	Percentage (%)
Group concerned	Male	229	61.6
	Female	136	36.6
	Organization	7	1.9
Marital status	Married	228	61.3
	Single	123	33.1
	Widow	21	5.6
Educational level	No Education	15	4.0
	FSLC	234	62.9
	GCE O level	99	26.6
	GCE A level	23	6.2
	Higher Education	16	4.3
Age (years)	<20	25	6.7
	[21-30]	86	23.1
	[31-40]	175	47.0
	[41-50]	69	18.5
	>51	17	4.6

It can be observed that those who spray more are men (61.6%) and organizations too are involved at 1.9%. Also most of them are married (61.3%). The level of education indicated that, most of sprayers worked by experience gotten from relatives. Great number of farmers were having only First School Leaving Certificate (FSLC) (62.9%) and very few have been to higher education (4.3%). The last aspect taken into consideration was the age. It was noticed that 70.1% of pesticide applicators involved are aged between 21 and 40 years old; while less than twenty and above fifty are very few (11.3%).

B. *Vegetables Cultivated in the Santa Area*

The most cultivated vegetables in the study area are presented in the table II. Many others are less cropped.

Table II: Type of Vegetables Cultivated in the Santa Area

S/N	Crop	Scientific name	Frequency of cropping	Percentage (%)
1	Carrot	*Daucus carota*	114	30.6
2	Cabbage	*Brassica oleracea*	161	43.3
3	Leeks	*Allium porrum*	124	33.3
4	Onion	*Allium cepa*	55	14.7
5	Huckleberry	*Solanum nigrum*	188	50.7
6	Tomatoes	*Lycopersicon esculenttum*	278	74.7
7	Irish potato	*Solanum tuberosum*	198	53.3
8	Celery	*Apium graveolens*	206	55.3
9	Okra	*Hibiscus esculentus*	129	34.7
10	Parsley	*Petroselinum crispum*	186	50.0
11	pepper	*Capsicum frutescens*	178	48.0
12	Green beans	*Phaseolus vulgaris*	166	44. 7
13	Lettuce	*Lactuca sativa*	129	34.7
14	Garden egg	*Solanum melongena*	64	17.3

Fourteen vegetables are almost equally cropped. But tomato is the most cultivated (74.7%) while onion is less cultivated (14.7%). Others vegetables are cropped accordingly.

C. *Pesticides Used*

The table III presents the different types of pesticides used by vegetables farmers in the Santa area. Fourteen active ingredients incorporated into are used in twenty-eight formulations. Among which five are insecticides, six fungicides and three herbicides. Their use frequency varies from one active ingredient to another: Herbicides (Glyphosate ammonium: 97.1% - Diuron: 4.3%), Insecticides: Deltamethrine, cupermethrine and lambda-cyalothrine: 97.1% - Acetamipride: 51.4%) and fungicides: Chlorothalonil : 90% - Metalaxyl**:** 31.4%. They are fixed into twenty six formulations. Except the case of metalaxyl which is lowly used, the five others remain almost equally used (68.6 – 90%). The metalaxyl has been banned since 2016 for uses in Cameroon.

D. *Factors Affecting Spraying Parameters*

Application of pesticides in the study area follows certain parameter that can affect the amount of the residues in the harvested food. They are pre-harvest time, spraying period and frequency as summarized in table IV.

