EVALUATION OF FARMER'S KNOWLEDGE ON PESTS AND DISEASES OF VEGETABLES AND THEIR MANAGEMENT PRACTICES IN THREE DIFFERENT AGROECOLOGICAL ZONES IN CAMEROON

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World-wide, vegetables are commonly and frequently consumed. In most Sub-Saharan countries, although vegetables are considered as food commonly consumed by people especially those in the rural and peri-urban areas, these foods have been reported to be rich in vitamins, minerals, anti-oxidants and are relatively affordable, easier to cultivate/having shorter time from planting to harvest, and easier to prepare for eating (playing an important role in both prophylactic and therapeutic purposes in rural communities). In addition to these nutritional/medicinal uses, many people are benefitting from the vegetable sector as a fast source of income.

With the increasing importance of vegetables, increasing demand, together with a sector consisting of farmers with little or no knowledge on safe and effective production/processing techniques, the sector is gradually but surely been faced with both producer and consumer constraints. One common and very serious problem facing the vegetable sector is the excessive use of agrochemicals, especially pesticides most of which are very toxic to human/animal health.

Furthermore, with very little research especially on traditional African vegetables in the Sub-Saharan Region, carrying out a scoping study to get farmers' (and other stakeholders) perceptions on pests of vegetable and their crop protection practices is paramount in developing future research and extension plans that will ultimately result to high yields, safer foods, protection of the environment and reduction of cost of production. Specifically, the purpose of the project/assignment was to undertake a scoping study on farm level crop protection practices and policies to identify policy-level and institutional constraints and opportunities for the introduction of integrated crop and pest management (ICPM) methods, including use of biopesticides.

Methods

This scoping study was carried out in three agro-ecological zones (Zones III, IV & V) in Cameroon, where Zone III = Western Highlands in Northwest and West Regions), Zone IV = Humid Forest with Monomodal rainfall in Southwest, Littoral and small part of South Regions and Zone V = Humid Forest with Bimodal rainfall in major parts of South and East Regions. From each agro-ecological zone, four sites (two

from the peri-urban areas and two from rural areas) were selected and used as focal points for the study. From these focal points, to get data and/or information that will reflect the overall goal and specific objectives of the study, the following quantitative and qualitative methodologies were applied:

(i) intensive desk study, which involved mainly retrieval and review of documents and research articles via Internet search engines and archives of appropriate government/private offices.

(ii) key informant interview, where people having more knowledge or experience on vegetable production were interviewed. Such people included government officials, Non Governmental Organizations, farmers, etc

(iii) focus group discussions, where 8-15 persons shared their ideas on the study topic. In these discussions, all participants were given the chance to give their opinion and all opinions were considered right.

(iv) rapid observational assessments, where houses and farms were visited to actually confirm some of the responses or comments made by farmers and other stakeholders

(v) administration of questionnaires, where farmers where required to respond to questions related to the study topic. Questionnaires were administered to at least 40 persons per agro-ecological zone.

Major Findings

A significant gender difference occurred between the different Regions. More female farmers were recorded from the South West Region (60.61%) while more males were recorded from the West (46.88%) and South (40.63%) Regions. A majority of the farmers (41.86%) were above 45 years of age. Over 95% of the farmers have attended at least primary level education. The South constitute the Region with the highest proportion of farmers (40.5%) who have attended at least a primary level of education while cases with no formal education(6) were recorded only in the South West Region. About 85% of the respondents have never attended any workshop or training on vegetables.

Vegetable farming and cropping systems in the action sites are highly diversified. Farmers plant vegetables as sole crop or intercrop, in home gardens or distant farms with or without the use of fertilizers or pesticides. Most of these vegetable farms are situated near a stream/lake/ponds/river (38.3%), where there is no forest (25.0%), within a forest (10.9%) and behind their houses (10.2%) and smaller proportion of the farms are situated in a swampy area (8.6%). In the Southwest Region (Buea action site), very few specialized vegetable farmers exist. The vegetables are usually intercropped sequentially into existing food crop farms or planted in free spaces within plantations of industrial crops mainly rubber, oil palm, banana and cocoa. The West Region (Bafoussam action site) is the major vegetable production zone in Cameroon. Most of the vegetables produced or marketed are exotic particularly tomato, cabbage, green pepper and water melon. The indigenous vegetables are limited to a few species particularly night shade. Vegetable farming is a specialized activity, cultivated not only in home gardens but also in distant farms. Sole cropping is the dominant cropping system, though some few farmers grow vegetables alongside with other food crops particularly maize and beans or green spices. The situation at the South Region (Ebolowa action site) is similar

to that of Southwest. Vegetables are cultivated both as sole crop and intercrop with food crops such as cassava, plantains and cocoyams or industrial crops like cocoa and oil palm. However, the availability of vegetable seeds is low and the use of fertilizer is on the rise due to the poor nature of the soil (ferralsol), at the action site.

The main purpose for cultivating is for consumption by the family and for sale. Of the about 15 vegetables recorded in all the zones, more than 60% were traditional African vegetables. On these vegetables, Although the major living constraints were insects and fungi, molluscs (e.g. snail), mammals (e.g. antilope, goats) and birds were serious on specific vegetables. Concerning vegetable loss estimates, all the vegetable farmers provided a quantity loss estimate of 0-25% for the respective vegetables they cultivate except for bitter leaf where a majority (37.0%) of its cultivators estimated a quantity loss of 50-75%. In all the vegetables, the main signs/symptoms resulting from pests/diseases damage were skeletonise leaves, leaf curling, holes on leaves and leaves rot.

Although the crop protection practices varied from one vegetable to another, the most commonly applied was the use of pesticides (mainly insecticides and fungicides) especially on huckle berry, tomato, pepper and green. Other applied practices were use of wood ash, sanitation and a combination of pesticides and wood ash or pesticides and fertilizers. Of the 61 agrochemicals recorded from the questionnaires (all regions inclusive), 23 are insecticides, 27 are fungicides, 8 are fertilizers, 2 are herbicides and 1 is a botanical (wood ash) that is commonly applied on all vegetables and in all the regions. Generally, most of the female vegetable farmers do not apply pesticides. In case pesticides are being applied at any level of the production chain, it is done by both adult male and females in the family or only adult males of the family. It was also found that farmers still use pesticides that have been banned by the country. Such pesticides include malathion, methyl parathion and carbofuran.

Concerning health effects resulting from pesticide application, no significant disparity occurs between sexes. However, skin irritation only (27.36%) and a combination of skin irritation and watery eyes (20.75%) are common health effects among applicators. Skin irritation are most frequently experienced by farmers in the South Region (68.97%) while those in the West Region experience a combination of skin irritations and watery eyes (86.36%).

Men are more conscious of where they keep pesticides compared to women. About 41.4% of the men keep in a separate room where only pesticides are kept, 44.8% keep in a locked cupboard while a small proportion of some careless women keep in the kitchen (13.9%) and bed room. Keeping pesticides in the bed room (85.7%) and kitchen (75%) is mostly practiced in the South West while locking up in a cupboard is a routine practice in the South (34.3%) and Western Regions (58.8%).

Also, there is a significant difference in the type of containers used in keeping pesticides by both sexes, with the use of original pesticides containers dominating (84.7%) the case of misuse mainly seen mostly with the female farmers. Up to 11.9% of them keep pesticides in used supermont/tangui (mineral

water bottles) and beverage bottles while 4.8% keep in plastic papers (polyethene bags). This type of misuse (100%) happens only in the South West Region. The manner in which used pesticides containers are disposed is as follows: 46.1% are thrown in farm/stream/river or dustbin, 20.6% are gathered and burned and 21.6% are washed and water or palm oil are kept in them. This time around, using used pesticide containers to put water or palm oil in them is a common practice with the male farmers (68.2%) and is a practice resulting mostly from the West Region (77.3%).

Conclusions

- Vegetables are very important compliments in the diets of most people in Cameroon. These vegetables do not only supply cheap and readily available sources of essential minerals/vitamins, but some are also considered as having important medicinal values. In addition to these nutritional/medicinal importance, vegetables are also becoming an important source of income especially to peri-urban farmers. In spite of the significance of these vegetables, more than 80% of the farmers have not attended training or workshop on vegetable cultivation. To make matters worse, with the exception of tomatoes, very little research has been focused on vegetables.
- Most of the vegetables cultivated are done in mixed cropping systems (87.5%) and practiced mainly by women (85%). Vegetables that can easily be integrated in cocoa plantations are bitter leaf, pepper, cocoyam leaves, and tomatoes. Water leaf, huckle berry, and green, do very well within sugarcane plantations while huckle berry and green are best suited for banana/rubber plantation fallows.
- Generally, in all the study sites, biotic factors are the major constraints hindering production. Of all the biotic stresses, insects and fungi are the most serious on all vegetables causing losses that can reach 100% during severe infestation and no pesticide application.
- Protection of vegetables from biotic constraints is done mainly by application of pesticides such as insecticides and fungicides. Although most farmers prefer this practice, it is usually accompanied by certain problems; (i) use of banned and/or extremely toxic pesticides (ii) sales of fake chemicals, (iii) non use of personal protection equipments – about 65%, (iv) overuse of same active ingredients for so many years and therefore possibility of development of resistance, (v) acute toxicity expressed in the form of stomach disorders, vomiting, skin irritations, dizziness, and watery eyes, (vi) in spite of the frequent and overuse of pesticides, pest problems (densities and diversities) are increasing every year.
- The West Region uses more agrochemicals with over 60% of the recorded chemicals. In all the Regions, in spite of the frequent and/or heavy use of pesticides, many farmers are aware of the dangers and SouthWest farmers (especially women) are topping the list with respect to misuse (keeping pesticides in kitchens and/or bed rooms.
- Women are more exposed to pesticide risks due to the following reasons;

- Even though there are laws guiding use of agrochemicals especially pesticides, enforcement of these laws seems to be weak or non-existence. Also, government officials in charge do not take the issue of pesticide misuse/safety measures serious – no control.

Recommendations

- The government, Non-Governmental Organizations, and funding organizations should consider the vegetable sector as an important component in their development plans concerning food security and safety. Based on this, much efforts should be put in place to increase production and improve on quality.
- Training of farmers and relevant stakeholders should be focused on vegetable cultivation techniques, use/misuse of pesticides, adding value to vegetables (processing, storage, transformation), and proper identification of pests of vegetables.
- Prices of agriculture inputs (e.g. agrochemicals & equipments) should be reduced or government should provide these inputs at subsidized prices.
- Provide quality seeds, agrochemicals and equipments to farmers
- Serious efforts should be put in place to enforce plant protection laws and/or decisions. This can be achieved by carrying out strict and/or regular surveillance on pesticide use/misuse. This will help to prevent illegal, obsolete and banned chemicals in the Cameroonian market. Defaulters should be heavily fined or jailed.
- Encourage the formation of vegetables' groups or cooperatives. With such groups or cooperatives, demonstration plots and/or farmers' field schools could be put in place so as to facilitate transfer/adoption of technologies. Such groups could also be supported to construct and manage vegetable markets with storage facilities.
- Construct/improve on farm-to-market roads of certain areas. This will facilitate evacuation of vegetables that are very perishable.
- As a first step to develop and implement an integrated pest management strategy on traditional or indigenous vegetables, there is need to study the bio-ecology of major pests on major vegetables such as pepper, green, huckle berry, bitter leaf, okongobong, and okra.
- Encourage and fund participatory research so as to come out with high-yielding and resistant varieties that can be distributed to farmers.
- Urgent need to study the effects of pesticides on the management of pests/diseases on vegetables and this should include efficacies of the pesticides, effects on natural enemies, adequate doses, timing of application, as well as phytotoxicity.

- Agronomic studies are also necessary. For example, the effects of transplanted and non-transplanted vegetables on growth, yield and infestation. The effects of planting distances on growth, yield and infestation or development of diseases.
- Need to evaluate the impact of implementing an IPM strategy on vegetable growth, infestation and yield.

1. Background or Project Statement

1.1. Statement of the Problem

AVRDC – The World Vegetable Center is a key partner for the implementation of the Humid tropics program, along with the CGIAR Centers (IITA, ILRI, ICRAF, IWMI, CIP, CIAT and Bioversity) and other advanced research institutions (Wageningen University, *icipe*, FARA and Swedish University of Agricultural Sciences) in implementing this program. The Humidtropics program is a CGIAR Program on integrated agricultural systems for the humid tropics. This program is one of the CGIAR Research Programs (CRPs) designed to address major global development challenges, and aimed at accomplishing the following outcomes: (i) Reducing rural poverty via improved productivity, market development and income generation, (ii) increasing food security by increasing global supply of key staples and reducing potential price increases and price volatility, (iii) improving nutrition and health by consuming diets that will provide adequate proteins, vitamins and minerals especially for women and children, (iv) sustainable management of natural resources particularly in light of climate change.

In Africa, especially in the humid tropics, people have been eating lots of plant species (vegetables) since the existence of humans on earth. While the vegetable sector in many developing countries have been more advanced, that of Sub-Saharan Africa has been underdeveloped and vegetable consumption is relatively extremely low (Smith and Eyzaguirre, 2007). Even though in most of these Sub-Saharan countries vegetables are considered as food for the poor people especially in the rural and peri-urban areas, these foods have been reported to be rich in vitamins, minerals, anti-oxidants and are relatively affordable, easier to cultivate/having shorter time from planting to harvest, and easier to prepare for eating (playing an important role in both prophylactic and therapeutic purposes in rural communities.

In addition to these nutritional/medicinal uses, coupled with the increasing demand in urban areas, vegetables seem to be serving as a fast source of income. With the increasing importance of vegetables, increasing demand, together with a sector consisting of farmers with little or no knowledge on safe and effective production/processing techniques, the sector is gradually but surely been faced with both producer and consumer constraints. A common problem usually associated with vegetable production nowadays is the excessive use of agrochemicals particularly pesticides; most of which are either banned or very toxic (WHO

class 1a or II pesticides) and some not meant for vegetable production. (Ndi Amuoh, 2010, Abang et al., 2013). Such practices may be resulting to direct and indirect health/environmental effects.

As a sector where there is very little research especially on traditional African vegetables in Central African Region, carrying out a scoping study to get farmers' (and other stakeholders) perceptions on pests of vegetable and their crop protection practices is paramount in developing future research and extension plans that will ultimately result to high yields, safer foods, protection of the environment and reduction of cost of production.

1.2. Overview of Purpose and Scope of Project

Based on the terms of reference for the consultancy, the purpose of the project/assignment was to undertake a scoping study on farm level crop protection practices and policies to identify policy-level and institutional constraints and opportunities for the introduction of integrated crop and pest management (ICPM) methods, including use of biopesticides. With all these information, the consultant is expected to formulate recommendation for ICPM practices that would be tested and validated by AVRDC -The World Vegetable Center and other Humid Tropics partners.

