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Original Research Article

Vegetable Production and the Livelihood of Farmers in Bamenda Municipality, Cameroon

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A B S T R A C T

Vegetable plays a key role in food security but often cultivated in inappropriate sites. This survey evaluated smallholder vegetable cultivation within the wetlands of Bamenda Municipality. On average, farmers cultivate an area of 150 m^2 that yields about 750.000 FCFA ($1500), other inputs inclusive. While there is unsustainable use of pesticides, fertilizers, and sewage sludge, vegetable gardens are still sprouting up in the most unlikely places, which are closed to mechanic workshops and roads densely used by automobiles. With the lack of advice and support from the stakeholders, farmers are obliged to farm in unsafe areas, which are of concern for food security.

Introduction

Cameroon is endowed with enormous agricultural potentials, which would contribute significantly in poverty reduction and sustainable development. About 75% of the active population of Cameroon is involved in agricultural production, which accounts for 50% of total exports (MINEFI, 2002). For several decades now, agriculture has been a very important sector that has increasingly significantly contributed to the national economy. In 1999, it accounted for 42.4% of the national gross domestic product (MINEFI, 2002). Of recent, the government of Cameroon has laid emphasis on agriculture as one of the pillars for an emerging country.

Low-income farmers account for most of the staple food that feeds the country. A very significant proportion of the national food production by these farmers is also sold to the neighbouring countries. The success of Cameroon's agriculture is thus not only important for the producers and the nation, but has a significant impact on the Right to Food for the Central Africa sub region. Because of the relatively high agricultural production, many deny the fact that, food insecurity in Cameroon is problematic. This is because it is not often considered as one of the hunger "hotspots" in the region when compared with countries like Gabon, Chad, Niger, the Central African Republic, Sudan and others (USAID, 2003). Nevertheless, the

problem of food insecurity in Cameroon is real and is most noticeable and frequent in the northern regions and some urban centres.

Urban gardening is growing in popularity. It is an integral component of the push to improve food quantity and quality in neighbourhoods where healthy food is scarce or not readily available.

This trend is unlikely to change, especially as food insecurity continues to rise. This is more severe in regions with high human activities as levels of environmental contaminants are often elevated (Aelion *et al*., 2009; Diamond and Hodge, 2007). Such environmental toxins include: polyaromatic hydrocarbons (PAHs), chlorinated hydrocarbons, and heavy metals (Alloway, 1995; Pastor *et al*., 2005). Their accumulation leads to stress conditions in plant systems: by interfering with the uptake of essential nutrients (micronutrient antagonism), metabolic activities and physiological functioning of the plants (Zhang *et al.*, 2002; Long *et al.*, 2003), which is a health concern as potential carcinogens or causal agents of human organ dysfunction (Al- Chaarani, 2009).

Chronic heavy metal toxicity for example, has been the result of long term low level exposure to pollutants and is associated with many chronic diseases. Foods containing heavy metals when consumed could lead to several health impairments to man and other living organisms ranging from infertility, coronary diseases and kidney failures, to respiratory imperfections (Odukoya and Ajayi, 1987; McBride, 2003; Nigerian Department of Water Affairs and Forestry (NDWAF), 1996; Jarup, 2003).

However, taken in small quantities, certain heavy metals such as the micronutrients: Cobalt (Co), copper (Cu), Manganese (Mn), Molybdenum (Mo), Zinc (Zn), and iron (Fe) are nutritionally essential for a healthy life. Zn is more readily absorbed than most other heavy metals. The presence of Cu inhibits Zn transport through the plant (Yerima and Van Ranst, 2005a). On the other hand, Silver (Ag), Arsenic (As), Barium (Ba), Cadmium (Cd), Chromium (Cr), Mecury (Hg), Lead (Pb), Sb, and Thorium (Th) have no known essential functions (Alloway, 1995).