Table III: Distribution According to types of Pesticides Used

Active ingredient	Formulations	Toxicity lass	Frequency	Percentage (%)
Chlorothalonil **(F)**	Banko**,** Banko plus	III	63	90.0
Carbendazine **(F)**	Banko plus	III	59	84.3
Mancozebe **(F)**	Ivory Mancozan**,** Penncozeb**,** Mancostar	III	52	74.3
Metalaxyl **(F)**	Mancozan super	III	22	31.4
Chlorothalonil **(I)**	Balear	III	48	68.6
Cypermethrine **(I)**	Cigogne, Cypercal**,** Cypercot, Cyper Plant	II	68	97.1
Lambda-cyhalothrine **(I)**	Parastar , PACHA	III	68	97.1
Diuron **(H)**	Action	III	3	4.3
Glyphosate **(H)**	Glycot**,** Herbistar, Glycot ultra**,** Glyphader**,** Plantop**,** Round up	III	36	51.4
Manebe **(F)**	Plantineb	III	48	68.6
Mefenoxam**(F)**	Rodomil Plus	III	59	84.3
Glyphosate ammonium **(H)**	Plantop Ultra	III	68	97.1
Deltamethrine **(I)**	Decis	II	68	97.1
Acetamipride **(I)**	PACHA	III	36	51.4

(I)= Insecticide, (H)= Herbicides, (F)=Fungicide

Table IV: Spraying Parameters Measured in the Santa Area

Factors Evaluated		Frequency	Percentages
Pre-harvest time	4 days	52	14.0
	7 days	123	33.1
	14 days	52	14.0
	21 days	23	6.2
	Product used	13	3.5
	Availability of buyers	105	28.2
	Crop cultivated	4	1.1
Spraying Period	Morning	324	87.1
	Under sun light	11	2.9
	Afternoon	11	2.9
	Afternoon and under sun light	26	7.1
Spraying frequency	Alternative day	223	60.0
	Once a week	85	22.9
	Twice a week	37	10.0
	Undetermined	27	7.1

Most farmers consider seven days as normal interval to harvest crops no matter the type of pesticide used while a good number of them (28.2%) harvests their crops according to the availability of the client. Very few numbers (4.6%) however take into consideration the fact that the amount of pesticide residues varies with the type of crop and pesticide properties. Most of the farmers (87.1%) prefer spraying when the weather is still calm. While the remaining (32.9%) spray in the afternoon either under sun light or not. The frequency of spraying varies from one group of farmers to another. By observing table 4, it shows that 60% of the farmers spray pesticide every two days. However, others (7.1%) do it with no regularity: some spray once or twice a week (22.9 and 10 respectively).

E. *Training and experience in pesticide uses*

Pesticide sprayers have gained experience due longevity and at time can be trained or not, can be assisted or not according to the availability of qualified man power (table V).

Table V: Experience and Ability in Using Pesticides Among the Santa Farmers

Factors Considered		Frequency	Percentage
Experience Longevity (years)	<5	90	24.3
	[5-10[	56	15
	[10-15[	92	24.6
	[15-20]	60	18
	>20	74	20
Training /Assistance	No Training	285	76.5
	training	87	23.3
	No Assistance	317	85.3
	assistance	55	14.5

Farmers have experienced spraying of pesticides for more than 5 years (24.3%) and more than 20 years (20%), which implies that a large number of farmers get exposed, to pesticides over long duration. This may cause chronic health impacts to the farmers.

Results had shown that only 23.3 % of farmers attended a seminar (short training) to receive knowledge on pesticide uses while the remaining (76.5%) had never attended any training session. This is also considered when considering the assistance of farmers by qualified personnel from the Ministry of Agriculture and Rural Development. So far, only 14.5 % of workers were recognized to been time to time assisted by state agricultural agents.

F. Safety Measures

Farmers, pesticide applicators, use various personal protective equipments (PPE) when operating and after the exercise take other measures to limit the harmfulness of pesticides on their health. Also, after spraying, they manage the containers in different manners as shown in table VI.

The usage of Personal Protective Equipment during pesticides application constitutes a great issue in the study area. In fact, most of farmers wear boots only and about 25% of them do not use any protective materials during the exercise. They can wear either one or another but about 8% are well protected since all their body are covered when working.