Generally, the main goal of the study was to articulate and document local knowledge and perceptions of stakeholders on pests and their management practices as well as on the use and misuse of pesticides. The importance of this goal was to (i) establish a baseline for future project implantation quality, monitoring, evaluation and impact assessment, (ii) identify needs and opportunities for ICPM farmer training and directions for future vegetable pest management programs. Furthermore, this overall goal had the following specific objectives:

- Assess the current situation of major identified farming systems vis-a-vis the potential for vegetable integration and/or diversification in the respective study sites of the Humidtropics from the perspective of the socio-political and economic conditions, standard poverty indices, power relations, information on most excluded groups and nature of exclusion, prevalent social/cultural practices, income and food and nutritional status among beneficiaries of the Humidtropics program..
- Identify major vegetable crops grown and describe individual vegetables production system, rain fed, irrigated and supplemental irrigation, and production constraints of each system.
- Document and review the policy and regulatory environment on crop protection, with respect to the horticultural sector with a focus on importation of pesticides and mandate active ingredients approved for use in the vegetable sector.
- Document local knowledge systems regarding undesirable vegetable crop protection practices, particularly on pesticide (mis)use and its associated health hazards.

- Identify vegetable farmers' crop protection practices (inclusive biopesticides and its possible combination with inorganic pesticides), constraints, and needs and opportunities for improvement to enhance safer vegetable production for consumers.
- On the basis of secondary data and expert producer interviews, provide estimates of production and farm profitability using partial budgets of representative farms under varied representative grower crop protection practice regimes of 2 focus vegetables in the study area.
- Describe how farm-level vegetable crop protection practices and national policies have changed during the past 5 years and their effects of safer vegetable production or otherwise.
- Identify mechanisms for integrated crop and pest management knowledge, awareness creation and training needs development, implementation and institutionalization.
- Suggest entry points (including establishment and institutionalization of research for development platforms) aimed at policy advocacy on sound and enabling crop production/protection policies to enhance system productivity while ensuring safer vegetable production within intensified farming systems in the target country study sites.

2. METHODOLOGY

2.1. Description of Study Sites

2.1.1. Brief about Cameroon

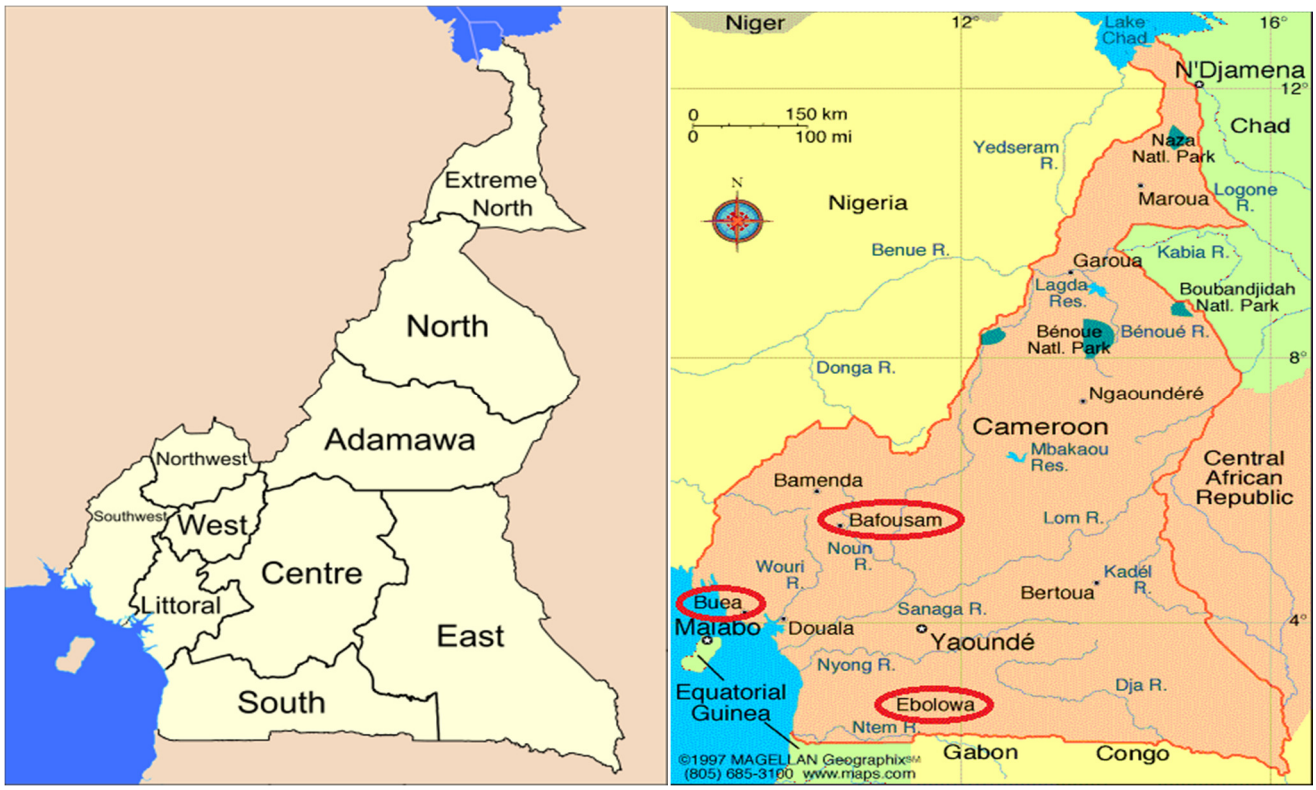
This scoping study was carried out in three agro-ecological zones in Cameroon. Generally, Cameroon is a Central African Nation located on the Gulf of Guinea and one of the member countries of the Economic Community of Central African States (CEMAC). This country has a population of about 20 million people (population density in 2011 = 42.1 per km^2, land surface area of about 475,442 km^2, (http://data.un.org) and French and English as official languages but with over 24 major African language groups. Cameroon shares boundaries with the following countries; Nigeria, Chad, Central African Republic, Democratic Republic of Congo, Gabon, Equatorial Guinea, and the Atlantic Ocean. It has GDP per capita of 1,700, life expectancy of 48 years and literacy rate of 79%. It is divided into 10 Regions with the SouthWest Region usually considered as the bread basket of the Nation due to its large plantations and enormous supply of food crops including vegetables.

Cameroon has a much diversified agricultural sector resulting from various agro-ecological zones. Because of this, there is a wide range of crops and livestock species ultimately leading to difficulties and/or complexities in on-farm data collection methods as well as low rate of coverage. Noted as an agricultural hub in the Central African Zone, over 60% of the population lives in the rural areas and has agriculture as the main activity; with 4 persons out of 10 living below the poverty line; 75% of which live in the rural areas.

The country's agricultural sector plays an important role in the National Economy; (i) it contributes over 20% to the national GDP with annual growth rate of about 4.1% as against 3.4% for the rest of the economy, (ii) the sector provides employment to over 60% of the active population, (iii) contributes significantly to the export taxes, with the rural sector contributing about 54%.

However, in spite of its great agricultural potentials, it should be noted that besides a few mechanized industrial exploitations, agriculture in Cameroon is essentially traditional comprising of traditional tools and production techniques. With such traditional conditions, work is usually manual and very difficult, cultivated surface area is reduced, yields are low and are insufficient to meet domestic and regional demands for food.

As part of the continuous effort to improve living conditions of Cameroonians, the government has subscribed to the following; (i) Millenium Development Goal – MDG, (ii) New Partnership for Africa's Development - NEPAD, (iii) The New US/African Partnership, (iv) ACP/EU Cotonou Convention, (v) Tokyo International Conferences on African Development (TICAD). In addition to these signed conventions, in the last agro-pastoral show in Ebolowa (South Region), the President of the country (H.E. Paul Biya) stressed the need to modernize the agricultural sector so as to increase productivity of small farmers especially in the rural and peri-urban areas.



(a) (b)

Figure 1: Map of Cameroon showing the ten Regions (a) and their headquarters (b)

2.1.2. Agro-ecological zones of the study

The scoping study was carried out in three agro-ecological zones (Zones III, IV & V) in Cameroon. Generally, Cameroon is characterized into five major agro-ecological zones:

- Zone I = Sudano-Sahelian in the Extreme North and North Regions
- Zone II = High Guinea Savanna in the Adamawa Region
- Zone III = Western Highlands in Northwest and West Regions)
- Zone IV = Humid Forest with Monomodal rainfall in Southwest, Littoral and small part of South Regions.
- Zone V = Humid Forest with Bimodal rainfall in major parts of South and East Regions

Figure 2: Agro-ecological zones in Cameroon

Selection of the Regions where this study was carried out was strictly based on the terms of reference of the consultancy and these were Zones III and IV and V. The major information about Zones III, IV and V are shown in **Table 1**.

Table 1: Major characteristics of the different zones where the study was carried out

Characteristics	Agro-ecological Zone III	Agro-ecological Zone IV	Agro-ecological Zone V
Region(s)	West and Northwest	Southwest, Littoral & small parts of South	Southwest, Littoral & South
Main Regional Research Center	IRAD Bambui	IRAD Ekona	IRAD Mbalmayo
Region considered for the study	West	Southwest	South
Divisions of selected Region	Bamboutos, Haut-Nkam, Haut-Plateaux, Koung-Khi, Menoua, Mifi, Nde, Noun	Ndian, Lebialem, Fako, Kupe-Manengouba, Meme, Manyu	Dja-et-Lobo, Mvila, Ocean, Vallee du Ntem
Capital Town of selected Region(s)/Coordinates	Bafoussam (5°30'N & 10°30'E)	Buea (4°10'0"N & 9°14'0"E)	Ebolowa (2°55'N & 11°9'E)
Surface area of selected Region	13, 892 km^2	25,410 km^2	47, 191km^2
Total population and population density of selected Region	Total population = 1, 720,047 (2005 data) and population density of 124 per km^2	Total population of 1,316,079 (2005 data) and population density of 52 per km^2	Total population of 634,655 (2005 data) and population density of 13 per km^2
Climate	High elevations, moderate to high relative humidity, moderate rain fall and temperatures averaging 22°C	Equatorial with abundant and regular rains as well as constant high temperature (26°C average)	Guinea type (part Equatorial) with high humidity, rainfall (1500-2000mm per year), annual average temp. rang of 24-26°C
Soil	Varied	Dark fertile volcanic soil	Red soil mainly ferrallitic and marginally productive or fertile
Major cash crops	Coffee, tea	Rubber, Oil Palm, Tea, Cocoa, Banana	Cocoa and rubber
Major food crops	Maize, rice, Solanum potatoes, Beans and Vegetables e.g. cabbage, tomatoes	Plantains, Cassava, Cocoyams, Yams, Vegetables	Plantains, cassava, Cocoyams

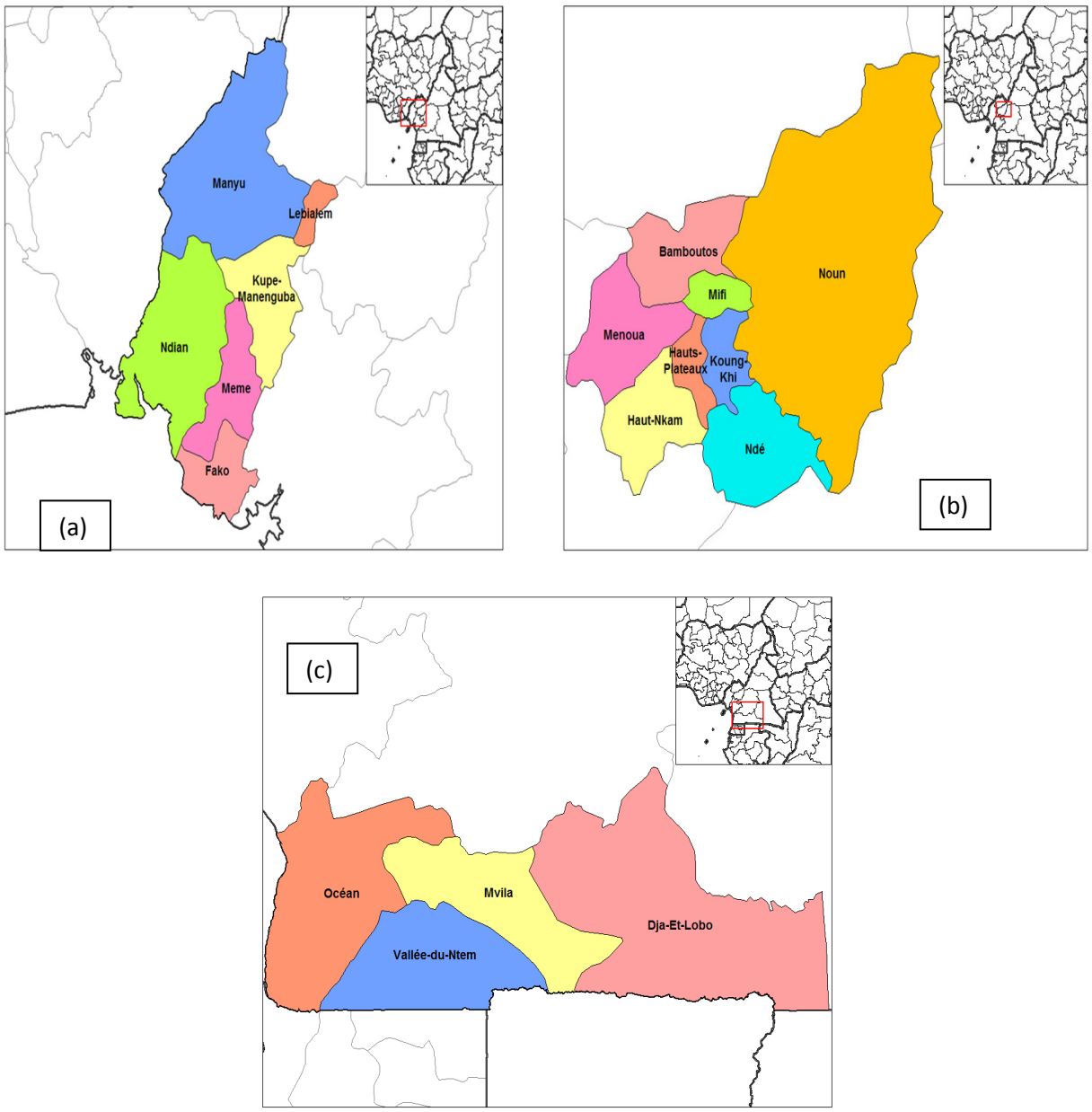


Figure 3: Various Divisions of Southwest (a), West (b) and South (c) Regions

2.1.3. Approach

To begin with, from each agro-ecological zone, four sites (two from the peri-urban areas and two from rural areas) were selected and used as focal points for the study. From these focal points, to get data and/or information that will reflect the overall goal and specific objectives of the study, the following quantitative and qualitative methodologies were applied; (i) intensive desk study, (ii) key informant interview, (iii) focus group discussions, (iv) rapid observational assessments, and (v) administration of questionnaires. **Figure 4** gives a summary of the research tools/approaches used during this study.

