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Plight of Pesticide Applicators in Cameroon: Case of Tomato (*Lycopersiconesculentum* Mill.) Farmers in Foumbot

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Abstract

Vegetables play a significant role in human nutrition, especially as a source of dietary fibre, minerals and vitamins and the over use of pesticides to manage pests and diseases have been noticed. This study was carried out in Foumbot (5° 16' - 5° 35' N, 10° 30' - 10° 45' E and 1100-1300 m asl) Cameroon, from October 2014 to June 2015, in order to understand phytosanitary practices conducted by tomato (*Lycopersiconesculentum* Mill.) farmers. In this study, questionnaires were administered to 111 tomato growers concerning the farmers (gender, age, level of education), the farm (size, cropping period/system), pesticide (source, choice, rate, frequency, days to harvest, applicator (plant protection equipment, personal hygiene, payment), waste management (spray leftover, empty containers) and the role of pesticide distributors and agricultural extension agents. Complimentary information was obtained from 34 pesticide distributors and 5 agricultural extension agents. Results showed that 98.3% of respondents were men, aged 21-40 years, illiterate or had primary education with farm sizes varying from 0.1 to 0.5 ha and half of the farmers grow tomato only during the dry season due to low pest and disease pressure. Tomato was grown in a pure cropping system or associated to green beans or huckleberry. Tomato growers did not receive any formal training on pesticide application and 75.7% of the growers did not receive any assistance from agricultural extension agents. Consequently, farmers did not respect treatment frequencies neither did they use gloves, masks and goggles. Pesticide wastes were left in the environment, burned and the reuse of empty plastic containers for domestic purposes was widespread in Foumbot. Pesticide poisoning cases were recorded and cases of death were observed. This study calls for pesticide residue analysis of tomato and potable water as well as the monitoring of the health status of the farmers for chronic illnesses.

Keywords: Tomato, pesticide, plant protection equipment, environment, Foumbot, residues

1. Introduction

Vegetables are mainly annual plants cultivated as field and garden crops in the open and under glass, and used almost exclusively for food (FAO, 1994). Vegetables play a significant role in human nutrition, especially as a source of dietary fibre, minerals and vitamins – C (ascorbic acid), A, thiamine (B_1), niacin (B_3), pyridoxine (B_6), folacin, B_9 and E (Wargovich, 2000).

The contribution of vegetables, nuts and fruits as a group was estimated at 91% of vitamin C, 48% of vitamin A, 30% of folacin, 27% of vitamin B6, 17% of thiamine and 15% of vitamin niacin in diets. Other important nutrients supplied by fruits and vegetables include riboflavin (B_2), zinc, calcium and phosphorous. 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.

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Fruits, nuts and vegetables in the daily diet have been strongly associated with reduced risk of cancer, heart disease, stroke and other chronic disease. Some components of fruits and vegetables are strong antioxidants and function to modify the metabolic activation and detoxification /disposition of carcirogens, or even influence processes that alter the course of tumor cells (Wargovich, 2000).

Tomato fruit flavour and texture increases the palatability of the diet (Ngamie, 1987) due to its nutritive value. Tomato contains a component P3 that by preventing platelets clot helps to cut down deaths from heart diseases and strokes. Tomato was the most widely cultivated vegetable in Cameroon covering all the five ecological zones mainly for consumption but market gardens are becoming more and more common. Most tomato produced is consumed locally while about 1 % was exported to neighbouring countries such as Gabon and Equatorial Guinea.

Cameroon produces an estimated at 900,000 tonnes and average yields was evaluated at 14 t/ha (FAO, 2015), which was low compared to Netherlands (430 t/ha) and Belgium (425 t/ha) yields of the same year. These low yields may be attributed to many factors including the susceptibility of the crop to diseases (late blight, early blight), insects such as melon fruit fly (*Daucuscucurbitae*), whitefly (*Bemisiatabaci*) and spider mite (*Tetranychusurticae*), (Fontem et al., 1996; 1998-99;). Late blight can cause 100% yield losses while early blight causes 30-60 % yield losses (Fontem, 2003).

This study was carried out in Foumbot (5° 16' to 5° 35' N, 10° 30' to 10° 45' E and 1100-1300 masl), in Noun Division of the West Region of Cameroon. The soils were volcanic and rich in nitrogen, phosphorus and potassium. The climate was Sudanian tropical with two main seasons. The dry season starts from November to March while the rainy season starts from April to October. Minimum and maximum temperatures were 15 and 30°C respectively with an average of 25 °C. Relative humidity was generally higher than 80% with a minimum of 23% between the months of January and February. This climate favours the high disease and pest pressure.

The main ethnic groups were Bamileke and Bamoum followed by Banso, Wimbum and Hausas. Inhabitants of Foumbot live on agriculture and coffee was the main crop before a shift to vegetable cultivation. This shift was caused by the economic crisis that led to the liberalization of the coffee and cocoa sector and the government subventions suspended. The main vegetable crops were green beans (*PhaseolusvuIgaris*L.), green pepper (*Capsicumannuum*L.), water melon(*CitrilluslanatusL.*), leek (*Alliumporrum*L.), tomato, Lettuce (*Lactucasativa* L.), amaranth (*Amaranthuscruentus* L.), huckleberry (*Solanumscabrum*Mill.) carrot (*Daucuscarota* L.), pepper (*Capsicumfrutenscens* L.), cabbage (*Brassicaoleraceae*var. *capitata* L.) and traditional vegetables. Animal breeding was a secondary activity.