The most notorious of these metals with regard to potential hazards and occurrence in contaminated soils include: As, Cd, Cr, Hg, and Pb (Alloway, 1995). In Russia, arsenic and chromium are cited among the first class and second class hazards, respectively (Vodyanitskii, 2009). In peri-urban and urban ecosystems, industrial and/or municipal wastewaters are mostly used for the irrigation of crops presumably due to its availability or scarcity of fresh water (Alloway, 1994, 2004). Such water sources could cause contamination (Khan *et al*., 1998; Arora *et al.*, 2008).

Consequently, the levels of heavy metals, like many other environmental toxins, could thus be more elevated in urban wetland soils as a direct result of human activities (Khan *et al.*, 1998; Alloway, 1995, 2004; Diamond and Hodge, 2007; Douay *et al*., 2007; Arora *et al.*, 2008; Asongwe, 2010; Fonge *et al*., 2011; Tening *et al*., 2013). Globally, vegetables, either traditional or indigenous, are important components of diets and have been widely consumed and recommended (Chweya, 1997; Mnzana, 1997; FAO/WHO, 2004).

There has been a resurgence of interest in African leafy vegetables during the past decade with several studies reporting on their regional availability and use (Odhav *et al.*, 2005). Nutritional studies have shown

that, indigenous vegetables, which are better adapted to local conditions, and may be tolerant to biotic and abiotic stresses are as nutritious as, or more than, traditional ones (Chweya, 1997; Mnzana, 1997). Malgras (1992) and Ayodele (2005) showed that, they also contain non-nutrient bioactive phytochemicals that have been linked to the protection against cardiovascular and other degenerative diseases although Orech and colleagues (Orech *et al*., 2005) observed that, some of the phytochemicals found in some African leafy vegetables consumed in Western Kenya may pose toxicity problems when consumed in large quantities or over a long period of time. Cameroon's government policy recognises this long-term preventative ability through sustained increased consumption of fresh vegetables and fruits, rather than the distribution of iron and vitamin supplements. Published information on the production of indigenous and traditional leafy vegetables tends to be anecdotal (Gockowski and Ndoumbe, 2004). However, the Spore magazine quoting reports from the International Institute for Tropical Agriculture (IITA) indicated that, in 1998, total leafy vegetable production in Cameroon was estimated at 93,600 tons of which 21,549 tons was "bitter leaf", *Vernonia amygdalina* (Spore No. 116, 2005). Stevels (1990) presented 67 underutilized vegetables in Cameroon, 20 species of which were described in great detail. Despite their great importance, indigenous vegetables in the past had been regarded as minor crops and thus given low priority in most agronomic research and development programmes in Cameroon due to limited documentation on their yields and sales. Presently, leafy indigenous vegetables are assuming an increasingly important commercial role, especially for low income households living near urban centres (Gokowski and Ndumba, 1997). This type of vegetable cultivation presumably supports livelihoods primarily through food provision, income generation and employment as they are preferred cash crops. Despite the importance of leafy vegetables, and the important role played by wetlands of peri-urban and urban environments in its production, the latter environments are increasingly becoming a threat to their quality as they are increasingly receiving huge amounts of effluents that could result in micronutrients antagonism and heavy metals toxicity in the target vegetables. Apparently, this is the case of Bamenda City, the most industrialized municipality in the North West Region of Cameroon, which has witnessed within the last decades a rapid increase in growth and urbanisation. Small-scale agriculture in this urban environment has been neglected, leading to increased cultural erosion of food habits. Due to the limited availability of arable land and increasingly high demand for off-season vegetables, potentially contaminated wetlands of this municipality are being put under vegetables and other food crops cultivation by small scale holders. Thus, concerns related to the health and safety of the urban populations and vegetables from gardening generate such questions as: Is it wise to eat vegetables from gardens in areas where contamination is known or can be reasonably expected? Where would heavy metals in wetland gardens in Bamenda come from? What can urban gardeners do to minimize heavy metals in their garden soils? to date, relatively few scientific studies have been conducted to document potential heavy metal sources in the Bamenda urban garden vegetables, which is the object of this study. The objectives of this study are to (a) evaluate vegetable production within the wetlands of the Bamenda urban and peri-urban areas, and its contribution to the livelihoods of small scale farmers in this area, b) identify potential heavy metal

sources in the wetland vegetable gardens of this Municipality, and c) make some recommendations on the husbandry of these crops in this area.