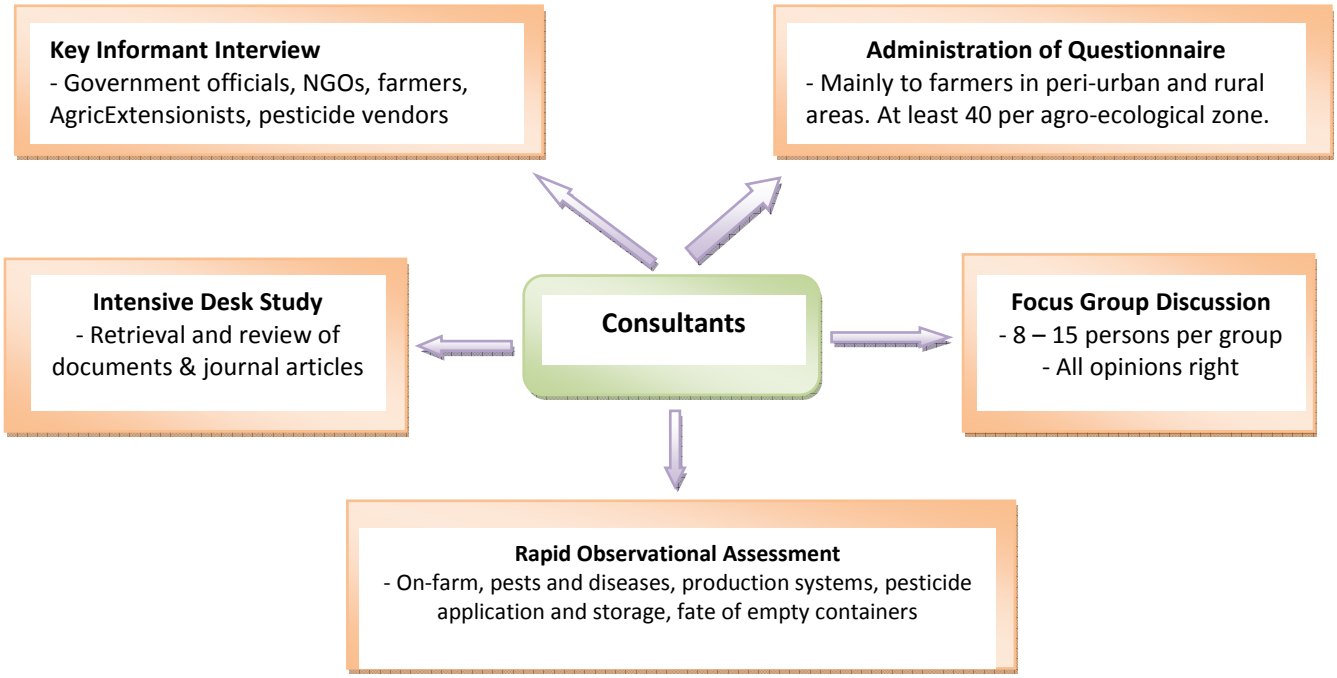


Figure 4: Summary of the major qualitative and quantitative tool used for data collection

The intensive desk study was mainly for the purpose of taking stock of existing secondary data thorough review of documents and/or journal articles. These documents and articles were obtained from the following sources; internet searches using all available and functional search engines; government offices/ministries; libraries of research centers and universities as well as from personal books/articles/documents of the consultants. Documents and articles reviewed were mainly related to background information on agriculture in Cameroon, vegetables, production systems, crop protection practices and pesticides.

The key informant interviews were carried out so as to get first hand information via in-depth knowledge from persons that are experts or experienced in the fields related to the study objectives. In each agro-ecological zone, at least 1 key person was interviewed. These persons included farmers who have cultivated vegetables for at least 10 years; agriculture extension officers with at least 10 years experience; Non-Governmental Organizations dealing with vegetables; Divisional/Sub-Divisional Delegates of Agriculture; whole/retail sellers of fresh vegetables, and those selling pesticides directly to farmers. Questions and discussions for the interviews were based on four major themes; vegetables and their importance to the community; vegetable production constraints; Crop protection practices; and cases of pesticide misuse and effects of pesticides on human health. During the interviews (that usually began with the purpose and intended use of the information), the consultant used an interview guide consisting of about two to three questions per theme. In the course of the interviews, efforts were made to avoid the use of

jargons and close-end questions, to maintain a neutral attitude, and characteristic probing questions were used wherever necessary.

In addition to the key informant interviews, focus group discussions on the study topic were organized. A total of five focus groups were organized and consisting mainly of farmers (8 to 15 participants in number). In choosing participants for the focus groups, the villages or towns were first visited (with permission from the Sub-Division Delegate of Agriculture/Rural Development and/or the Chief of the area concerned). A meeting of vegetable farmers was held from which participants for the focus group were chosen. These focus groups had the same themes like the key informant interviews. However, unlike the key informant interviews, focus groups had eight predefined questions based on the themes.The conduct of the focus group took place either in the Chief's palace, a government office or the house of a farmer. The entire discussion ranged from 90 to 120 minutes depending on the interest and questions from the participants. In all cases, jargons were avoided, 'pidgin-English' was used for better understanding, all opinions or answers were right and attempts were made to encourage all the participants to have something to say. Furthermore, although the discussion was open for every participant, they were moderated by the consultants. Finally, at the end of the discussion session, participants were given incentives in the form of washing/bathing soaps.

Another very important tool used for this study was the use of questionnaires (**See Appendix 1for questionnaire**). This was used to get both qualitative and quantitative data from the farmers. The questionnaire was designed such that it reflects the objectives of the study. Generally, the questionnaire consisted of both open-ended and close-ended questionnaires on different major areas of interest that included; general information of the participant and production potential of farms; pests and diseases affecting vegetables and their management practices; application of agrochemicals (use and misuse), cost of applying agrochemicals, yield and profitability with and out agrochemicals, as well as what the farmers think other important stakeholders could do to improve production/crop protection practices.

Concerning administration of the questionnaires, the numbers given to each town/village of each agro-ecological zone depended on the availability and willingness of the farmers to respond to the questions. However, in all cases, at least 10 questionnaires were administered per village/town. Before administration of the questionnaires, the consultants had working sessions with enumerators on the topic. These enumerators were also trained on how to be effective and on necessary ethics for administering and conducting questionnaires especially in rural settings. During the administration proper, enumerators and consultants got information individually from vegetable farmers. Only farmers that were willing to participate were allowed to fill the questionnaires in the presence of the administrators. Questions were read to the farmers in 'pidgin English', English or French depending on which one the farmer is most comfortable

with. Answers given by the respondents were immediately written in the questionnaire by the enumerators/consultants.

In order to confirm some of the responses (gotten via interviews, focus groups, and questionnaires) of the farmers, the consultants with the help of some technicians carried out a rapid observational assessment in each selected village/town of the different agro-ecological zones. A few farmers' fields were inspected rapidly to actually see the types of vegetables grown, the types of pests and diseases attacking them, damages caused by the pests, the various crop protection practices, how pesticides are applied, production systems, transportation and sales of vegetables. In addition to field inspections, some houses of farmers were visited to find out the types of pesticides they are using, how these pesticides are stored and what they do with empty containers of the pesticides.

Generally, before carrying out this study in the different agro-ecological zones, the consultants passed through an official route before contacting the farmers. **Figure 5** shows the route used by the consultants to get to the farmers.**Figure 6** shows how researchers/consultants in the field

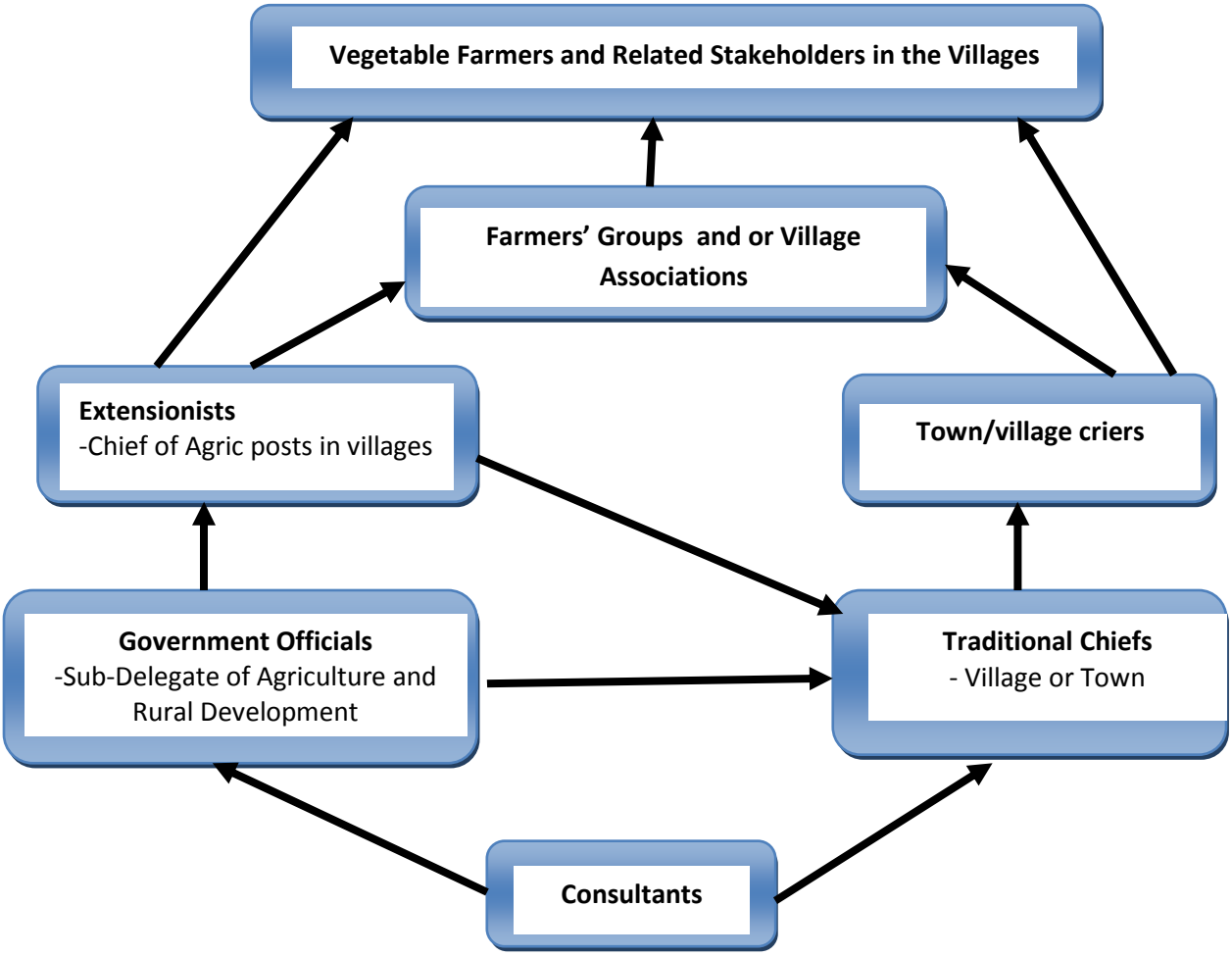


Figure 5: Flow chart to show the official route used by consultants to reach the vegetable farmers

(a) (b) (c) (d)

Figure 6: Consultants in the field (a) key informant interview (b) focus group discussion (c) administration of question (d) with vegetable vendors ('buyam sellam')

2.2. Data Analyses

Data was keyed and double checked for obvious reasons to avoid errors. Cases with missing values were assigned the value "99"and were thus not included in the analysis. The questionnaire data was analyzed using the IBM SPSS statistical package version 21.0. Firstly, the various variables were subjected to descriptive statistics to get the frequency of responses. Secondly, the effect of one variable on another was determined using cross tabulations. Proportions as percentages resulting from such output were manually computed. Finally, to determine if significant differences existed between one variable or a set of variables and another or not, a chi square test was used at the 95% probability level. Qualitative information from questionnaires was used to supplement useful statistical outcomes. Apart from word format presentation, Tables both generated by the software and computed were also used to present the results.

3. RESULTS AND DISCUSSION

3.1. Gender and Age Considerations

Tables 2, 3 and 4 show gender representation by Regions, Divisions and Towns. Generally, in this survey, there was no significant difference in the overall gender representation (Males = 64, Females= 66) (χ^2 = 2.805, df = 3, P = 0.423). However a significant gender difference occurred between the different Regions (χ^2 = 33.07, df = 2, P = 0.001). More female farmers were recorded from the South West Region (60.61%) while more males were recorded from the West (46.88%) and South (40.63%) Regions. Table 5 shows gender representation between the different age groups. A majority of the farmers (41.86%) were above 45 years of age mostly distributed in towns in the South West (20.93%) and West (20.16%) Regions. A greater part of farmers in the South Region fall within the age ranges of 25-34 (51.42%) and 35-44 (40.06%).

Table 2: Gender representation by Regions/Agro-ecological zones

		Region of vegetable production			Total
		South West	South	Western	
Gender of vegetable farmers	Male	8	26	30	64
	Female	40	15	11	66
Total		48	41	41	130

Table 3: Gender representation by Divisions

		Division of vegetable production					Total
		Fako	Kupe-Manenguba	Mvila	Mifi	Nde	
Gender of vegetable farmers	Male	3	5	26	14	16	64
	Female	24	16	15	8	3	66
Total		27	21	41	22	19	130

Table 4: Gender representation by Towns

		Town of vegetable production								Total
		Lysoka	Owe	Tombel	Oding	Galane	Baffoussam	Nkong-Ngam	Banoumdim	
Gender of vegetable farmers	Male	1	2	5	14	12	14	8	8	64
	Female	12	12	16	10	5	8	2	1	66
Total		13	14	21	24	17	22	10	9	130

Table 5 Gender representation in the various age groups

	Age range of vegetable farmers				**Total**
	18-24	**25-34**	**35-44**	**Above 45**	

Gender of vegetable farmers	Male	1	18	18	27	64
	Female	5	17	16	27	65
Total		6	35	34	54	129

3.2. Level of Education, Association Membership and Training

On average, 95% of the farmers have attended at least a certain level of education, with the majority (43.8%) boosting of a first school leaving certificate. Unfortunately, only 32 (36.0%) and 16 (12.8) belong to a farming group and have attended workshop or training on vegetables respectively. Names of the farming groups to which they belong, the purpose of the training they attended, where the training was organised and the organizers are presented in **Tables 6 and 7**. None of the farmers in the Nde Division of the West Region belonged to a group.