Foumbot was a major tomato growing zone in Cameroon and the over use of pesticides to manage pests and diseases have been noticed. These chemicals ameliorate crop yields but can also cause health and environmental hazards when used improperly. The main objective of this study was to characterise pesticide application practices in Foumbot.

Methodology

From October 2014 to June 2015, questionnaires were administered to 111 tomato farmers selected randomly. In this study, questionnaires concerned the farmers (gender, age, level of education), the farm (size, cropping period/system), pesticide used (source, choice, applicator, rate, frequency, days to harvest, the applicator (plant protection equipment, personal hygiene, payment), waste management practices (spray leftover, empty containers) and the role of pesticide distributors and agricultural extension agents. Complimentary information was obtained from 34 pesticide distributors and 5 agricultural extension agents. This information was confirmed by focus group discussions, field's visits and reports from phytosanitary brigade. Descriptive (frequency and percentage) and analytical statistics were used for data analysis with Statistical Package for Social Sciences, 17th edition.

Results and Discussion

Interviews revealed that 98.3% of farmers were men while 1.7% were women. This can be justified by the fact that tomato production requires a lot of pesticide application and capital which women may not be able to have.

These results corroborate with the findings of Hernandez (2001) who reported that 96% of … farmers in the Centre Region were men. Women assisted their husbands in activities that did not require a lot of energy such as transplanting and harvesting of tomato fruits.

Tomato was cultivated by farmers aged 15-60 but a majority of tomato growers were 21-40 (Table 1). Tomato growing was energy intensive (drudgery) from land preparation, maintenance, harvesting to packaging in such a way that only youths can be able to bear the backbreaking operation.

Table 1: Classification of respondents according to age groups

Age (years)	Number	Frequency (%)
<20	2	5.4
21-30	11	29.7
31-40	14	37.8
41-50	6	16.2
51-60	4	10.9
Total	37	100.0

Up to 42.4% of tomato farmers had never gone to school while 34.3% went to primary school (Fig. 1). Level of education plays a major role in technology adoption of agricultural innovations. Farmers need more training in exotic crops like tomato compared to African indigenous vegetables like huckleberry.

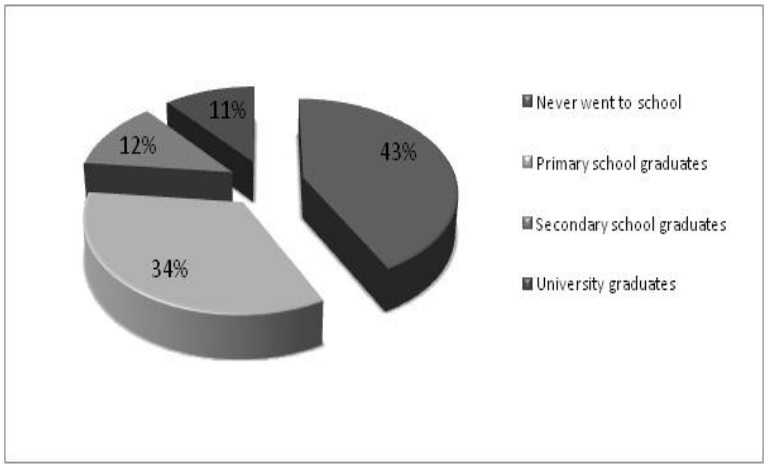

Fig. 1: Distribution of tomato farmers according to level of education

Tomato farms were generally small, varying from 0.1 to 0.5 ha (Fig. 2). Labour and capital were the main limiting factors for farmers to cultivate large surface areas. Farmers who cultivate large surface areas got pesticides on credit to be paid after the sale of tomato and assistance was also obtained from tomato buyers who gave advance to the farmers before the crop was mature for harvesting.

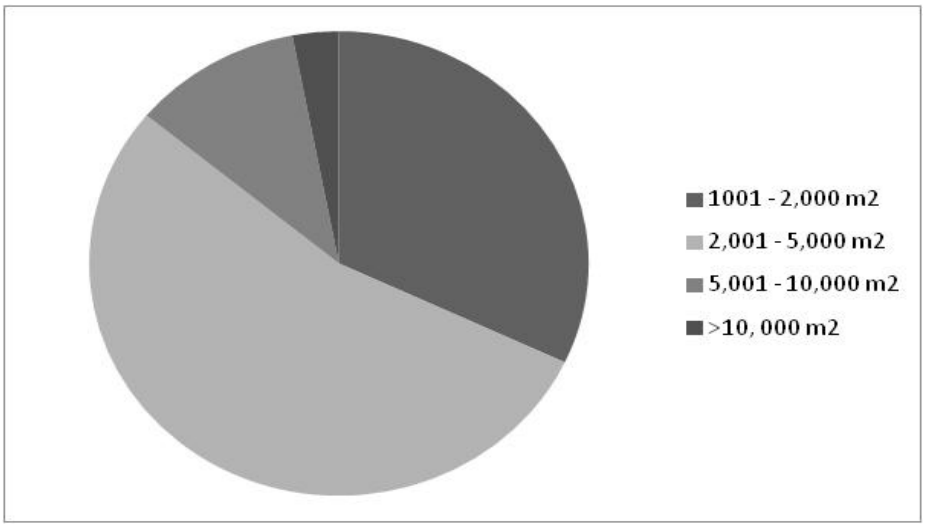

Fig. 2: Distribution of tomato farmers according to the farm sizes owned

Half of the farmers cultivated tomato during off-seasons to avoid crop failures from pests and diseases. Some farmers (43.2%) have the capital to cultivate tomato all year round (Table 2). During rainy season, farmers apply pesticides twice a week. This implies high cost of pesticides and labour. When family labour was insufficient, hired labour was employed at the rate of $0.33/sprayer, $4.17/day or $50.00/ month (Asongwe et al., 2014). Berinyuy and Fontem (2011) reported the poorest groups of agricultural wage labourers work on vegetable farms. Farmers from the North West Region of Cameroon treat their crops once every fortnight (Kamga et al., 2013).