Table VI: Safety Measures Among Santa Pesticide Users

Safety Measures Considered		Frequency	Percentage
Personal Protective Equipment	Boots and gloves	7	2
	Nose mask and boots	37	10
	Nose mask, boots and gloves	3	0.7
	Long dress, boots and gloves	3	0.7
	Long dress and boots	42	11.3
	Long dress, nose mask and boots	25	6.7
	Boots only	129	34.7
	All protective clothing	32	8.7
	No protection	94	25.3
Safety measures after spraying	special clothes	4	5.7
	Wash clothes separately	1	1.4
	Wash hands	11	15.7
	special clothes and wash hands	6	8.6
	special clothes, wash clothes separately and wash hands	20	28.6
	special clothes and washed clothes separately	15	21.43
Disposals of used containers	Burial	37	10
	Burning	119	32
	Keeping in farm	60	16
	Throwing in river	30	8
	No precise discarding methods	100	27
	Reusing	19	5
	Disposal to council dustbin	7	2

Some pesticides applicators (81.4%) take precaution after spraying by washing their clothes and taking bath to remove any particles from their bodies. Generally hands are washed before eating, drinking or smoking. They can wash their clothes separately or at time don't. In addition, the treatment given to used containers varies from burning, burying, keeping in the farm or throwing in the river or in the council trash cans to the reuse for home purpose. But burning is the most common practice (32%) and many of them (27%) don't have a precise treatment.

G. Exposure Factors to Pesticides

Amongst pesticides users, certain comportment usually accompanied their activities and can increase the chances of intoxication. The most frequent ones are: talking, eating, smoking, singing, and drinking or the proximity of their inhabitation to the spaying area. The table 7 shows the distribution of respondents according to respective actions.

Table VI: Some Risks Factors Amongst Pesticide Workers in Santa Locality

Exposure factors		frequency	Percentage (%)
Comportment during spraying	Smoking	12	3.3
	Eating	15	4
	Talking	122	32.7
	Drinking	5	1.3
	Singing	57	15.3
	None	161	43.3
Location habitat/farm	Far	183	49.3
	neighborhood	149	40.0
	Merged	40	10.7

Following the table VII, few workers (10.6%) smoke, eat or drink when spraying while 46% of them talk and sing when exercising. However, 43.3% are aware of the risk and cannot do other thing than spraying.

Inhabitants of Santa are exposed to pesticides chronic intoxication through many factors such as proximity to the farm. It has been observed that the distance between habitats and farms varies. Many farmers live far from the working place (49.3%) while 40 % of them are in or closer to their farm. However 10.7 % live in their farm and spray

regularly the pesticides. This is indicating the lack of knowledge on the risk of intoxication.

H. Combination of Pesticides and Criteria

The combination of pesticides is very common in the Santa locality. It is shown that the mixture can vary from two to four products according to the table VIII below. More than 75% of the farmers practice pesticides mixture before spraying.

To mix pesticides, two to four formulas can be used. The most frequent mixture involves three products. Many reasons have been made to the farmer's choice when spraying pesticides.

Table VIII: Mixture of Pesticides for Spraying

Parameters evaluated		Frequency	percentage
Number of pesticide mixed	One	27	7.2
	Two	75	20.2
	Three	203	54.7
	Four	67	17.9
Mixture criteria	Price	10	3
	Effectiveness	44	12
	Availability	67	18
	Color improvement	126	34
	Crop protection	125	33

Few of applicators mix pesticides for effective and reasonable crop protection (12%) but because of the availability and vague crop protection objective, or even for color improvement (85%). And some will mix just because of the price. So by mixing cheap products, they expect to reach effectiveness in view of protecting their crops. This intention can lead them to mix up to four products.

I. Factors Affecting The Choice and Uses of Pesticide

The farmers face various difficulties that can influence the uses of pesticides. The table IX presents two majors parameters taken into consideration when buying the products.