A significant difference existed between the levels of education attended by both male and female farmers, with 69.42% of them attending only the primary level whether obtaining a certificate or not (χ^2=18.00, df =6, P =0.006). A proportion of 59.5% of farmers with this level of education are made up of females while men make up the remaining 40.5%. The South constitute the Region with the highest proportion of farmers (40.5%) who have attended at least a primary level of education while cases with no formal education(6) were recorded only in the South West Region.

The farmers indicated that the best way to bring vegetable farmers together for a training activity is through one of the following ways:

- Produce invitation letters and distribute to vegetable farmers;
- Passed an announcement through the local chiefs, chief of agric posts, churches and radio stations (e.g. radio Bonakanda in the South West Region);
- Inform farmers in their groups on their meeting days;
- Inform farmers through NGOs;
- Create group and provide training;
- Organise seminars and invite farmers to attend;
- Provide group training in a demonstration farm; and
- A group can also write to invite a trainer.

Generally, many of the farmers (60.04%) do not belong to any farmer's group or association. For those who do belong, a greater majority are women (65.63%). Most of these groups or associations are found in the South West Region (59.38%). Again, 85.20 % of the respondents have never attended any workshop on

vegetables but for those who did attend, there is no gender disparity (i.e. 50:50 attendances). Regional wise, 50% of the trainings have taken place in the Western Region followed by 37.5% in the South West Region.

Table 6: List of farmer's group represented in the survey

Name of group	Division of group	Region of group
Fako Women Development Association	Fako	South West
Able Ladies Lysoka		
Social Women group		
Depend not Sisters Progression group-Mbonjia		
Lajuber group		
Hope Raising Farmers		
Social Sisters Farming group (CIG)		
One Hand group (CIG)		
HIEFER International	Kupe-Manenguba	
Tombel Area Farmers Association (TAFA) (Meeting)		
Farmer's Business School		
Customs Farmers group		
Green Gold (Ebolowa)	Mvila	South
Waziri group (Ngalane)		
GAJI group (Oding)		
NOTEMBO CIG (Houong I)	Mifi	West
JUISSAN CIG (Bamoungoum)		
GIC des GrandsMaraicheres des Houong III		

Table 7: Workshop training on vegetables

Organiser	Venue	Purpose	Group
MINADER	MINADER office	Sweet bitter leaf and water leaf preservation	Fako Women Development Association
MINADER	MINADERoffice	Vegetable cultivation in the dry season	Customs Farmers group
AVRDC-CASD	Ebolowa	Techniques of vegetable production and protection	Green Gold
PNVRA	Bamoungoum	Confectionary, nursery and pest and diseases management strategies.	DJUISSAN CIG

3.3. Vegetable farming and cropping systems

Vegetable farming and cropping systems in the action sites are highly diversified. Farmers plant vegetables as sole crop or intercrop, in home gardens or distant farms with or without the use of fertilizers or pesticides. It is hypothesized that vegetable production could be intensified in all the three action sites if an efficient seed production system is put in place and sufficient training and promotion of all stakeholders carried out. In the following sections, the vegetable farming and cropping systems of the three action sites are presented.

In the Southwest Region (Buea action site), very few specialized vegetable farmers exist. Most of the farmers grow food crops such as cassava, cocoyam, yam, banana, plantain, maize and sweet potato alongside vegetables. The vegetables are usually intercropped sequentially into existing food crop farms or planted in free spaces within plantations of industrial crops mainly rubber, oil palm, banana and cocoa. Some exotic vegetables such as tomato, cabbage and water melon are cultivated occasionally as sole crop while traditional vegetables such as night shade are cultivated mostly along river banks. Climbing leafy vegetables such as okongobong are cultivated along fence lines or beside fruit trees or shrubs to serve as support for the climbing vegetables. Fallow is a common practice in most parts of the action site due to the availability of land. Occasionally, farmers rotate vegetables and cereals or legumes. This is important for the reduction of pests and diseases infestation in the farms. The use of pesticides and fertilizers are low compared to the Bafoussam action site. This is probably because the dominant soil in this action site is the rich andosol originating from volcanic activities of Mount Cameroon in Buea. Most field operations are done manually though labour is expensive and scarce. Though rainfall is generally sufficient for vegetable production in most of the cropping season, farmers do irrigate to substantiate rainfall particularly during short dry periods within the rainy season.

The possibilities of boosting vegetable production at this action site are huge, as the soil is fertile, land available and climate favourable. Additionally, there is huge market in neighbouring Nigeria, as well as in Douala, the economic capital of Cameroon. What needs to be done is to put in place of an efficient seed production and distribution system, promotion and the training of stakeholders.

The West Region (Bafoussam action site) is the major vegetable production zone in Cameroon. Most of the vegetables produced or marketed are exotic particularly tomato, cabbage, green pepper and water melon. The indigenous vegetables are limited to a few species particularly night shade. Vegetable farming is a specialized activity, cultivated not only in home gardens but also in distant farms. Sole cropping is the dominant cropping system, though some few farmers grow vegetables alongside with other food crops particularly maize and beans or green spices. Averagely, exotic vegetable farms especially tomatoes and cabbages are larger than in the other action sites. Fallow is not a common practice due to land scarcity. Consequently, organic fertilizers such as chicken waste, cow dung, compost and crop residues are used for soil fertility improvement. Organic fertilizer application is usually accompanied by high use of chemical fertilizer to compensate for the poor ferralsols that dominate in the action site. Crop rotation particularly cabbage and tomato is common to limit the spread of pests and diseases. However, pesticides and fungicides are used regularly to control pests and fungi respectively in the vegetable fields. Most of the farm activities such as land preparation, planting and maintenance are done using hired manual labour that is very available and or household labour. Irrigation is carried out either to supplement rainfall or to sustain crop growth

during the dry season. Since the pressure on land is very high in this action site, vegetable production could be improved mainly by putting an efficient seed production system and training of stakeholders.

The situation at the South Region (Ebolowa action site) is similar to that of Buea. Vegetables are cultivated both as sole crop and intercrop with food crops such as cassava, plantains and cocoyams or industrial crops like cocoa and oil palm. However, the availability of vegetable seeds is low and the use of fertilizer is on the rise due to the poor nature of the soil, ferralsol, at the action site. Leguminous cover crops particularly pueraria are promoted for soil fertility improvement to replace the long duration fallow rotations that existed in the past. Home gardens are scarce possibly because of stray animals. Labor for field operations is very scarce. Most of the workers to carry out field operations are hired from the Bafoussam action site. The Ebolowa action site is also noted for the use of forest or wild vegetables such as eru that are harvested regularly from the forest. This action site has a lot of available land for agriculture. The climatic conditions are favourable for vegetable cultivation. The site is close to neighboring Gabon, Equatorial Guinea and Central Africa Republic. Thus, there is a huge market for the product. But the availability of vegetable seeds is very low. If put in place an efficient seed production and distribution system and capacity building of stakeholders, the production of vegetables in the action site could be increased significantly.

Vegetables generally cultivated include 'Anchia' (cultivated only in the South West Region), Jute Mallow (cultivated only in the South Region), Cabbage, 'Bitter leaf', "Okongobong", and Water leaf (cultivated both in the South & South West Regions) while Green, Huckle berry,cocoyam leaves, Okro, Pepper and Tomato are cultivated in all the regions. Other vegetables cultivated in limited quantities by a fewer number of farmers include: 'Nkenenkene' in the South West Region, Onion, Green beans, Melon & Leeks in the Western Region and Garden egg in the regions.

Table 8 shows the type of vegetables cultivated by the various farmers, purpose for cultivating and region cultivated. The main purpose for cultivating is for consumption by the family and for sale. 'Anchia' is cultivated only by female farmers and only in the South West Region. 'Bitter leaf', 'Green', 'Okongobong' and Waterleaf are vegetables cultivated mostly by female farmers and mostly in the South West Region. Jute Mallow is cultivated by both sexes alike but occurs only in the South Region. Cabbage, Pepper and Tomato are cultivated mostly by male farmers and mostly in the Western Region. Finally, Huckle berry based on the survey can be considered a general vegetable, cultivated by both sexes alike in all the regions.

Table 8: Type, cultivators, purpose and regions of vegetables cultivated

Vegetable type	Main cultivators (% respondents)	Main purpose for cultivation (% respondents)	Main region of cultivation (% respondents)
Anchia	Female farmers (100)	Consumption by the family and for sale (75)	South West Region (100)
Bitterleaf	Female farmers (80)	Consumption by the family and for sale (75)	South West (86.67)
Cabbage	Male farmers (60)	Consumption by the family and for sale (80)	Western (70)
Green	Female farmers	Consumption by the family and for sale (78.57)	South (54.76) South West (42.86)
Huckle berry	Male farmers (50.46) Female farmers (49.52)	Consumption by the family and for sale (85.32)	All regions (100)
Jut Mallow	Male farmers (50) Female farmers (50)	Consumption by the family and for sale (80)	South (100)
Okongobong	Female farmers (91.30)	Consumption by the family and for sale (94.44)	South West (95.65)
Okro	Male farmers (52.78) Female farmers (47.22)	Consumption by the family and for sale (77.78)	South (66.67)
Pepper	Male farmers (67.21)	Consumption by the family and for sale (70.49)	Western (42.62)
Tomato	Male farmers (77.36)	Consumption by the family and for sale (67.92)	South (47.17) Western (45.28)
Waterleaf	Female farmers (84.21)	Consumption by the family and for sale (89.47)	South West (78.95)

Significantly higher number of farmers (both males and females) cultivate vegetables as a main crop (χ^2 = 12.88, df = 1, P = 0.001). Regrettably, however, a greater proportion (86.36%) of those who do not

cultivate as a main crop are females, 50% of which are located in the West Region. As a matter of fact, 66.09% of the farmers have been cultivating these vegetables for at least 5 years. Men (57.9%) constitute the majority in this category while up to 30.91% of some female farmers have been cultivating for only 1-2 years. A majority of such women are located in the South Region (54.55%). Up to 87.5% of the vegetables are cultivated in a mixed cropping system and is most often done by women (85.71%) compared to the men. Again, up to 53.78% of the farmers practicing this system are located in the Western Region.

3.4. Pests/Diseases, Damage, Yield Loss and Crop Protection Practices

Table 9 shows the various pests/diseases attacking vegetables, their damage signs/symptoms, estimated yield losses and the different practices applied by the farmers to protect their crops from these biotic constraints. Although the major biotic stresses mentioned by the farmers were insects and fungi, molluscs (e.g. snail), mammals (e.g. antilope, goats)and birds were serious on specific vegetables. In all the vegetables, the main signs/symptoms resulting from pests/diseases damage were skeletonise leaves, leaf curling, holes on leaves and leaves rot. Common vegetable protection practices were use of pesticides (mainly insecticides and fungicides), use of wood ash, and sanitation (constant weeding and pruning of infected/infested plants/parts); combination of pesticides and wood ash, and combination of pesticides and fertilizers (**Figure 7**) In most of the farms, farmers apply a sort of integrated pest management by applying different techniques (cultural, use of biopesticide, physical/manual, and application of pesticides). Generally, bitter leaf, green, huckle berry, pepper, water leaf, and okongobong were vegetables that were heavily infested/infected.

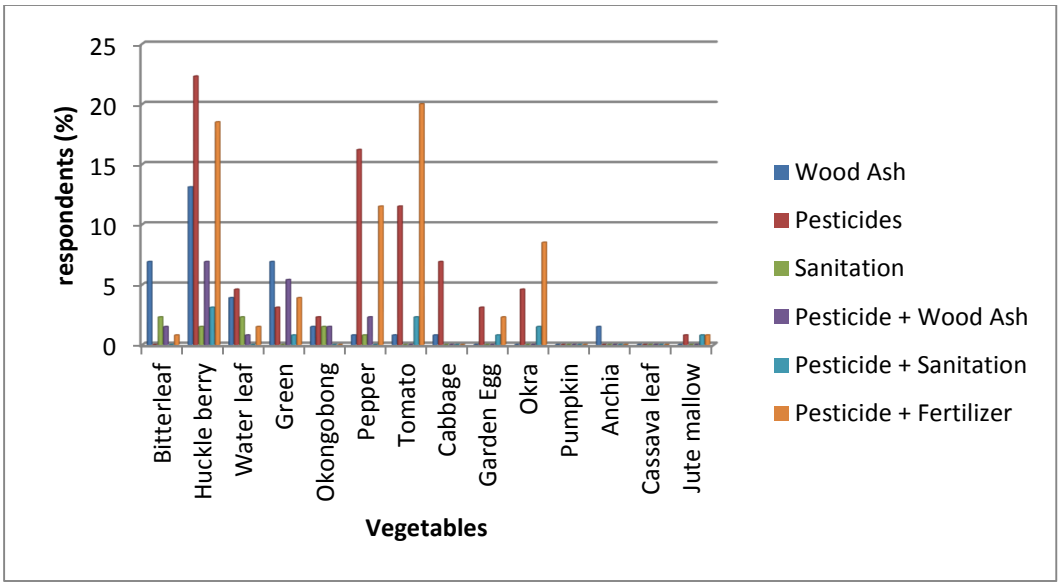


Figure 7: Percentage of respondents using different crop protection practices in their farms/gardens for different vegetables

Of all the vegetable protection practices, the use of pesticide was the most common and the reason for this was attributed to the high efficacies of most as well as being labour less intensive. **Figure 8** shows the proportion of vegetable farmers applying pesticides in their farms. The highest proportion of farmers using pesticides was in the South Region (95.1%) and the least was SouthWest with 56.3%.