Table 2: Distribution of tomato farmers according to cropping period

Period	Number of farmers	Percent (%)
Off-season (October – March)	57	51.4
Rainy season (April – September)	06	5.4
All year round	48	43.2

Tomato was grown under two cropping systems: pure and mixed cropping systems. Results showed that 27.0% of farmers grew tomato as a sole crop. Most farmers grew tomato in association with green beans (38.0%) followed by huckleberry, maize and okra. One of the main concerns in tomato association was residues. Apart from tomato, most crops were sprayed weekly or biweekly. When crops were intercropped in a tomato farm, the crops received more pesticides than usual. This explains why many consumers complain of stomach disorders when vegetables from Foumbot were consumed. According to the farmers, mix cropping helped in the diversification of revenue, reduction of diseases and pests pressures, and amelioration of soil fertility and provision of vegetable to the farm family. Tomato had a 4-month cycle while huckleberry and green beans had cycles of 2.5 months. Farmers therefore used the income from huckleberry and green beans to complete the production of tomato. Huckleberry was one of the most important vegetable in Western Highlands of Cameroon both as a subsistence and cash crop (Berinyuy, 1998; Kamga et al., 2013) but the tomato-huckleberry association was just 27% because both crops require a lot of labour compared to green beans.

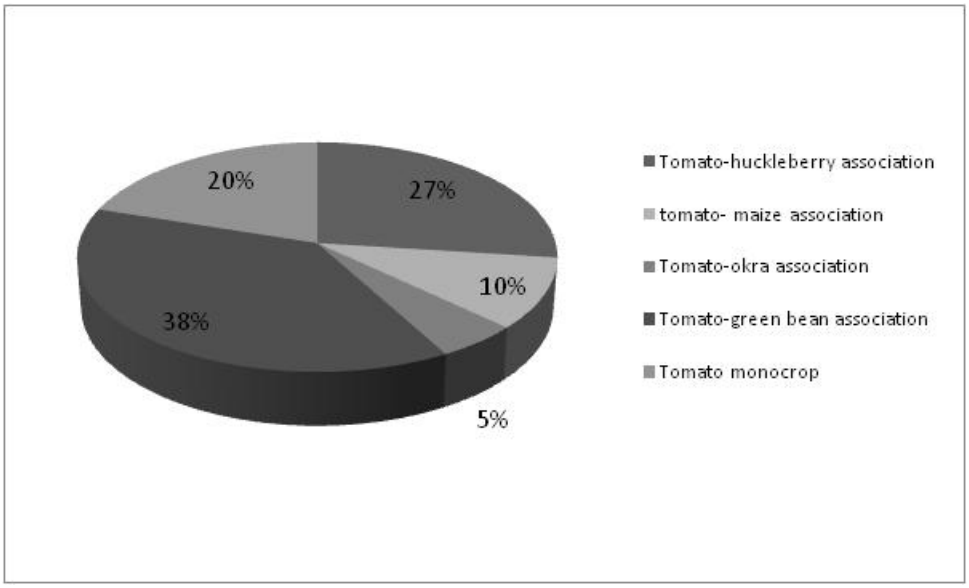

Fig. 3: Distribution of tomato farmers according to the cropping system used.

Mancozeb was the highest used fungicide (67%) in Foumbot followed by maneb. It should be noted that prepacked mixtures of metalaxyl and copper oxide was not registered for vegetable cultivation in Cameroon. It should be reiterated that farmers used fungicides on tomato than any other group of pesticide (Table 3).

Table 3: main active ingredients used in Foumbot in tomato cultivation

Pesticides	Family	Active ingredient	Composition (%) commer
Fungicide	Dithiocarbamate	Mancozeb	80
		Maneb	80
	Phenyl amide	Metalaxyl	6-12
	Copper	Copper oxide	60, 86
Insecticides		Cypermethrin	1.2,2.0, 5.0, 10.0, 20.0, 36.0
		Chlorpyrifos-ethyl	48, 60
		Lambda-cyhalothrin	0.15
		Acetamiprid	2.0
		Imidachloprid	2.0, 3.0
		Spinetoram	5.6
Herbicide		Glyphosate	26, 45, 68
		Paraquat	20

Different concentrations of six active ingredients were used to manage insect pests. Pyrethroid insecticides were less toxic, degraded rapidly in the environment compared to organophosphorous and carbamate insecticides. High rates of cypermethrin (20, 36%), acetamiprid, spinetoram and chlorpyrifos-ethyl were not registered for vegetable crops but the farmers do used them due to their efficacy.

Four insecticides manufactured from dimethoate were used in Foumbot though this active ingredient was banned all over the national territory. Expired chemicals were also used in the study area. At least, 35% of all pesticides inventoried were considered to be obsolete.

Two main herbicides were sold: glyphosate and paraquat (Kamga et al., 2013). Glyphosate was a total, post-emergent and systemic herbicide that was sold under many commercial or trade names. Round up® was the main trade name used. Paraquat was a total, post-emergent and contact herbicide used due to its immediate action. About 83.3% of tomato growers use glyphosate before transplanting to reduce competition between tomato and weeds. In some cases, these herbicides were applied in spots after transplanting.

For farmers to purchase a pesticide, the most important factors were seller's advice, personal knowledge, neighbour's advice and advice of the agricultural extension workers while 14% of respondents purchased their pesticides at random (Fig. 4). Tourneux (1993) reported that the choice of a pesticide was not 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.