Table IX: Measuring and Application Instruments

Elements considered		Frequency	percentage
Measuring instrument	Tomato tin	64	17
	Table spoon	72	19
	Measuring cup	59	16
	Beer corks	31	9
	All above (indistinctively)	88	23
	Tomato tin and table spoons	29	8
	Tomato tin and measuring cup	29	8
Method of spraying	Knap sack spraying	295	79
	Brush spraying	8	2
	Knap sack and Brush spraying	69	19

The measuring of pesticides is done considering no standard or instruction. There is no basis of using available tools such as tomato tin, spoon, beer corks or table spoon. There is no distinction or a permanent measurement tools as shown in the table IX (23%). The Farmers, according to the means that are on their disposals, will spray a given pesticide preparation. This such material can be knap sack spraying, brush or according to the availability of the mean (19%). But knap sack sprayer is the most commonly use materials.

J. Types of Illnesses Experienced by Workers

The spraying of pesticides in Santa area has caused a lot of health problems that are summarized in the table X. Different types of illnesses related to the use of pesticides are frequently met in the area and can affect different parts of the farmers: digestive tract, heads, skin, sense organs, reproductive system and respiratory system.

Table X: Types of Illnesses Among Farmers of yhe Santa Area

Health problems	Frequency	Percentage (%)
Abdominal Pain	156	41.9
Dizziness	182	48.83
Headaches	103	27.9
Nausea	95	25.6
Vomiting	104	27.9
Skin irritation	190	51.2
Cancers	17	4.6
Eye problems	86	23.2
Couugh/Catarrh	182	48.83
Reproductive problems	69	18.6
Mental problems	26	7.00

Many diseases affect pesticide users found in the Santa locality. The most common are abdominal pain (41.9%), dizziness, skin irritation, and cough. They affect and concern the different ways of penetrating the body: skin (mostly by irritation and 51.2% persons are concerned), digestive tract (represented by abdominal pain, nausea, vomiting, 94% complain about that), eye (by irritation and 23% people are concerned), respiratory tract affected by cough, dizziness and 98% people are of concern). Obviously, many also suffer from the long term arising diseases such as cancer (4.6 %), reproductive problems (18.6%) psychological disturbance (7%). Some can experience very immediate manifestation of pesticide effect such as headache, dizziness, abdominal pain, nausea, vomiting, and eye irritation after work session.

IV. DISCUSSIONS

Pesticide applicators found in the Santa area are mostly men or married and have low educational level. They are mostly holders of First School Leaving Certificate (FSLC). This low education level reflects the ignorance on application that obviously leads to misuse and long term high amount of residues in harvested vegetable. This is linked to their ignorance on following instructions from manufacturers [11] but whose study revealed that, in the North West Region of Cameroon in general, gardeners were mostly secondary school leavers. This situation has also been observed [12] in the Foumbot area, on tomato farmers. This is an evident issue since the level of education play a major role in technological

adoption of agricultural innovations. Farmers need more training in exotic crops like tomato compared to african indigenous vegetables like huckleberry.

The Santa area, according to the ecological zones repartition in Cameroon belongs to Western High Plateaus Zone where the climate is very favorable in vegetables cropping [13] and [14]. The most cultivated are those mentioned in this study. Santa sub division contributes in no small measure to food security in the Central African Sub-Region. Market gardening is a very important farming type in Santa as it is a major livelihood activity of the people in terms of income, employment and subsistence. Variations in temperature and rainfall on a seasonal and annual basis for a 10 year period (2001 to 2011) have affected the productivity of these gardening crops (tomatoes, carrots, cabbage, leeks, etc.) [15]. These crops are generally cultivated in mono-multiple cropping system where many vegetables can be found in the same surfaces area as observed [16].