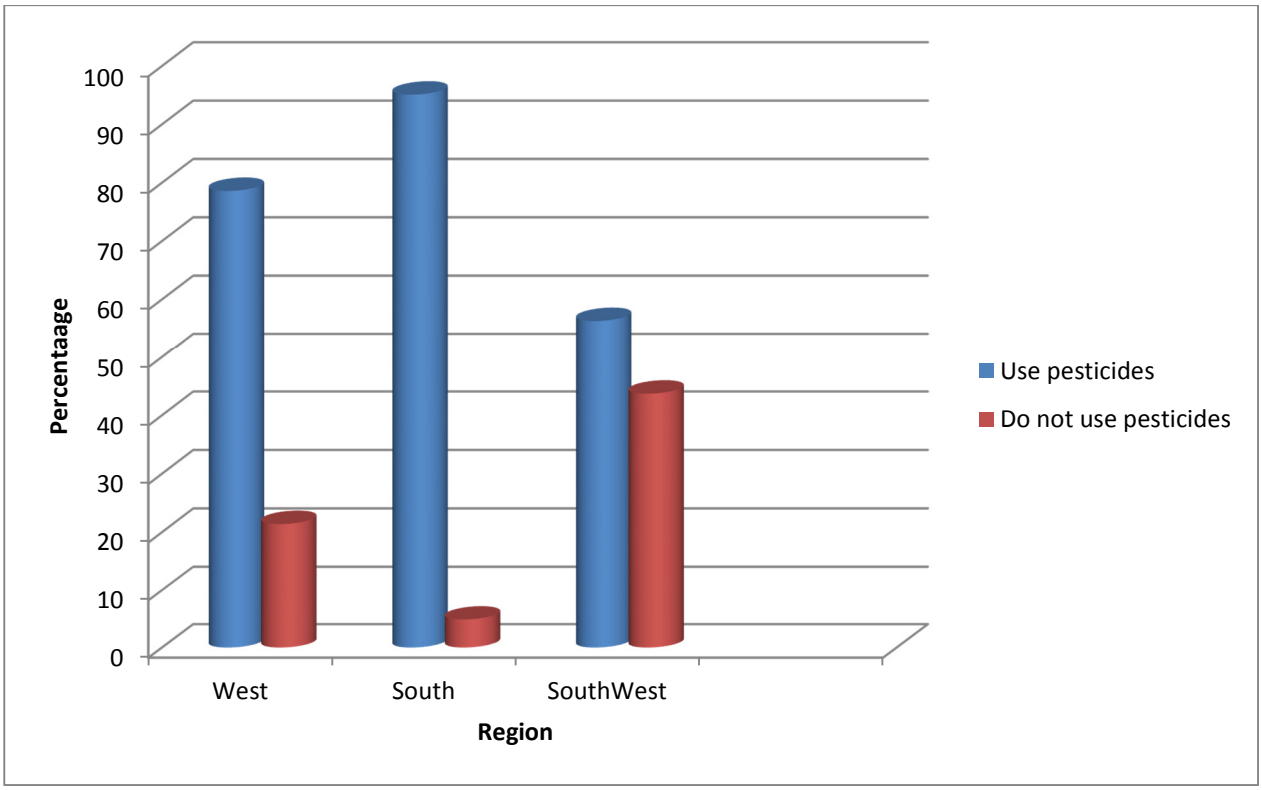


Figure 8: Proportion of vegetable farmers of the different Regions applying pesticides in their farms

Table 9: Vegetable pests/diseases, damage signs/symptoms, estimated yield losses and protection practices

Vegetable	Pests/Diseases	Damage Signs/Symptoms	Protection Practices
1. Bitter leaf	Insects (caterpillars, ants), small snails, goats, red leaves	Skeletonised leaves, curled leaves, holes on leaves and stems, red leaves	Wood ash mixed with insecticide (Dursban) and spread on leaves. Wood ash alone on leaves. Cut off infested leaves. Manually remove small caterpillars.
2. Huckle berry	Insects (black ants, brown caterpillars), red leaves	Leaf curling, holes on leaves, red leaves	Mix wood ash with insecticide and spread on leaves. Spread only wood ash on leaves.
3. Water leaf	Fungi	Brown spots on leaves	
4. Green	Insects (caterpillars, ants), fungi mammals, small snails	Curled leaves, holes on leaves, yellow leaves, red leaves, skeletonised leaves	Wood ash mixed with insecticides spread on leaves. Wood ash solution on leaves. Mix insecticide (methyl parathion) with wood ash and spray on leaves. Methyl parathion solution only on leaves. Much Dursban solution on leaves. Mix wood ash and kerosene and spread on leaves. Wood ash on leaves Application of insecticide/nematicide (Bastion 10 G)
5. Okongobong	Insects (grasshoppers, caterpillars), wild and domestic mammals	Curled leaves, dark or brown spots on leaves, withered plants, leaves partially eaten, small holes on leaves, red and yellow leaves.	Spread wood ash on leaves. Cut and throw away dead plants. Apply Mocap (Ethoprophos) powder on leaves. Mix wood ash and insecticide and apply on leaves
6. Pepper	Insects (caterpillars, grasshoppers, fruit flies, white flies, scales) Fungi Wild animals (antilope) Mollusc (small snails, slugs) Birds	Curled leaves Partially eaten leaves and fruits Holes on leaves Fruit rot Premature falling of fruits Eaten shoots and cutting tip of growing region Blight	Spray mixture of wood ash and insecticide (cypercal) on leaves. Spray mixture of fungicide (Plantomil) and insecticide on the leaves. Spread wood ash on the leaves Spray fruits and leaves with insecticide (methyl parathion) solution Fence farm to prevent entry of animals Change planting seeds annually
7. Tomato	Insects (fruit flies, aphids, crickets, caterpillars)	Eaten fruit pulp Holes on fruits	Apply insecticide (Parastar, Cypercal) solution on fruits and leaves

Vegetable	Pests/Diseases	Damage Signs/Symptoms	Protection Practices
	Fungi	Dark/brown spots on fruits Curled leaves Cut shoots of young plants	
8. Cabbage	Insects (caterpillars)	Partially eaten leaves Holes on leaves	Mix fungicide (Manet) with insecticide (Eforia) and spray on leaves before the leaves start folding.
9. Garden egg	Insects (maggots, caterpillars, ants)	Eaten pulp of fruits Curled leaves Holes on fruits	Nothing
10. Cocoyam leaves	Fungi	Brown spots on leaves Dead leaves	Nothing
11. Okra	Insects, Snails	Curled leaves Partially eaten fruits Holes on leaves and fruits	Spray insecticide solution on the fruits Plant during off season
12. Pumpkin	Nothing	Nothing	Nothing
13. Anchia	Soil fungi Insects (ants)	Dead plants Yellow leaves Curled leaves	Apply wood ash on the leaves
14. Cassava leaves	Fungi	Leaf rot	Weeding
15. Nkenekene	Insect (caterpillars) Fungi Molluscs (small snails)	Holes on leaves Red leaves	Apply wood ash on the leaves

Of all the vegetable protection practices applied in vegetable cultivation in all the regions, farmers emphasized on certain techniques which they claim are the best for managing biotic constraints in the farms (**Table 10**)

Table 10: Best vegetable pest management techniques as reported by vegetable farmers

Pest and disease control technique	Reason
Eforia application	No pest or disease attack appear after treatment with this pesticide
Wood ash application (powder)	Very effective in killing insects and fungi
Grass weeding	Kills weeds and prevent small mammals from destroying the crops
General insecticides and fungicide application	To kill all insect pests (broad spectrum) and fungi
Mocap (ethoprophos) + wood ash application	To kill ants
Gamalin + wood ash application	Prevents and kill insects (very effective- many inherited from their parents)
Nematocide application (Bastion 10 G)	To fight against nematode infections

The various problems hindering vegetable production in the various regions are presented in **Table 11**. Pepper and Waterleaf production are hindered mainly by fungi infections, Tomato by a combination of small mammals, insects, low inputs and not enough land while the remaining vegetable types are mostly attacked by insect pests. The South West Region appears to be more susceptible to these hindering problems. A rapid observation of fields confirmed the presence of most of the biotic constraints mentioned by the farmers. In addition, field observation revealed the presence of an bug (**Figure 9**) serving as predator of one of the major caterpillars defoliating and skeletonising leaves

Table 11: Problems hindering vegetable production in the various Regions

Vegetable type	Main problem encountered (% respondents)	Main region of problem encountered (% respondents)	Gender affected by problem (% respondents)
Anchia	Insect attack (55.56)	South West (100)	Female farmers (100)
Bitterleaf	Insect attack (69.23)	South West (83.3)	Female farmers (61.90)
Cabbage	Insect attack (100)	South West (100)	Male farmers (75)
Green	Insect attack (78.05)	South (59.38)	Female farmers (73.33)
Huckle berry	Insect attack (60)	South West (44.44) South (46.03)	Male farmers (46.03) Female farmers (53.96)
Jute Mallow	Insect attack (50)	South (100)	Male farmers (60) Female farmers (40)
Okongobong	Insect attack (55)	South West (90.91)	Female farmers (72.73)
Okro	Insect attack (81.82)	South (74.07)	Male farmers (55.56)
Pepper	Fungi infections (31.58)	West (83.33)	Male farmers (66.67)
Tomato	Combination of small mammals, insects, low inputs and not enough land (38.78)	West(89.47)	Male farmers (84.21)

Waterleaf	Fungi infections (50)	South West (100)	Female farmers (90)

Figure 9: Predator bug eating a major caterpillar pest of green in the field

Concerning vegetable loss estimates, all the vegetable farmers provided a quantity loss estimate of 0-25% for the respective vegetables they cultivate except for bitter leaf where a majority (37.0%) of its cultivators estimated a quantity loss of 50-75%. Details of these are as presented in the **Table 12**.

Table 12: Quantity loss estimates of vegetables cultivated in the three regions in Cameroon

Vegetable cultivated	Quantity loss estimates			
	75-100%	50-75%	25-50%	0-25%
	Response frequency (% responses)			
Anchia	1 (11.1)	3 (33.3)	1 (11.1)	4 (44.4)
Bitter leaf	1 (3.7)	10 (37.0)	8 (29.6)	8 (29.6)
Cabbage	/	/	/	8 (100)
Green	2 (5.4)	11 (29.7)	2 (5.4)	22 (59.5)
Huckle berry	1 (1.0)	27 (26.0)	16 (15.4)	60 (57.7)
Jut Mallow	/	/	/	12 (100)
Okongobong	3 (13.6)	3 (13.6)	5 (22.7)	10 (45.5)
Okro	1 (2.5)	3 (7.5)	6 (15.0)	29 (72.5)
Pepper	6 (9.8)	20 (32.8)	13 (21.3)	22 (36.1)
Tomato	2 (3.6)	20 (35.7)	5 (8.9)	28 (50.0)
Waterleaf	2 (8.0)	8 (32.0)	2 (8.0)	11 (52.0)

As for the developmental stage of attack, this was found to be 1-2 months after planting based on responses from farmers irrespective of the vegetable crop cultivated.

3.5. Farm locations, Production Systems and Marketing

3.5.1. Farm locations and production systems

Most of these vegetable farms are situated near a stream/lake/ponds/river (38.3%), where there is no forest (25.0%), within a forest (10.9%) and behind their houses (10.2%). A smaller proportion of the farms are situated in a swampy area (8.6%) while the remaining proportions are a combination of these. A total of 106 (82.8%) of the vegetable farmers indicated that vegetable is one of the main crops they cultivate and 66.1% of them have been doing this activity for more than five years. However, a majority (87.5%) of those who do not cultivate vegetables as a main crop practise the mixed cropping system. They mix vegetable crops with other food/cash crops such as Beans, Plantains, Banana, Fruit trees, Cassava, Cocoyams, Yams, Potatoes, Maize, Cabbage. It was also noticed that most farmers who cultivate within forest or tree areas usually associate them with perennial crops such as Cocoa or Rubber. Also, some farmers especially in the Bouba area (SouthWest Region), take advantage of fallows of banana plantations to cultivate their vegetables.

About 73.47% of the vegetable farms owned by male farmers are situated near a stream/lake/pond/river and 71.88% of farms owned by their female counterparts are situated where there is no forest. Most of the farms located near a stream/lake/pond/river are found in the South (40.82%) and Western (46.94%) Regions while 46.88% of those situated where there is no forest are found in the South West Region.

3.5.2. Planting material

Generally, most of the farmers use traditional seeds as the main source of planting material. This is however not exclusive as they also use imported seeds to some limited extent. The sources and extent of use are varied depending on the vegetable in question. Percent responses for main sources of planting material from the farmers cultivating a particular vegetable are as indicated in parenthesis for each vegetable as follows. Anchia (85.7%), Jut Mallow (80%), Bitter leaf (87.5%), Green (94.4%) Huckle berry (73.1%), Okongobong (78.3%), Waterleaf (85%) & Okra (66.7%) planting materials are sourced traditionally. Cabbage (55.6%) & Tomato (52.8%) planting material are imported. Only about 5.7% of the tomato farmers use local tomato seeds while 56.7% of those who cultivate pepper use both local and imported planting material. No vegetable farmer cultivating waterleaf, “Okongobong”, green, bitter leaf &Anchia use exclusively imported seed as planting material.

3.5.3. Market for vegetables

From every indication, there is a ready market for vegetable in these Regions, Divisions and Towns surveyed based on responses from 126 (96.4%) out of 130 farmers. As a result of a ready market for vegetables in all the areas, 104 (82.5%) attest that the proceeds from the sale of vegetables has made a

significant impact on their annual income. Despite this, a total of 83 respondents (64.3%) sell only part of their produce because vegetables are a major contributor to food on their tables as indicated by 114 (89.8%) of the farmers.For the simple reason of income generating abilities of vegetables and their nutritional importance to the vegetable farmers, the sole purpose of cultivation is both for sale and for consumption by the family (**Table 13)**

Table 13: Main purpose for vegetable production

Vegetable cultivated	Consumption by the family	For sale	Both for sale and for consumption by the family
	Response frequency (% responses)		
Anchia	1 (12.5)	1 (12.5)	6 (75)
Bitter leaf	6 (20)	2 (6.7)	22 (73.3)
Cabbage	2 (20)	/	8 (80)
Green	3 (7.1)	6 (14.3)	33 (78.6)
Huckle berry	8 (7.3)	8 (7.3)	93 (85.3)
Jut Mallow	1 (10)	1 (10)	8 (80)
Okongobong	2 (8.7)	3 (13)	18 (78.3)
Okro	/	8 (22.2)	28 (77.8)
Pepper	5 (8.2)	13 (21.3)	40 (70.5)
Tomato	2 (3.8)	15 (28.3)	36 (67.9)
Waterleaf	1 (5.3)	1 (5.3)	17 (89.5)

Based on a regional analysis, a ready market for the vegetables cultivated exists for both men and women in all the three regions. Because of this, there is a significant disparity in terms of quantities sold or consumed by both gender (χ^2= 6.77, df= 2, P =0.034). Vegetables are generally cultivated for consumption by the family and for sale, but 34.38% of the male farmers sell everything while 12.31% of the female farmers do not sell at all. Farmers in the South Region seem not to consume vegetables much as a greater proportion (94.60%) of them sell all, a very minute proportion (7.23%) sell part and none keep it solely for the family (**Table 14**).