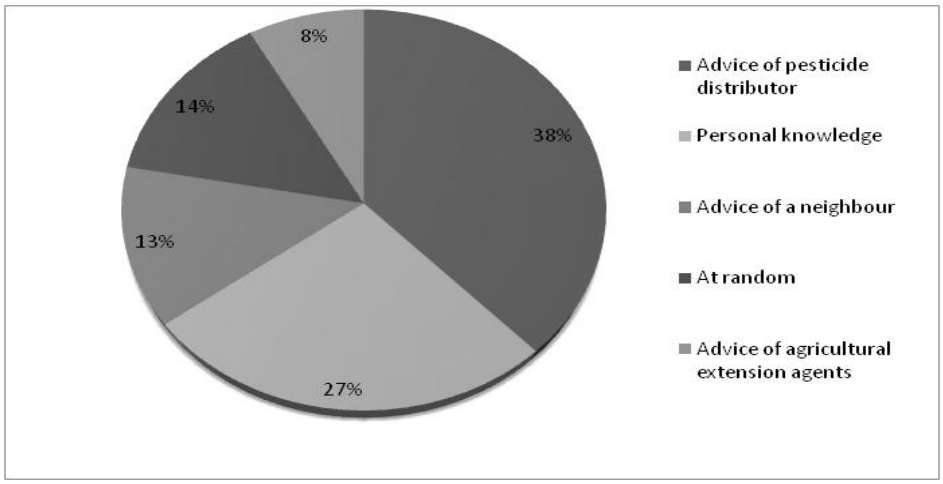

Fig.4: Distribution of tomato farmers according to their advice on the choice of pesticide before purchasing.

Farmers did not read pesticide labels (80%) due to illiteracy and ignorance. In the same line, 74% of Bolivian did not read pesticide labels, showing that pesticide labels were not read in developing countries in general (Jors et al., 2006). Only 15.8% of respondents verified that pesticides were registered before they purchased them and up to 69.9% of the respondents did not know the importance of pesticide registration. Farmers who verified the registration status of pesticides were generally those who had been to secondary school and beyond. Reports from Brazil confirmed that farmers do not understand the information on the pesticide label (Waichman et al., 2007). Cameroon government losses about $14000 annually from taxes due to illicit sale of pesticides. Open borders, insufficient law enforcement staffs and availability of a myriad of commercial products are factors that circulation of illicit, banned expired pesticide in Cameron.

According to the interviews, the rate and frequency of pesticide application was influenced by the disease/pest pressure, season, label, frequency of rainfall, or the advice of pesticide distributors (Fig. 5). During the rainy season, farmers apply pesticides twice a week and when rainfall was at its peak, they field was treated thrice a week. The quantity and frequency of treatment applied here overloads the environment and residues in the harvested products and the water should be above the maximum tolerable levels for human consumption.

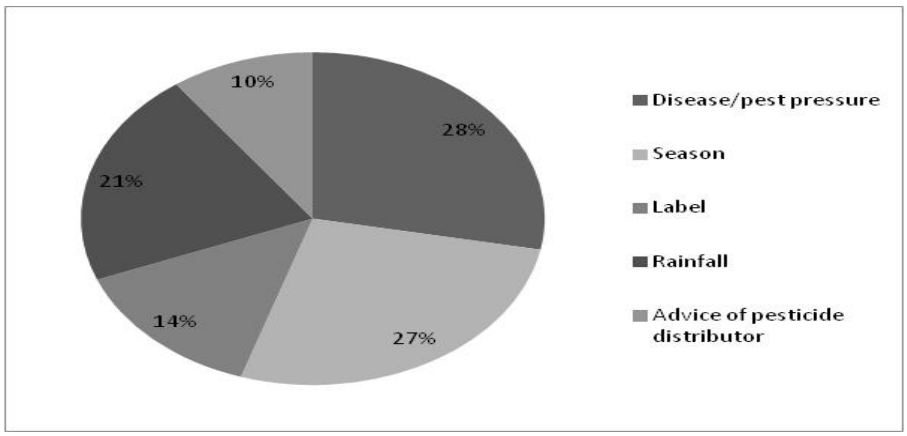

Fig. 5: Distribution of tomato farmers according to the main factors that influence the dose and frequency of pesticide application

Farmers stored pesticides on the field due to the possibility of theft; hence, other farmers store their chemicals at homes (Fig. 6). In 2014, 3 cases of suicide and 2 cases of accidental poisonings of children were recorded in a Mangoum village in Foumbot. This year, a grandmother used herbicide in the place of spices leading to the dead of the lady and her three grand children. World suicides using pesticides was estimated at 371,594 (range 347,357 to 439,267). The proportion of all suicides using pesticides varies from 4% in the European Region to over 50% in the Western Pacific Region but this proportion was not concording with the volume of pesticides sold in each region; it was the pattern of pesticide used and the toxicity of the products that influences the likelihood. Epidemiological and toxicological data suggest that many of these deaths might be prevented if (a) the use of pesticides most toxic to humans was restricted, (b) pesticides could be safely stored in rural communities, and (c) the accessibility and quality of care for poisoning could be improved (Gunnell et al, 2007) .