Materials and Methods

Description of the study area

The area covered by this study includes urban and peri-urban wetlands in the Bamenda City Council of the North West Region of Cameroon (Figure 1). It is part of the Bamenda escarpment and located between latitudes 5° 55'N and 6° 30'N and longitudes 10° 25' E and 10° 67'E. The town shows an altitudinal range of 1200 - 1700 m, and is divided into two parts by escarpments; a low lying gently undulating part with altitudes ranging from 1200 – 1400 m, with many flat areas that are usually inundated for most parts of the year, and an elevated part at 1400 – 1700 m altitude that forms the crest from which creeks, streams, and supplying the low lying parts take their rise. This area has two seasons; a long rainy season, which runs from mid-March to mid-October and a short dry season that spans from mid-October to mid-March. The area lies within the thermic and hyperthemic temperature regimes. Mean annual temperatures stand at 19.9 ^oC. January and February are the hottest months with mean monthly temperatures of 29.1 ^oC and 29.7 ^oC, respectively. Yerima and Van Ranst (2005a) report that the area is dominated by the Ustic and Udic moisture regimes with the Udic extending to the south. Annual rainfall ranges from 1300-3000 mm (Ndenecho, 2005). The area has a rich hydrogrphical network with intense human activities and a dense population along different water courses in the watershed. The main human activity in and around this area is agriculture, which according to GP-DERUDEP (2006) involves over 70% of the population that uses rudimentary tools. The area equally harbors the commercial center that has factories ranging from soap production, and garages to metallurgy, which may be potential sources of pollutants. An important vegetation type in this area is the raffia palm bush, which is largely limited to the wetlands (Valleys and depressions). The raffia palm (*Raffia farinifera)* provides raffia wine, a vital economic resource to the indigenes who are fighting against the cultivation of these wetlands by vegetable farmers.

Sampling strategy

To collect data for this paper, the first step was an inventory of the study area to identify the wetlands used for market gardening in order to determine the number of questionnaires and interviews to be administered to farmers along the water courses.

Administration of questionnaire

A total of seventy semi-structured questionnaires were administered to randomly selected small holder wetland green vegetable farmers in the Bamenda urban and peri-urban areas. Each package of questionnaires was made up of sixty one questions. The questions were grouped in five sections: A, B, C, D, and E. Section A sourced out biodata information, section B captured information on individual farm management practices and the crops cultivated, section C focused on knowledge pertaining to heavy metal awareness by the farmers, section D extracted information relating to environmental sustainability, economic profitability, and public concerns about the production of vegetables, while section E was devoted to information on the use of other aquatic resources of the area and readiness to cooperate with authorities for environmental education and extension.

To reduce farm work interference during questionnaire administration during the day time, farmers whose residences were known to the researchers were visited during evening periods. For those with unknown residences, the questionnaires were administered on their farms.

To assess the reliability of the responses, cross referenced questions were introduced. Non- uniformity of answers to these questions were considered as indicators of infidelity and thus discarded. Of the 70 questionnaires administered, 60 were used for evaluation. Also, in cases where respondents refused to continue with the questions, they were automatically replaced. Interviews were also conducted with the City Council Environmental Department on their activities on wetland management and protection. Field observations were complimentary to the questionnaires.