Table 14: Proportion of vegetables cultivated and sold in the different regions

		How much of your produce do you sell?			Total
		All	Part	None	
Region of vegetable production	South West	1	42	5	48
	South	35	6	0	41
	Western	1	35	4	40

Total	37	83	9	129

Proceeds from sales of vegetable crops generally seems to make a significant impact on the vegetable farmer's income (χ^2 = 10.27, df = 1, P =0.001) but 26.13% of some female farmers disagree with this. Income from sales was however not significantly affected by region of cultivation. Both the male and female farmers are on the same opinion that vegetables are major contributors to food on their table. This statement is more valid in the South West and South than in the Western Regions as can be seen in **Table 15** below.

Table 15: Contribution of vegetables to food in households in the various Regions

		Are vegetables major contributors to food on your table?		Total
		Yes	No	
Region of vegetable production	South West	47	1	48
	South	38	1	39
	Western	29	11	40
Total		114	13	127

3.5.4. Estimation of partial budgets for tomatoes and water leaves

Many models have been suggested for the estimation of partial budgets using varying factors. It has been generally demonstrated that estimating partial budgets in small scale agriculture especially vegetable field crops is complicated and difficult to access (Horna et al, 2008). This is because although farmers will typically use higher level of inputs, they have hardly accessed the cost implications. As well, labour is never budgeted since most households depend on family labour (Horna et al., 2008). In the Buea action site, when farmers used increase labour for input application, they simply intensified the working hours of the family members, use friends and relatives to assist or abandoned other activities for vegetable cultivation. All this is hardly valuated in monetary terms and therefore not considered as increase cost. Most inputs used for water leaves cultivation are, fertilisers and pesticides. Commercial farmers said they bought fertilisers but applied it depending on its availability. Most pesticides were bought for cocao and small amounts applied on vegetable fields. For some cases, vegetables farmers bought perticides in small quantities from retailers. Equipment used for input application were largely traditional, begged or borrowed. A few farmers bought spraying cans (Matabi) but others simply used watering cans or anything that could produce drops of water for spraying their fields. **Tables 16 and 17** show partial budget estimate for two common vegetables.

Table 16: Partial budget analysis for Tomatoes

Positive Change	**Negative change**
Additional Income Increase production = 75000 FCFA	**Reduce Income**
Total = 75000 FCFA	Total = 0
Reduce cost Less Pesticide use = 33400 FCFA Reduced pesticide labour = 15000 FCFA Less fertilization = 15000 FCFA Reduce fertilization labour = 6000 FCFA	**Additional cost** *Training time = 4700 FCFA *Training cost =6500 FCFA
Total = 69400 FCFA	Total = 11200FCFA
Total positive change = 144400	Total negative change = 11200 FCFA
Net change = 133200FCFA	

*Actual cost divided for five years and two production period

Table 17: Partial budget analysis for Water leaves

Positive Change	**Negative change**
Additional Income Increase production = 25000 FCFA	**Reduce Income**
Total = 25000 FCFA	Total = 0
Reduce cost	**Additional cost** *Training time = 4700 FCFA *Training cost =6500 FCFA Less Pesticide use = 20000 FCFA Reduced pesticide labour =5000 FCFA
Total = 0	Total = 18200 FCFA
Total positive change = 25000 FCFA	Total negative change = 18200 FCFA
Net change = 6800FCFA	

*Actual cost divided for five years and two production period

3.6. Agrochemical Application, Misuse and Health Effects

3.6.1. Agrochemical application

Table 18 gives a summary of some agrochemicals applied in vegetable production in Cameroon. Of the 61 agrochemicals recorded from the questionnaires (all regions inclusive), 23 are insecticides, 27 are fungicides, 8 are fertilizers, 2 are herbicides and 1 is a botanical (wood ash) that is commonly applied on all vegetables and in all the regions. Of all these agrochemicals, 62.3% were used in the West Region, 19.7% in the SouthWest and 18% in the South. Based on the responses got, 30.08% of the farmers do not apply chemicals to plants in the nursery. Up to 86.49% of this category of farmers are women and is a common practice mostly in the South West Region (70.27%). Generally, most of the female vegetable farmers do not apply pesticides. In case pesticides are being applied at any level of the production chain, it is done by both adult male and females in the family or only adult males of the family. Once the crops are harvested, pesticide application is generally not a common practice by both male and female farmers (66.67%) in all the different regions. That notwithstanding, a proportion of about 27.5% of farmers in the West Region do apply pesticides on their vegetable crops after harvesting.

Considering equipment, no significant differences exist between the type of pesticide/agrochemical application equipment used by men and women ($\chi^2 = 0.99$, df= 1, P = 0.504) in all the regions ($\chi^2 = 1.94$, df = 2, P = 0.378). Regarding knowledge of the dangers associated with pesticideuse, up to 97.3% of the male and 79.63% of female farmers are aware. A greater percentage of those expressing ignorance of pesticide use risks are from the South West Region (66.7%). Despite knowledge of pesticide use risks, a very large proportion of the applicators (65.1%) do not protect themselves during application. Greater majority of these careless pesticide applicators are women (53.5%), mostly located in the Western (39.4%) and South West (33.8%) Regions.

Table 18: Different agrochemicals applied on vegetables

Agrochemicals	Active Ingredient	Application Doses	Application Frequencies	Vegetables Applied On	Comments/Toxicity
Insecticides					
Parastar 40 EC	Imidaclopride 20g/l + Cyhalothrine 20g/l	1tin tomato/15L,	Weekly,	Tomatoes	Class III
Mocap 15 G	Ethoprophos 150g/kg	Not Available	Once/month	Water leaf, Okongobong, Bitterleaf	Sometimes mixed with wood ash or methyl parathion .Class Ia
Eforia 045 ZC	Thiametoxam 30g/l + Lambdacyhalothrine 15g/l	20ml/15L	Twice/month	Water leaf, Cabbage, Pepper,	Over dose burns plants. Class II
Methyl parathion		1 sachet/15L, 1 table spoon/15L, 1 tin tomato/15L	2-4 times per month	Huckle berry, Green	Over dose burns plants. Has been banned.
Dursban 4 E	Chlorpyrifos-ethyl 480g/l	1 beer cork/15L, 15ml/15L, 1tin tomato/15L	1-2 times per month	Nkenekene, Green, Pepper, Okongobong, Okra, Bitterleaf, Huckle berry, Water melon, poivron	Over dose burns leaves. Sometimes mixed with wood ash (mixing done with bare hands). Class II
Pyriforce 600 EC	Chlorpyriphos-ethyl 600g/l	I beer cork/10L,	Twice per month	Pepper	Class II
Cypercal 50 EC	Cypermethrine 50g/l	1sachet/15L, 1 beer cork/15L, 10ml/15L	Twice per month, once per week	Pepper, Okra, Hucke berry, Garden egg, Cabbage	Class II
Laminda Gold 90EC	Imidaclopride 30g/l + Lambda-cyhalothrine 60g/l	80ml/15L, 25ml/15L, 30ml/15L	Once per week	Tomato, Pepper, Huckle berry, Green	Class III
Cicogne 360 EC	Cypermethrine 360g/l	80ml/15L	Once per week	Tomato	Class II
Capt Forte 184 WG	Lambda-cyhalothrine 120g/l + Acetamipride 64g/kg	Not Available	Not Available	Not available	Class II
Cyplandin Super	Lamda-cyhalothrine 15g/l + Acetamipride 20g/l	150ml/15L	Once per week	Tomato	Class III
Cyperplant 100 EC	Cypermethrine 100 EC	100ml/15L	Once per week		Class II
Chlorcot 480 EC	Chlorpyriphos-ethyl	Not Available	Not Available	Not available	Class II

Agrochemicals	Active Ingredient	Application Doses	Application Frequencies	Vegetables Applied On	Comments/Toxicity
	480g/l				
Kung Fu B 50 EC	Imidaclopride 10g/l + Cypermethrine 40g/l	75ml/knapsack, 1sachet/knapsack	Once per week, once per 2 weeks	Huckle berry, Jute Mallow	Class II
Nurelle D 20/200 EC	Cypermethrine 20g/l + chlorpyrifos 200g/l	Not Available	Once per week	Tomato, Huckle berry, Pepper	Class II
Timilde 80		1beer cork/15L	Once per week		
Caiman B 50 WG	Emamectine-benzoate 50g/kg	10ml/knapsack	Once per 10 days		Class III
Greforce 480 EC	Chlorpyrifos 480g/l	15ml/knapsack	Once per week	Tomato, Huckle, Pepper, Water melon, Poivron	Class II
Methane 50 EC	Malathion 500g/l	10ml/knapsack	Once per week	Tomato, Pepper, Water melon, Poivron, Green beans	Has been Banned
Golden Stand	-	15ml/knapsack	Not available	Tomato, Huckle, Pepper	
Bastion 10G	Carbofuran 100g/kg	Not available	Not available	Huckle, Green	Has been banned
Grebtac 100 EC	B-cypermethrine 100g/l	5ml/knapsack	Once per week	Not available	Class II
Decis 25 EC	Deltamethrane 25g/l	1beer cork/knapsack	Once per week	Huckle berry	Class II
Grefonsec Complex 210 WP	Carbenddazim 50kg/k + Sulfure 120g/kg + Imidaclopride 20g/kg + Lamda-cyhalothrine 20g/kg	15ml/knapsack	Not available	Not available	Class III
Fungicides					
Mancozeb		60ml/knapsack,	Once per week	Huckle berry , Water leaf	Usually mixed with insecticides and sprayed on leaves
Platinus		40ml/knapsack	Once per week	Water leaf, Huckle berry	
Maneb		30ml/knapsack	Once per month	Cabbage, Tomato	
Plantomil 72 WP	Cupper oxide 600g/kg + Metalaxyl 120g/kg			Pepper	Usually mixed with insecticides
Ridomil Gold Plus	Mefenoxam 6% + cupper oxide 60%	1 sachet/knapsack, 50g/knapsack	Once or Twice per month	Okra, Pepper, Tomato	Class III

Agrochemicals	Active Ingredient	Application Doses	Application Frequencies	Vegetables Applied On	Comments/Toxicity
Plantizeb 80 WP	Mancozeb 80%	Not available	Not available	Not available	Class III
Baobab 80 WP	Mancozeb 800g/kg	Not available	Not available	Not available	Class III
Cleanzeb Blue 80	Mancozeb 800g/kg	Not available	Not available	Not available	
Curlyplant 730 WP	Sulphur 60.8% + Cupper oxychloride 12.7%	Not Available	Not Available	Not available	Class III
Beauchamp 72% WP	Metalaxyl 8% + Mancozeb 64%	Not available	Not available	Tomato	
Mantizeb		Not available	Not available	All	
Fongistar 72% WP	Metalaxyl 80g/kg + Mancozeb 640g/kg	Not available	Not available	Green	Class III
Maneb		1tin tomato/knapsack	Not available	Cabbage, Okra, Garden egg, Huckle berry	
Bin Laden		Not available	Not available		
Jacob		Not available	Not available		
Ivory 80 WP	Mancozeb 800g/kg	Not available	Not available		Class III
Benlate		Not available	Not available		
Pencozeb 80 WP	Mancozeb 800g/kg	Not available	Not available	Tomato, Water melon, Huckle, Pepper, Poivron	Class III
Banko Plus	Chlorothalonil 550g/l + Carbendazine 100g/l	Not available	Not available	Tomato, Water melon, Huckle, Pepper, Poivron	Class III
Callomil Plus	Copper oxide 600g/l + Metalaxyl 120g/kg	Not available	Not available	Tomato, Water melon, Huckle, Pepper, Poivron	Class III
Ballair		Not available	Not available		
Funguran	77% cupric hydroxide equivalent to 50% copper	Not available	Not available		
Nordox 75 WG	Copper oxide 86%	Not available	Not available		Class III
Kocide		Not available	Not available		
Baobab 75 WG	Mancozeb 750g/kg	Not available	Not available		Class III
Poudrox		Not available	Not available		
Agrizeb 80 WP	Mancozeb 800g/kg	Not available	Not available		Class III
Fertilizers					
Urea		20g/plant	Once per week	Huckle berry, Green	

Agrochemicals	Active Ingredient	Application Doses	Application Frequencies	Vegetables Applied On	Comments/Toxicity
NPK (20-10-10)			3 months interval	All	
Plantonus					
Folivert (20-20-20)					
Ammonium sulfate		400kg/ha	Once per week	Tomato, Huckle, Pepper	
Yarra		20g/plant	Not available		
Potassium nitrate		10g/plant	Not available		
Nitrate Calcium		10g/plant	Not available		
Herbicide					
Glyphosalm 360 SL	Glyphosate 360g/l	50ml/knapsack	Not available		Class III
Gramazone		Not available	Not available		
		Not available	Not available		
Botanical pesticide					
Wood ash		Not quantified	As available	All vegetables	Hot ash kills plants

3.6.2. Health effects

Concerning health effects resulting from pesticide application, no significant disparity occurs between sexes. However, skin irritation only (27.36%) and a combination of skin irritation and watery eyes (20.75%) are common health effects among applicators. Skin irritation are most frequently experienced by farmers in the South Region (68.97%) while those in the West Region experience a combination of skin irritations and watery eyes (86.36%). Both sexes in all the regions are for the fact that pest and disease problems are increasing in their farms as time passes (χ^2 =5.64, df = 2, P = 0.059).

3.6.3. Pesticide use/misuse practices

Majority of the farmers (54.3%) mix different pesticides before application. A greater proportion (70.2%) of these is men and it is a more common practice in both the South and Western Regions. A highly significant different exist between the various places where pesticides are kept after use by both sexes (χ^2 = 19.40, df = 6, P = 0.004. Men are more conscious of where they keep pesticides compared to women. About 41.4% of the men keep in a separate room where only pesticides are kept, 44.8% keep in a locked cupboard while a small proportion of some careless women keep in the kitchen (13.9%) and bed room. Keeping pesticides in the bed room (85.7%) and kitchen (75%) is mostly practiced in the South West while locking up in a cupboard is a routine practice in the South (34.3%) and Western Regions (58.8%).

Also, there was a significant difference in the type of containers used in keeping pesticides by both sexes (χ^2 =15.51, df = 4, P = 0.004), with the use of original pesticides containers dominating (84.7%). A clear case of misuse here is seen mostly with the female farmers. Up to 11.9% of them keep pesticides in used supermont/tangui (mineral water bottles) (**Figure 10**) and beverage bottles while 4.8% keep in plastic papers (polyethene bags). This type of misuse (100%) happens only in the South West Region. In this same Region, based on rapid inspection of some houses, most farmers keep drinking water in used pesticide containers (**Figure 10**). The manner in which used pesticides containers are disposed is as follows: 46.1% are thrown in farm/stream/river or dustbin, 20.6% are gathered and burned and 21.6% are washed and water or palm oil are kept in them. This time around, using used pesticide containers to put water or palm oil in them is a common practice with the male farmers (68.2%) and is a practice resulting mostly from the West Region (77.3%).