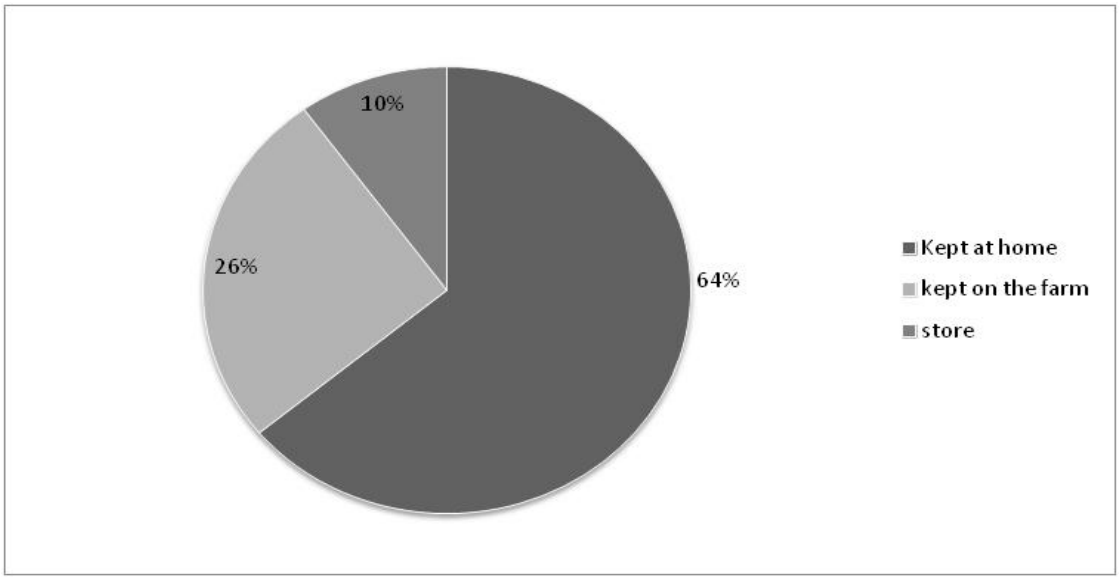

Fig. 6: Distribution of tomato farmers according to pesticide storage environment

Concerning the use of plant protection equipments, 12% of farmers used coveralls, 75.7% wore boots but goggles, masks and gloves were never worn. During and after pesticide application, farmers ate, smoke and drank. Ninety five percent of farmers in Bamenda Municipality (Cameroon) do not protect themselves during pesticide applications (Asongwe et al., 2014). Filipino farmers believe in immunity, meaning that the youths were not

susceptible to the adverse health effects of pesticides. Consequently, plant protection equipments were not important for them (Palwas et al., 2006).

Tanga (2014) showed that farmers in Foumbot had liver and kidney alterations linked to chronic illnesses from pesticide mishandling. Reports from Egypt were in accordance with these results (Arafa et al., 2013). It was important to mention that accidents during pesticide manipulations were recurrent. In fatal cases, deaths resulted while many cases of pesticide poisonings were hospitalized. Unfortunately, no data were available as hospital and agricultural staffs were neither trained in pesticide illnesses nor do they keep records of these issues. It should be noted that data on tomato production or vegetables in general, specifying the number of farmers involved, its contribution to the gross domestic product, residues in water and harvested products could be a driving force to government and its partners (NGOs, researchers,) to understand and intervene this dilemma. Total serum protein and fasting blood sugar level were significantly decreased in the sprayers who were involved in spraying for more than two years (Ritu et al., 2013). Male farmers of Djutitsa (West Cameroon) who were exposed to pesticides like Foumbot might have impaired reproductive function through inhibition of testosterone synthesis (Manfo et al., 2010).

A paucity of information exists on pesticide poisonings in Cameroon (Litchfield, 2005). Sonchieu and Ngassoum (2007) reported 51 cases of pesticide poisoning in Ngaoundere in which two of the victims died within 27 months.

Taking into account the fact that farmers went to the hospital only in fatal cases, it could be inferred that the number of pesticide poisonings to be fourfold more than the cases hospitalized. In 2008, and three died in Bafang, West Region of Cameroon when a pesticide was put into the sauce in the place of salt (CPAC, 2008) while in 2010, six children died in Yagoua, Far North Region of Cameroon in a day after consuming grains that were stored with insecticides purposefully for planting but the lady did not have food to cook for the children. The mother washed the grained but the casualties show that the initial insecticide application was verify high and the insecticide could also be from an unknown source/active ingredient (APA, 2010). Funding the cocoa and coffee sector was good for foreign exchange earnings but vegetable production should not be neglected.

After interviewing 6,300 pesticide applicators from 24 countries across Europe, Asia, Latin America and Asia, Tomenson and Matthews (2009) found out that the pproportions of users reporting any incident varied from 39 to 85% in six countries Bangladesh, China, Cameroon, Colombia, Morocco and Tanzania. In the same study, Costa Rica, Cameroon and Tanzania also had rates of more than 2% incidents/ spraying hours. In an earlier study (Tarla et al., 2013), it was shown that the condition of vegetable farmers in the Western Highlands was pathetic but NGOs and government agents has not taken the matter serious enough.

For personal hygiene, 89.2% of farmers did not wash their coveralls after each spraying session. Only 12.1% of the farmers took a bath after spraying while 83.4% wash their coveralls monthly. When these coveralls were reused, the farmer lived the whole month with the pesticide (Leilanie& Prado-Lu, 2007). In Foumbot, half of the farmers received pesticides when weeding, fertilizer application and staking went on concurrently. Farm workers who did not apply pesticides inhale the pesticide drift during these working hours. In the North West Region of Cameroon, gardeners to a bath after spraying and this could be attributed to the high level of education as 48.3% of gardeners were secondary school graduates (Kamga et al., 2013).