The most used of herbicides, fungicides and insecticides testifies the favorable environment for plant diseases development and the effectiveness of those active ingredients. The frequency of uses shows the desire of farmers to protect their crops [6]. The less use of Metalaxyl refers to it removal from Cameroonian markets [17]. However, they will not always apply pesticides adequately [18]. It has been reported that, the choice of a pesticide should be always specific to a pest/disease problem found on the field because farmers do not have technical documents establishing the relationship between the pest/disease and the product to be used[18]. Pesticides used are manufactured abroad while formulation and packaging are locally done by companies in Cameroon: FIMEX, JACO, ADER, PHYTOGRAIN, TROPICASEM amongst others. These companies had wholesalers or representatives in Bamenda who sell to big farmers and retailers of Santa Sub-Division. This attitude was also observed [19] in Ngaoundere and peripheral farming area.

The application parameters such as pre-harvesting time, spraying frequency and period are meticulous and will obviously lead to high amount of residues in harvested foods. This will be harmful for the consumers since many of them are for class II. Days given for active ingredients degradation vary from one product to another. But the pesticide workers don't take it into consideration since they harvest according to the availability of buyers and so that main factor which contribute for the existence of residues in harvested product will highly affect. The period of spraying and frequency also will greatly contributes to the presence of residues. Considering these three factors the consumer is under high risk. Farmers did not read pesticide labels due to illiteracy and ignorance as reported in 2015[12] in Foumbot agricultural area. In the same line, Bolivian small farmers did not read pesticide labels, showing that pesticide labels are not almost read by small scale farmers allover in developing countries [20].

The method of spraying too will contribute to the level of residues and will lead to the high contamination of the environment[11]. So untargeted organisms will be affected and can induce the ecosystems disturbance. The measuring tools are not adequate and they can just use what they have at their one disposal. Use 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 [21]. This attitude was also mentioned in 2008 [22 and 23].The rate and frequency of pesticide application are generally influenced by the disease/pest pressure, season, label, frequency of rainfall, or the advice of pesticide distributor [12]. Treatment given to containers after use is very common as observed in 2008 [24]. This contaminates the environment in the same area [25].

In addition the mixture done by pesticides applicators does not have any basis. They mix mostly insecticides and fungicides for once spraying. But some will mix many fungicides to improve the effectiveness and to cope with the market prices because powerful pesticide are expensive and their capital does not permit them to invest on that [15]. In this regard, some authors [26] reported the poorest groups of agricultural wage laborers work on vegetable farms.

This can be understood since they are not assisted by experts and have not been trained or even educated to be pesticide applicators. Many of them have been self-trained or educated by relatives just by adaptation. This is in line with the observations of previous works [11]. The safety measures taken by these farmers are not enough for the majority since there is no training and assistance to conveniently take precautions for their personal health as observed in 2009 [27] and 2007 [28]. This is why they are affected by many diseases mentioned in this work; even their comportment during or after spraying is hypothetical because they eat or smoke during spraying. This attitude will affect their personal health and can justify the fact that many applicators are young [16] reported the same comportment, in Bamenda Municipality (regional head quarter of North-West) where ninety five percent of farmers do not protect themselves during pesticide applications. According to this, deep investigation on health status may show extend affection of farmers [29] and [30] in Foumbot that had liver and kidney alterations linked to chronic illnesses from pesticide mishandling. Furthermore, Reports from Egypt were in accordance with these results [31]. It is important to mention here that accidents during pesticide manipulations were recurrent. It has been remarked that most of sprayers worked by experience gotten from relatives.

V. CONCLUSIONS

This study which was to evaluate the pesticide uses in the Santa area (North West Region, Cameroon)

revealed that fourteen major vegetables are cultivated in this area by farmers who use fifteen active ingredients (fixed in to twenty six formulas) to spray their crops. They are less educated (69.8% with FSLC). This low level of education leads to their ignorance on spraying parameters (doses, frequency, etc.) which were very under graded. The treatment of pesticide wastes and containers were not following any rule: left in the environment, burned and the reuse for domestic purposes. Also, famers were suffering for many ailments such as vomiting, headache, dizziness, etc. This study calls for pesticide residue analysis of tomato and potable water as well as the control of the health status of the farmers from chronic illnesses.

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