(a) (b)

Figure 10: Some of the different ways in which pesticides are misused by vegetable farmers (a) putting of pesticides into unlabelled containers of mineral water/sweet drinks (b) pesticide containers used to store drinking water

Regarding sources of advice on agrochemical application to vegetable farmers, agriculture officers, those selling chemicals and friends play key roles. However, male farmers seek advice from a combination of agric officers, those selling chemicals and friends (56.7%) while female farmers prefer to get from friends (31.9%).

3.6.4. Pesticide Policies and Vegetable Production

In Cameroon, laws exist that have been signed to guide the distribution and use of agrochemicals especially pesticides. These laws directly or directly concern the use or misuse of pesticides and are based on certain international conventions (e.g. Stockholm, Rotterdam, International Plant Protection) of which Cameroon is a signatory. One of such important law is N^{o} 2003/003 of April 2003 concerning phytosanitory measures or crop protection practices. According to this law, pesticides include all substances or group of substances destined to destroy or control below threshold levels crop pests, disease vectors, species that are undesirable to plants and animals or negatively affect the entire value chain of agricultural products. Pesticides could be harmful to man, animal or environment if not properly use or dispose. Furthermore, residues of some pesticides or phytosanitary products may accumulate in organisms after repeated applications. This may cause diseases and subsequently death. For this reason, laws and decrees have been put in place to regulate the sale, storage and use of all phytosanitary products that enter the Cameroonian markets. Meanwhile some products or active ingredients that are identified as toxic by the competent authorities have been banned and removed from the market.

This Law sets out the principles and rules governing plant protection in Cameroon. Generally, pest control is done through : the development, adoption and adaptation of standards - the prevention and fight against the pests of plants and plant products - use of pesticides that are safe to human and animal health and for the environment - the dissemination and popularization of appropriate techniques for plant protection - control of the import and export of pesticides , plants, plant products - control over the national territory, of phytosanitary products, plants.

Furthermore, chemical treatments must be applied in accordance with good agricultural practices issued by the competent authority in order to protect human and animal health and protect the environment from hazards arising from the presence or accumulation of pesticide residues. Any natural or legal person wishing to perform phytosanitary treatments in a professional capacity must first be approved by the competent authority. In additon, only registered pesticides or those with a provisional sales authorization must be imported, distributed , packaged or used in Cameroon. All plants, plant products , soil or growing medium, bodies and biological pest control products are subject to: - phytosanitary inspection regardless of their place of production, multiplication and storage and their mode of transport; - control during their manufacture, import, export, packaging , distribution and use .

The procedure for registration of pesticides in Cameroon is the same for the countries in the CEMAC region. This procedure was put in place by Central African Pesticides Committee (CPAC) in collaboration with all the CEMAC countries. The procedure involves three main steps as stated in CPAC, 2006a.

Step 1: The applicant submits a complete registration application file to the Permanent Secretariat of the Central African Pesticides Registration Committee (CPAC) and pays an examination fee. The file is then forwarded to CPAC experts for examination.

Step 2: After examination of the file, CPAC may decide to either (i) register the pesticide in Central Africa for 10 years; (ii) grant a Provisional Sale Authorization (PSA) for a two-year period pending further studies; (iii) retain the file under study pending additional information or (iv) refuse to register the pesticide. A registered pesticide is issued a unique number valid for all CPAC member states.

Step 3: The CPAC Permanent Secretariat transmits the results of the deliberation to the applicant and to the member states, and publishes the list of registrations and PSA in CPAC periodicals.

The pesticide registration application file comprise all information necessary to assess the efficiency of the pesticide and the foreseeable hazards that such a pesticide might pose to man, non-target organisms and the Central African environment as a whole. It includes all information on the identification and the physic-chemical properties of the product and the active ingredient, toxicology, effects on the environment and wildlife, the residues as well as information on the safety measures on the use of the product (CPAC, 2006a).The file include the following items submitted in French or English:

- An application for the registration of the commercial product;
- A specification sheet;
- A technical package;
- An analytical file;
- A toxicology file;
- The original label or scale model;

- A reference sample of the active ingredient(s) contained in the commercial product and a sample of the commercial product;
- A registration certificate in the country of origin

The registration criteria comprise of:

- an Administrative information (Name and address of applicant, patent holder, manufacturer of formulation and manufacturer of active ingredients);
- identity of the formulation (brand name of the formulation, names and proportion of active ingredients, etc)
- identity of the active ingredients (ISO, purity, proportions of additives, etc)
- Intended uses (type of pesticide, target crops, countries with similar ecologies where the formulation is registered).

The files include physico-chemical, biological efficacy, analytical, toxicology, environmental, residue and packaging and labeling files. The files shall comprise only abstracts of these studies. The complete studies shall be made available to CPAC on request.

Labeling of pesticide containers is designed as a means of attaining a high level of communication between the supplier and the user. Therefore, it should be clear and concise and should contain fundamental data for the use of pesticide in complete safety and with guaranteed efficiency throughout its life span. The label should describe the content, present a clear visible indication of the hazard, direction for the sound use of the content, name and address of manufacturer, manufacture and expiry date, etc. Additionally, a specification sheet or technical notice should be enclosed to supplement information on the description of active ingredients, direction for use and necessary precautions.

The importation, sale and use of pesticides in Cameroon are regulated by Law N° 2003/003 of 21st of April 2003 regarding phytosanitary protection, particularly in section 1 of chapter III of the law. Here, it is clearly indicated that only homologated phytosanitary products or products that have a Provisional Sale Authorization (PSA) could be imported, distributed, conditioned or used in Cameroon. These products are supposed to be marketed and used in their original packaging material. In addition, equipment used for the application of pesticides are supposed to respect specific norms. To this, their production, importation and distribution in Cameroon are regulated by law. Interested persons are supposed to submit an application file for certification of the equipment to the National Commission for Homologation of Pesticides and the Certification of phytosanitary equipment (CNPHCAT) in Cameroon and must pay an evaluation fee.Homologation is a process at the end of which a competent authority approves the importation, distribution and use of a phytosanitary product after results of scientific analysis indicate that the product is effective, does not present any risks or danger to man, animal or the environment when used as

recommended (PM, 2005). The homologation of pesticides and equipment used for the application of pesticides are regulated by law.

The regulation binding the homologation of pesticides in Cameroon is the same for the countries in the CEMAC region. This regulation was put in place by Central African Pesticides Committee (CPAC) in collaboration with all the CEMAC countries. The regulation clearly indicates that a pesticide may not be homologated unless its formulation conforms to the following criteria:

- It is sufficiently effective against the target harmful organism; has no phytotoxic effect, it is not harmful to humans and wildlife not initially targeted and has no negative effects on the environment.
- It is of acceptable biological efficacy.
- Established experimental and analytical methods can determine the components, impurities and residues of the pesticide;
- Maximum residue limits for agricultural products intended for human consumption and subject to homologation.

Where most of the above criteria are respected, a Provisional Sale Authorization (PSA) is granted, which will be valid for a limited period of two years nonrenewable.

In Cameroon the procedure for the homologation of pesticides is regulated by decree N° 2005/0772/PM of 06 April 2005 stipulating the conditions of homologation and the control of phytosanitary products. This decree states that all phytosanitary products are submitted to the procedure for homologation prior to importation, distribution and use in Cameroon. Homologation of a product involves the following:

- Chemical analysis of a sample of the product conducted in an accredited laboratory;
- Biological efficacy tests conducted by a research institute during one or two cropping seasons;
- Pre extension tests conducted by plant protection services of the Ministry of Agriculture and Rural Development over at least one cropping season;
- Combined tests of bio-efficacy and pre extension for at least one cropping season.

Individuals or group of persons who intend to submit a phytosanitary product for homologation are supposed to deposit an application file to the National Commission for Homologation of Pesticides and the Certification of phytosanitary equipment (CNPHCAT) and must pay an examination fee. This commission is created in MINADER but includes one or two members from other government ministries such as ministries of Scientific Research, Higher Education, Public Health, Animal husbandry and Fisheries, Environmental Protection and Nature Protection among others. The chair of the commission is the Minister of Agriculture and Rural Development as stated in chapter IV of the Prime Ministerial Decree n° 2005/0772/PM of 06 April 2005. This decree also provides details on procedure for submission of a phytosanitary product for homologation in its chapter II.

The number of products homologated in Cameroon in 2013 (record as of July 2013) is over 580. The products differ in their active ingredients, formulation, toxicological class, dosage, type of crop species involve and the targeted pests and diseases. Only 1 (one) adjuvant (Banole) is homologated for use in banana production as the case with avicides where only Fenthion 600 g/l is approved for the control of birds in cereal fields. The other homologated products include 139 fungicides, 162 herbicides, 38 public hygiene products, 9 insecticide-nematicides, 39 insecticide-fungicides, 162 insecticides, 8 molluscides, 13 nematicides, 8 growth regulatory substances and 7 rodenticides. One herbicide, sabre 720 SL, active ingredient MSMA 720 g/l has been awarded a Provisional Sale Authorization (PSA) for use in sugarcane plantations to control weeds.

The government of Cameroon, after careful scientific analysis, realized that certain active ingredients or products were very toxic. Consequently, phytosanitary products such as ***Captafol, Acetate de Dinosebe (Aretit), Dinosebe, Binapacryl (Morocide), Cyhexatin, Dieldrine, Aldrine***and***Heptachlore, 2-4-5 TCP*** are not allowed into Cameroonian markets since 1989 by ministerial decision N° 00002/MINAGRI/DIRAGRI/SDPV of 17thJanuary 1989. To this list is also added other products that were subsequently removed from the market, particularly;

Malathion, Amitraz, Carbaryl, Cartap, Diazinon, Endosulfan, Fenobucarb, Methyl-parathionand**Propoxur** by decision N° 71/08/D/MINADER/SG/SDRP/SRP of 17th July 2008;

Carbosulfan by decision N° 27/09/A/MINADER/SG/CNHPCAT/SEC of 23rd March 2009;

Lindane based pesticides by decision N°057/05/A/MINADER/SG/DPA/SRP of 22 August 2005,

Carbofuran by decision N°0699/A/MINADER/SG/CNHPCAT of 23rd July 2013 and

Dimethoateby decisionN°00829/A/MINADER/SG/CNHPCAT of 30th July 2013.

Despite the above laws and decisions, some of these products still find their way illegally in the local markets. In addition, chemicals such as Malathion, Methyl-parathion, carbofuran and Dimethoate banned by the Cameroon government are still being used for the management of pests on vegetables. Furthermore, compared to the list of registered pesticides for 2013, most farmers use pesticides that are not meant for vegetables as well as using extremely very dangerous chemicals (Class 1a) such as Mocap (ethoprophos) registered as an insecticide-nematicide for bananas. Also, most of the insecticides used by the farmers are classified as very dangerous (Class II) and warrant compulsory use of personal protective equipments; a practice which most farmers abandon either ignorantly or voluntarily. Therefore, there is need to increase surveillance in the local markets and borders as well as sensitizing the public on the dangers of the use of these products.

Generally, in the last five years, the government has formulated (in accordance with international standards) a number of laws, decrees and regulations all as a way to minimize the adverse effects of pests on crops as well as adverse effects of pesticides on human/animal health and the environment. However, strict

implementation of the articles of the laws is what is lacking in the country. For example, in principle, there should be frequent monitoring of use and misuse of pesticides, but this is hardly done. The result here is that lots of non-registered, banned chemicals and even obsolete chemicals easily get into the market and distributed to farmers. On the part of the farmers, there has been much dependency on use of pesticides. These farmers think that without pesticides, cultivation would be very difficult and yield would be seriously reduced. Based on this thinking or dependency on pesticides, these chemicals are usually misused and over use which usually result to pesticide poisoning, ecological backlashes (e.g. pest resistance, pest resurgence and pest replacement)

4. Conclusions and recommendations

4.1. Conclusions

- Vegetables are very important compliments in the diets of most people in Cameroon. These vegetables do not only supply cheap and readily available sources of essential minerals/vitamins, but some are also considered as having important medicinal values such as the case of "okongobong" (for typhoid), and huckle berry and cassava leaves for blood supply. In addition to these nutritional/medicinal importance, vegetables are also becoming an important source of income especially to peri-urban farmers focusing on vegetables such as tomatoes, bitter leaf, water leaf, okongobong, cabbage, huckle berry, green, pepper and okra. In spite of the significance of these vegetables, more than 80% of the farmers have not attended training or workshop on vegetable cultivation. To make matters worse, with the exception of tomatoes, very little research has been focused on vegetables.
- Most of the vegetables cultivated are done in mixed cropping systems (87.5%) and practiced mainly by women (85%). Such a system involves (i) planting different kinds of vegetables on the same farm, (ii) planting vegetables with other food crops such as maize, plantains, sugarcane, beans, and yams, (iii) planting vegetables in available spaces within perennial crops such as cocoa or rubber. Vegetables that can easily be integrated in cocoa plantations are bitter leaf, pepper, cocoyam leaves, and tomatoes. Water leaf, huckle berry, and green, do very well within sugar plantations while huckle berry and green are best suited for banana/rubber plantation fallows. Furthermore, since most of these farmers are resource-poor, and cannot afford and/or rent land, fallows of banana and rubber plantations as well as marshy/swampy areas are very important cultivation sites.
- Generally, in all the study sites, biotic factors were the major constraints hindering production. Of all the biotic stresses, insects and fungi are the most serious on all vegetables causing losses that can reach 100% during severe infestation and no pesticide application.
- Protection of vegetables from biotic constraints is done mainly by application of pesticides such as insecticides and fungicides. Although most farmers prefer this practice, it is usually accompanied by certain

problems; (i) use of banned and/or extremely toxic pesticides such as Mocap (ethoprophos), methyl-parathion, Bastion 10G (carbofuran), and Malathane (malathion) (all these categorized as WHO Class I – extremely toxic), (ii) sales of fake chemicals, (iii) none use of personal protection equipments – about 65%, (iv) overuse of same active ingredients for so many years and therefore possibility of development of resistance, (v) acute toxicity expressed in the form of stomach disorders, vomiting, skin irritations, dizziness, and watery eyes, (vi) in spite of the frequent and overuse of pesticides, pest problems (densities and diversities) are increasing every year.

- West Region uses more agrochemicals with over 60% of the recorded chemicals. In all the Regions, in spite of the frequent and/or heavy use of pesticides, many farmers are aware of the dangers and SouthWestfarmers (especially women) are topping the list with respect to misuse (keeping pesticides in kitchens and/or bed rooms.
- Women are more exposed to pesticide risks due to the following reasons; (i) many have not gone to school and those who have, do not complete primary level, (ii) only 31% of the women get advice on pesticide use and they do so mainly from friends.
- Even though there are laws guiding use of agrochemicals especially pesticides, enforcement of these laws seems to be weak or non-existence. Also, government officials in charge do not take the issue of pesticide misuse/safety measures serious – no control.