When tomato fruits were mature, farmers harvested twice a week and applied pesticides 1-3 times a week. It could therefore happen that the harvesting and spraying processes take place on the same day. This was an unfortunate situation in which the farm workers (pesticide applicator, harvesters) and consumers (farmer's family, buyers) were all consuming high levels of pesticides throughout the year. Monitoring of tomato for pesticide residues in order to protect the consumer from high levels of pesticides is important (Kole et al., 2002; Bempah et al., 2011).
After spraying the farms, spray leftovers were poured near streams, poured directly in the streams or poured in the furrows (Fig. 7). When the spray leftovers or first 3 rinsates were poured into streams, they constituted a health hazard to aquatic life (flora and fauna) as well as human beings who took their baths in these streams and used the water for domestic purposes (Adeyemi et al., 2008).

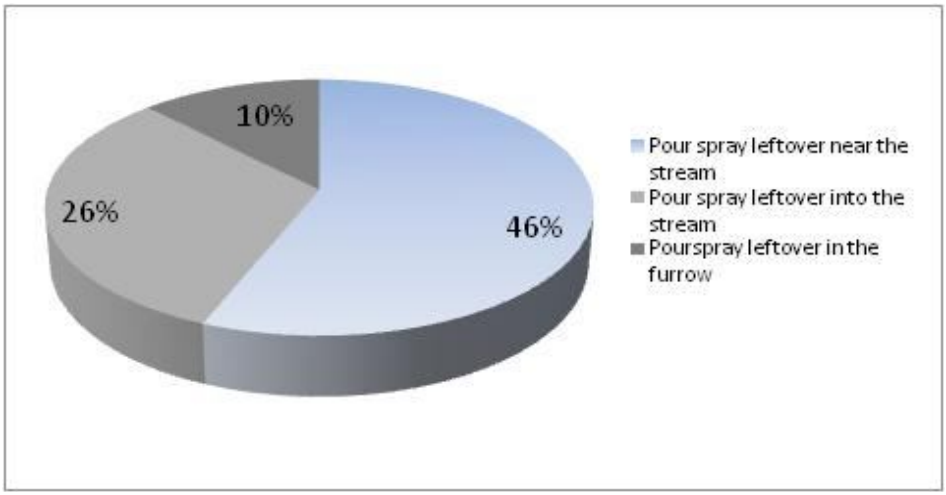

Fig.7: Distribution of tomato farmers according to their disposal of spray leftover after pesticide application

Empty sachets were dumped everywhere in the farm while plastic containers were taken home for reuse (Fig. 8). It should be noted that 1- or 5-litre plastic containers were used to carry water, palm wine, sha'a (local drink produced from fermented maize grains) and palm oil for human consumption.

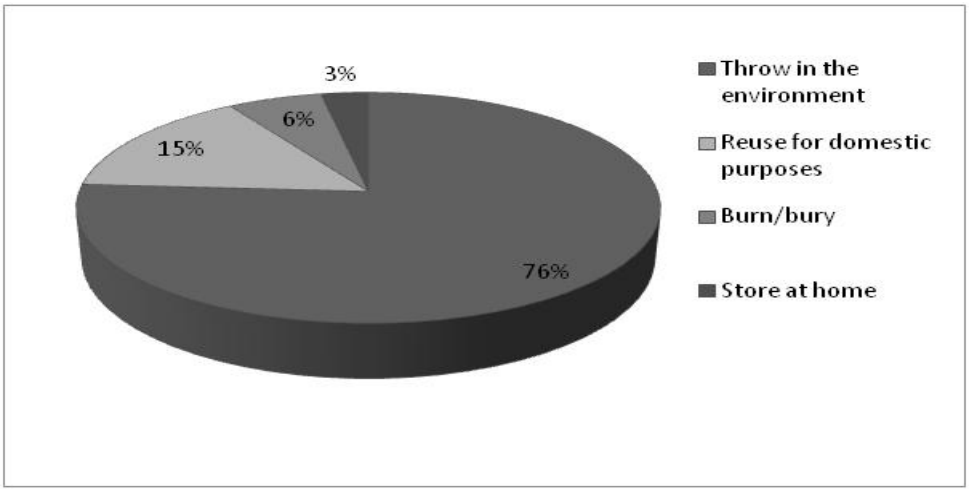

Fig. 8: Distribution of tomato farmers according to the disposal of empty pesticide containers.

In Greece, rinsates generated from washing the application equipment were reportedly poured into irrigation canals and streams by 40.7% of farmers and farmers dumped empty containers by the field (30.2%) or threw them near or into irrigation canals and streams (33.3%). Burning empty containers in open fire (17.9%) or throwing empty containers in common waste places (11.1%) was also reported (Damalas et al., 2008).

Pesticides were manufactured abroad while formulation and packaging was conducted by companies in Cameroon: FIMEX, JACO, ADER, Phytograin, TROPICASEM amongst others. These companies had wholesalers and representatives in Foumbot who sell to big farmers and retailers. This study showed that a third of respondents never received any benefit from the presence of pesticide distributors while a third received advice on the choice of pesticide (Fig. 9). It should be noted pesticide distributors and applicators were never certified neither are they grouped into professional organisations.

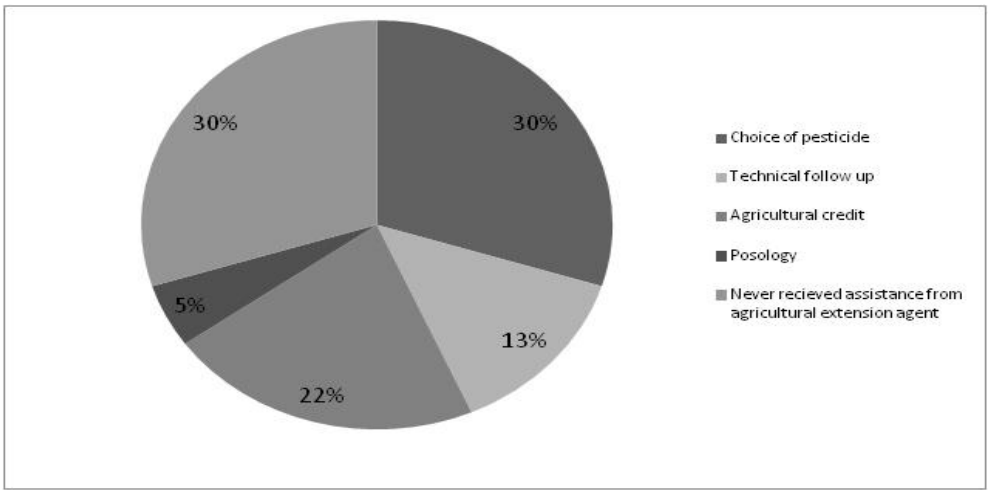

Fig. 9: Distribution of tomato farmers according to the role of pesticide distributors

Unfortunately, 75.7% of respondents did not receive any advice of these agricultural extension workers. According to the farmers who received their advice, they assisted in the choice of pesticides, technical follow up, agricultural credit and posology (Fig. 10). Agricultural extension workers attribute the ineffectiveness of their work to the insufficiency of funds to fuel their bikes and insufficient number of staffs to visit the farmers. When farmers were left on their own, pesticide sellers orientate them towards the available products or those products that correspond to the amount of money the farmer can afford.

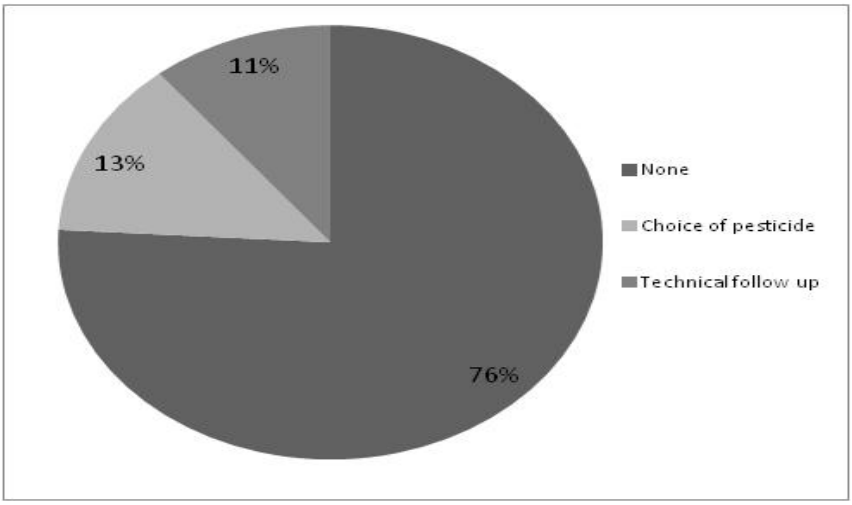

Fig. 10: Distribution of tomato farmers according to the role of agricultural extension agents

The poorest of the poor grow vegetables in their home gardens or small farms (less than half a hectare). The International Monetary Fund Boss (Cable News Network Television interview in January 2014) said that more growth was obtained by funding the poorest of the poor than giving aid to the richest citizens. In this process, government funds projects for the middle class but the poorest were never included in their considerations. This supports the theory that the poor remain poor because of seasonal disadvantage, technological bias, educational demerit, language barrier etc. From this report and earlier documented evidences (Berinyuy&Fontem, 2011; Asongwe et al., 2014), vegetable farmers were the poorest group of farmers in Cameroon contributing to the daily life of the nation but receiving the least attention in terms of funds and training.

Conclusion, recommendation and perspective

Results showed that 98.3% of respondents were men, aged 21-40 years, illiterate or had primary education with farm sizes varying from 0.1 to 0.5 ha and half (54%) of the farmers grow tomato only during the dry season due to low pest and disease pressure. Tomato was grown in a pure cropping system or associated to green beans or huckleberry. To manage pests and diseases, growers use a lot of pesticides purchased from untrained sellers. Tomato growers did not receive any formal training on pesticide application and 75.7% of the growers do not receive any assistance from agricultural extension workers. Consequently, farmers do not respect treatment frequencies neither do they use plant protection equipments. Pesticide wastes were left in the environment, burned and the reuse of empty pesticide plastic containers for domestic purposes was recurrent. Pesticide poisoning cases were recurrent and in fatal cases, the patients die. This study calls for pesticide residue analysis of tomato and potable water as well as the control of the health status of the farmers for chronic illnesses.

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References

Adeyemi D., Ukpo G., Anyakora C &Unyimadu J. P. 2008. Organochlorine Pesticide Residues in Fwash Samples from Lagos Lagoon, Nigeria.*American Journal Environment Science.* 4 (6): 649-653.

APA. 2010. Nord Cameroun: Une intoxication alimentaire fait six morts. Available at :www.bonaberi.com/nord_cameroun_une_intoxication_alimentaire_fait_six_morts_53 46.html. Accessed January 2014

Arafa A, Afify M, Samy N. 2013. Evaluation of Adverse Health Effects of Pesticides Exposure (Biochemical & Hormonal) among Egyptian Farmers. Journal of Applied Sciences Research, 9(7): 4404-4409,

Asongwe GA, Yerima BPK, Tening AS. 2014. Vegetable Production and the Livelihood of Farmers in Bamenda Municipality, Cameroon. International Journal of Current Microbiology and Applied Sciences 3(12): 682-700

Bempah CK, Buah-Kwofie A, Denutsui D, Asomaning J, Tutu AO. 2011. Monitoring of pesticide residues in fruits and vegetables and related health risk assessment in Kumasi Metropolis, Ghana. Research Journal of Environmental and Earth Sciences 3(6): 761- 771.