4.2. Recommendations

The recommendations given here are a combination of ideas from the vegetable farmers, relevant stakeholders interviewed, agriculture extensionists, and consultants

4.2.1. General

- The government, Non-Governmental Organizations, and funding organizations should consider the vegetable sector as an important component in their development plans concerning food security and safety. Based on this, much efforts should be put in place to increase production and improve on quality. This can be attained through mass sensitizations, trainings and making available adequate funding for vegetable research.
- Training of farmers and relevant stakeholders should be focused on vegetable cultivation techniques, use/misuse of pesticides, adding value to vegetables (processing, storage, transformation), and proper identification of pests of vegetables.
- Prices of agriculture inputs (e.g. agrochemicals & equipments) should be reduced or government should provide these inputs at subsidized prices.
- Provide quality seeds, agrochemicals and equipments to farmers
- Serious efforts should be put in place to enforce plant protection laws and/or decisions. This can be achieved by carrying out strict and/or regular surveillance on pesticide use/misuse. This will help to prevent

illegal, obsolete and banned chemicals in the Cameroonian market. Defaulters should be heavily fined or jailed.

- Encourage the formation of vegetables' groups or cooperatives. With such groups or cooperatives, demonstration plots and/or farmers' field schools could be put in place so as to facilitate transfer/adoption of technologies. Such groups could also be supported to construct and manage vegetable markets with storage facilities.

- Construct/improve on farm-to-market roads of certain areas. This will facilitate evacuation of vegetables that are very perishable.

4.2.2. Research

- As a first step to develop and implement an integrated pest management strategy on traditional or indigenous vegetables, there is need to study the bio-ecology of major pests on major vegetables such as pepper, green, huckle, bitter leaf, okongobong, and okra.

- Encourage and fund participatory research so to come out with high-yielding and resistant varieties that can be distributed to farmers.

- Urgent need to study the effects of pesticides on the management of pests/diseases on vegetables and this should include efficacies of the pesticides, effects on natural enemies, adequate doses, timing of application, as well as phytotoxicity.

- Agronomic studies are also necessary. For example, the effects of transplanted and non-transplanted vegetables on growth, yield and infestation. The effects of planting distances on growth, yield and infestation or development of diseases.

- Need to evaluate the impact of implementing an IPM strategy on vegetable growth, infestation and yield.

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6. Appendices

6.1. Appendix I: Questionnaire

A. General Information & Production Potential:

1. Name & Surname:…….

2. Sex (Male or Female):…… ……………………………………………………………………………………………………….

3. Age: (i) Below 18 (ii) 18-24 (iii) 25-34 (iv)35-44 (v) Above 45

4. Town/Village:……………………… ……………………………………………………………………………………….

5. Sub-Division…………………Division……………………………………………………………………………..

6. Region:………………………………………………………………………….

7. Level of education: (i) Primary with FSLC (ii) Primary without FSLC (iii) Secondary without GCE O Level (iv) Secondary with GCE O Level (v) High School (vi) University /Higher Institute

7b. Do you belong to a farming group or any association?

8. Have you ever attended a workshop or training on vegetables? (i) Yes (ii) No

9. If Yes, where did you attend the training/workshop?...and who organized it…………………………………………………………………………………………………. What was the purpose of the training?...

9b. What is the best way to bring vegetable farmers together for a training activity?

10. Plots/Farm, size and crops assessment

Farm/plot	Size (i) <1Ha (ii) 1Ha (iii) 1-2Ha (iv) 2-5Ha (v) >5Ha	Main crops/ land occupation	Vegetables and their percentage*
			(i)……………………(…….%) (ii)…………………………(……%) (iii)…………………………(…….%)(iv)……………………………(.%) (v)…………………………………(……%) (vi)……………(………%)
			i)……………………(…….%) (ii)…………………………(……%) (iii)…………………………(…….%)(iv)……………………………(.%) (v)…………………………………(……%) (vi)……………(………%)
			i)……………………(…….%) (ii)…………………………(……%) (iii)…………………………(…….%)(iv)……………………………(.%) (v)…………………………………(……%) (vi)……………(………%)
			i)……………………(…….%) (ii)…………………………(……%) (iii)…………………………(…….%)(iv)……………………………(.%) (v)…………………………………(……%) (vi)……………(………%)
			i)……………………(…….%) (ii)…………………………(……%) (iii)…………………………(…….%)(iv)……………………………(.%) (v)…………………………………(……%) (vi)……………(………%)
			i)……………………(…….%) (ii)…………………………(……%) (iii)…………………………(…….%)(iv)……………………………(.%)

			(v).....(.....%) (vi)……(……%)

11. What is the main purpose ((i) consumption by the family (ii) for sale (iii) consumption by family and for sale) of the vegetables that you cultivate?

(i)vegetable……(purpose ……..) (ii) Vegetable……(Purpose……..)
(iii)vegetable……(purpose ……..) (iv) Vegetable……(Purpose……..)

(v)vegetable……(purpose ……..) (vi) Vegetable……(Purpose……..)
(vii)vegetable……(purpose ……..) (vii) Vegetable……(Purpose……..)

12. Is vegetable one of the main crops that you cultivate? (i) Yes (ii) No

13. If yes, Number of years in vegetable cultivation: (i) <1 (ii) 1-2 (iii) 3-5 (iv) >5

14. (a)If no, is it planted in mixed cropping? (i) Yes (No) (b) If yes, which other food/cash crops do you have in your farm?.....

.....

(c) where is your vegetable farm situated? (i) in a swampy area (ii) near a stream/lake/pond/river (iii) behind your house (iv) within a forest (v) where there is no forest

15. Is there ready market for vegetables in your area? (i) Yes (ii) No

16. How much of your produce do you sell? (i) All (ii) Part (iii) None

17. Do the proceeds from the sale make a significant impact on your annual income? (i) Yes (ii) No

18. Are vegetables major contributor to the food on your table? (i) Yes (ii) No

19. What type of planting materials do you use (i) imported seeds in sachets (ii) traditional seeds (iii) both imported and traditional seeds *Fill below*

(i)vegetable……(planting material ……) (ii) Vegetable……(planting material ……)
(iii)vegetable……(planting material ……) (iv) Vegetable……(planting material ……)

(v)vegetable……(planting material ….) (vi) Vegetable……(planting material ……)
(vii)vegetable……(planting material ……) (vii) Vegetable……(planting material ….)

B. Pests & Diseases and Management Techniques:

20. Which of the following are those problems hindering you from producing more vegetables? (i) Weeds (ii) Fungi infection (iii) Small mammal (iv) Insects (v) Low input (vi) not enough land. *Fill below*

(i)vegetable……(problems …….) (ii) Vegetable……(problems ……) (iii)vegetable……(problems …….) (iv) Vegetable……(problems ……)

(v)vegetable……(problems ….) (vi) Vegetable……(problems ……) (vii)vegetable……(problems ……) (vii) Vegetable……(problems ….)

21. How can you quantify loss caused by pests and diseases? (i) 75-100 % (ii) 50-75% (iii) 25-50%% (iv) 0-25% *(Fill below)*

(i)vegetable……(Quantity loss …….) (ii) Vegetable……(Quantity loss ……)
(iii)vegetable……(Quantity loss …….) (iv) Vegetable……(Quantity loss ……)

(v)vegetable……(Quantity loss ….) (vi) Vegetable……(Quantity loss ……)
(vii)vegetable……(Quantity loss ……) (vii) Vegetable……(Quantity loss ….)

22. Fill in the table below (list the vegetables in order of importance with 1. as the most preferred)

Name of vegetable	Pests/diseases attacking the vegetables	Damage signs and/or symptoms	Estimated yield loss (%)	Control techniques
1.				
2.				
3.				
4.				
5.				

6.				
7.				
8.				

23. At what stage(s) of development of the plant do you have pests and/or diseases (e.g. (i) in the nursery, (ii) 1-2months after planting, (iii)3months after planting, (iii) after harvest or during storage)

Fill below

(i)vegetable……(stage of attack …….) (ii) Vegetable……(stage of attack ……)
(iii)vegetable……(stage of attack …….) (iv) Vegetable……(stage of attack ……)

(v)vegetable……(stage of attack ….) (vi) Vegetable……(stage of attack …….)
(vii)vegetable……(stage of attack ……) (vii) Vegetable……(stage of attack ….)

C. Agrochemical (Pesticide …) application

24a. Who does the application of pesticides on vegetable farms during the following stages of vegetable production

(a) Seed treatment in the nursery (i) = female children of the family (ii) female adults of the family (iii) =male adults of the family (iv) = hired female children (iv) = hired female adults (v) hired male adults (vi) = no treatment applied

(b) Chemical treatments during planting (i) = female children of the family (ii) female adults of the family (iii) =male adults of the family (iv) = hired female children (iv) = hired female adults (v) hired male adults (vi) = no treatment applied

(c) Chemical treatments 1-2 weeks before harvesting (i) = female children of the family (ii) female adults of the family (iii) =male adults of the family (iv) = hired female children (iv) = hired female adults (v) hired male adults (vi) = no treatment applied

(d) Chemical treatment after harvest (i) = female children of the family (ii) female adults of the family (iii) =male adults of the family (iv) = hired female children (iv) = hired female adults (v) hired male adults (vi) = no treatment applied
(e) Chemical treatment during transportation (i) = female children of the family (ii) female adults of the family (iii) =male adults of the family (iv) = hired female children (iv) = hired female adults (v) hired male adults (vi) = no treatment applied
24b. Is there a difference in the use of equipment/appliances for pesticide application between men and women? If yes explain

24c. Using the table below write the different agrochemicals (pesticides and fertilizers) used in your farm

Agrochemical/name	Dose of application/ apparatus used for application	Frequency of application	Type of vegetables used for	Dangers on plants of the use of this agrochemical
Insecticide				
1	1	1		
2	2	2		
3	3	3		
4	4	4		
Fungicide				
1	1	1		
2	2	2		
3	3	3		
4	4	4		
Fertilizer				
1	1	1		

2	2	2		
3	3	3		
Biopesticide				
1	1	1		
2	2	2		

25. What are the three best pest/disease control techniques used in your farm. Give reasons for your answer

Pest/disease control technique	Reasons

26. Do you know that pesticides are dangerous? (i) Yes (ii) No. If yes, how?

……

……

……

27. Do you protect yourself when applying pesticides? (i) Yes (ii) No. If yes, how?

……

……

28. What type of health effects have you encountered or seen during or after application of pesticides? (e.g. vomiting, running stomach, watery eyes, skin irritations, collapse, death etc)

(i)…… (ii)…….

(iii)…… (iv)…….

29. Is the problem of pests/diseases increasing in your farm (causing more damage as time passes)? (i) Yes (ii) No

30. Do you mix two or more different pesticides before applying in the farm? (i) Yes (ii) No If you do mix, give examples of chemicals that you mix.....

.....

.....

31. Where do you keep your pesticides ? (i) = bed room (ii) = kitchen (iii) = a separate room where only pesticides are kept (iv) = locked cupboard (v)where fowls, goats, pigs etc are living

32. In which type of container do you keep pesticides? (i) = used vegetable oil gallons (ii) = used tangui/supermont bottles (iii) = used beverage bottles with lids (iv) = original pesticide containers

33. What do you do with the empty pesticide containers? (i) = wash them and keep water or palm oil in them (ii) = wash and keep kerosene or petrol in them (iii) = gather and burn them (iv) = dig soil and bury (v) = throw in farm or dustbin

34. Where do you get advice before applying agrochemical (pesticides…) in your farm? (i) Researchers (ii) Agric officers (iii) those selling chemicals (iv) friends

D. Cost of application of agrochemicals

Now lets talk about the most important vegetable farm you have

35. What is the most important vegetable(s) on which you use agrochemicals?

Please precise the cost of the agrochemicals as on the table below

Agrochemical/name	Cost of chemical per season	*Itemized cost of application*	*Reduced cost due to use of agrochemical*	Increase cost due to use of agrochemical	Estimated yield without agrochemical	Yield with agrochemical	Selling price of vegetables
Insecticide							
1	1	1					
2	2	2					
3	3	3					
4	4	4					
Fungicide							
1	1	1					
2	2	2					
3	3	3					
4	4	4					
Fertilizer							
1	1	1					
2	2	2					

3	3	3					
Biopesticide							
1	1	1					
2	2	2					

36. What is the profit when you use agrochemicals on your field?

List the items that lead to added revenue and the corresponding revenue gain like increase yields etc

37. What is the increase cost from the use of agrochemical?

38. List the items that lead to added cost and the corresponding cost amounts like the cost of buying agrochemicals, equipment cost, labor for spraying…and other social costs, risk factors (illnesses), misuse of chemical and crop damage……..

……..

……..

39. Apart from the questions in this questionnaire, are you expecting other questions? (Yes or No). If yes, give an example

……
……
……
…….

40. What will you want research/government institutions or NGOs to do so as to help improve and increase production of vegetables?

……
……

6.2. Appendix 2: Key Informant Interview List

LIST OF KEY INFORMANTS

Name	Place of work	Position	Contact
Mr. Kondung Ignatius Njong	Sub-Divisional Delegation of Agriculture - Tombel	Chief of Agric Post – Bouba Area	Tel: +(237)77918983
Mr. Epie Wilson Ebah	Sub-Divisional Delegation of Agriculture - Tombel	Chief of Agric Post - Tombel	Tel: +(237)75630410
Mrs Alice Ndikontar	Ministry of Agriculture & Rural Development	Member, pesticide homologation committee	
Mrs Catherine Mojoko	Sub-Divisional Delegation of	Retired Agric Extension Worker	

	Agriculture, Buea		
Mr. Rawlings Ndobe	Sub-Divisional Delegation of Agriculture - Tombel	Chief of Agric Post – Bouba Custome	Tel: +(237)51357988
Mrs Evelyn Wirba	Muea Town	Vendor (buying & selling)	Tel: +(237)91911832
Mr. Esua Simon	Buea	Experienced gardener	Tel: +(237)73531002
Mr. Hansel Itue	Buea	Director, Ekwa Farms	
Mr. Bidol Yemming Gerard	Sub-Divisional Delegation of Agriculture – Bangante (Bafoussam)	Chief of Post	Tel: +(237)77622850 Bidolgerard@yahoo.fr
Mrs Elizabeth Lyonga	Muyuka Owe	Experienced Farmer	+(237)51428369
Mrs Mbowoh Florence	Muyuka Owe	Experienced Farmer	+(237)77956064
Mr. Ashu Augustine Tambe	CASD NGO Ebolowa	CEO/Trainer on Vegetable cultivation	+(237)74466963

6.3. Appendix III: Photo Gallery