Berinyuy J. E. 1998. Socio-economic survey on indigenous vegetables in the Foumbot areaof the high plateau agro-ecological zone in Cameroon.Report of NRI's Project on indigenous vegetables in East and Central Africa.32p.

Berinyuy, JE, and Fontem, DA. 2011. Evaluating postharvest opportunities and constraints to utilization and marketing of African leafy vegetables in Cameroon. African Journal of Food, Agriculture, Nutrition and Development 11:4646- 4663.

CPAC. 2010. Intoxication alimentaire: Des pesticides font des morts au Cameroun. *CPAC Info Pesticide*0010 : 15

Damalas CA, Telidwas GK, Thanos SD. 2008. Assessing farmers' practices on disposal of pesticide waste after use. *Science Total Environmental Journal* 390: 341–345

FAO (Food and Agriculture Organization of the United Nations).Summarized data from 1970–1990s estimates of Asia and Latin America farm households. Available at: Accessed: July 2015

Fontem, D.A. 2003. Quantitative effects of early and late blights on tomato yields in Cameroon.*Tropicultura* 21(1): 36-41

Fontem, D.A., Gumedzoe, M.Y.D. and Nono-Womdim, R. 1998-1999.Biological constraints in tomato production in the western highlands of Cameroon.*Tropicultura* 16-17(3): 89-92

Fontem, D.A., Nono-Womdim, R. Opena, R.T. and Gumedzoe, M.Y.D.1996. Impact of early and blight infections on tomato yields. *TVWASBulletin* 1:7-8

Gunnell D, Eddleston M, Phillips MR, Konradsen F. 2007. The global distribution of fatal pesticide self-poisoning: systematic review. *BMC Public Health*, 7: 357.

Hernandez S. 2001. Rapport d'activité service cultures maraîchères. IRAD/CRRA Nkolbisson, Yaounde. 12p.

Jors E, Morant RE, Aguilar GC, Huici LF, Baelum J, Konradsen F. 2006. Occupational pesticides intoxications among farmers in Bolivia a cross-sectional study. *Environmental Health* 5: 10.

Kamga A, Kouame C, Tchindjang M, Chagomoka T, Drescher AW. 2013. Environmental impacts from overuse of chemical fertilizers and pesticides amongst market gardening in Bamenda, Cameroon. Revue Scientifiqueet Technique Forêt et Environnement du Bassin du Congo 1: 6-19.

Kole R.K., Banerjee H. & Bhattacharyya A. 2002.Monitoring of pesticide residues in farm gate vegetable samples in West Bengal.*Pest. Res. J.* 14(1): 77-82.

LeilanieJ, Prado-Lu D. 2007. Pesticide exposure, risk factors and health problems among cutflower farmers: a cross sectional study. J Occup Med Toxicol.2007; 2: 9.

Litchfield M.H. 2005.Estimates of acute pesticide poisoning in agricultural workers in less developed countries.*Toxicol. Rev.* 24(4):271-8.

Manfo F.P.T., Moundipa P. F., Dechaud H., Tchana A. N., Nantia E. A., Zabot M-T, Pugeat M. 2010. Effect of agropesticides use on male reproductive function: A study on farmers in Djutitsa (Cameroon). *Environm.Toxicol*. 27: 423–432.

Ngamie, I .1982.Production problems of tomato in the Foumbot area. Final study memoir. ENSA, University Centre of Dschang.89p

Palwas G, Flor RJ, Warburton H, Hossain M. 2006. Our farmers at risk: behaviour and belief system in pesticide safety. Journal of Public Health 28(1): 43–48.

Ritu A, Nidhi T, Anjali C, Shiva A. 2013. Biochemical alterations among spray farmers due to chronic exposure to chlorpyrifos, an organophosphate pesticides. International Journal of Current Microbiology and Applied Sciences 2(11): 415-418

Sonchieu J. &Ngassoum M.B. 2007. Pesticides cases recorded in Ngaoundere, Cameroon over a 27-month period**.** *Toxicology and EnvironmentalChemistry* 89 (2): 295-296.

Tanga MG. 2014.Effects of pesticide use on hepatic and renal functions in gardeners in the Western highlands of Cameroon. Master of Science Thesis in Biochemistry, Faculty of Science, University of Dschang, Cameroon. 78 p.

Tarla DN, Assako VA, Meutchieye F, Fontem DA, Kome JJA.2013. Exposure of market gardeners to pesticide in Western Highlands of Cameroon. Scholarly Journal of Agricultural Science2013;3(5): 172-177.

Tomenson JA, Matthews GA. 2009. Causes and types of health effects during the use of crop protection chemicals: data from a survey of over 6,300 smallholder applicators in 24 different countries. International Arch Occupational Environmental Health 82(8): 935–949.

Tourneux H. 1993. Smallholder understanding of phytosanitary pictograms in North Cameroon, Cotton and tropical fibres. 48(1): 41-56.

Waichman A, Eve E, Silva C. 2007. Do farmers understand the information on pesticide product labels? A key question to reduce pesticides exposure and risk of poisoning in the Brazilian Amazon.*Crop Protection*. 26: 576–583.

Wargovich MJ. 2000. Anticancer properties of fruits and vegetables. Horticulture Science 35: 373-575.