Result and Discussion

General status of vegetable cultivation

The results indicate that in Cameroon, and in the Bamenda Municipality in particular, vegetables cultivation in the urban and peri-urban wetlands is assuming an increasingly important commercial role, especially for the low income households living near these centres. A greater portion of these wetlands are increasingly seasonally reclaimed for vegetable cultivation in defiance of government regulations prohibiting wetland reclamation. A variety of vegetables (Table 1): huckle berry *(Solanium scarbrium)*, green *(Amaranthus spp)*, bitter leaves *(Vernonia amygdalina)*, tomato *(Lycopersicon esculentum)*, pepper (*Capsicum chinensis L.*), eggplant *(Solanum melongena)*, cabbage *(Brassica oleracea)*, pumpkins (*C. moschata*, Duch) are cultivated in the study area in multiple cropping systems. They are often associated with other crops such as maize *(Zea mays)*, beans *(Phaseolus vulgaris)*, and cocoyams *(Colocasia spp)*, without any specific pattern. The most commonly grown vegetables are also the most perishable (leafy) ones, which have to be produced in proximity to markets given that very little refrigeration of vegetables is practiced. Most urban vegetable farming sites are on lands belonging to private developers who have not yet started constructing houses on them. Preferably, farming is done in reserve areas along streams and other water sources such as artificial ponds.

The vegetable farmers normally rent such land from the owner on a yearly basis with no written agreement and as such have no security as regards the length of tenancy rights. The production of vegetables is labour intensive requiring several inputs. Land has to be cleared, followed by the raising of beds, sowing of seeds by broadcasting, weeding, watering, etc. Due to the high labour requirements, farmers with bigger land areas have to hire labour or rent water pumps. However, the farmers mostly use buckets and watering cans to convey water from streams to their farms, which are often farther away from water sources. Sixty respondents (100%) to questionnaires indicated that manual irrigation requires frequent trips to the water source, which makes irrigation tiring, time consuming and labour intensive. When water is pumped, the cost for hiring pumps is high.

They use the latter occasionally and as a group. Weeding, which is also an expensive activity, was rated by 91.7% of the respondents to be labour intensive. However, most farmers who use manual labour rarely pay for it as they depend on family labour. Occasionally, labourers move round farms waiting to be hired for the

manual weeding tasks mainly by those who cultivate a higher number of beds; these employees rarely earn more than US$ 5 (2500 FCFA) a day.

Contributions of vegetables to livelihoods

All respondents to the questionnaires acknowledged that they sell a greater proportion of their produce from wetlands, and receive higher benefits than those from rainfed vegetables of the rainy season. Besides sales of other associated farm produce, an average farmer occupying an area of 150 m^2, at the end of the dry season, generates the sum of 750.000 FCFA (US $1500), with cost of inputs included. These vegetables, remain one of the mainstay of diets in the area as they often accompany their carbohydrate staples such as the local food called "achu" (produced from pounded *Colocasia spp.),* "corn fufu", obtained from corn (*Zea mays)* flour, plantains (*Musa spp.*), etc. Only 5% of the sampled population indicated that they do not consume these vegetables either because of health matters or because of fear of contamination. Those who fear contamination eat these vegetables when they are sure of their sources. Additionally, 95% of the inhabitants of the municipality prefer vegetables from the outskirts to those of the urban municipality. A ranking (by the scoring technique) of the three most common vegetables (*Solanum scarbrum, Vernonia amygdalina*, and *Amaranthus spp.)* cultivation preferences in the Bamenda Municipality of Cameroon indicates that, *Solanum scarbrum* and *Vernonia amygdalina* top the list (Table 2). These results are partly in agreement with those of Fontem *et al*. (2012) but with *Vernonia amygdalina* replacing *Amaranthus spp.* from the second to the third most preferred vegetable. The production of *Amaranthus spp*. is more widespread in the Mankon area than in the Nkwen area. Obuobie *et al.* (2006) observed that the production and consumption of irrigated urban vegetables in Ghana followed an ethnic pattern. Similarly, it could thus be infered that there is an ethnic pattern of vegetable consumption in the Bamenda area. The farming of vegetables in the Municipality is practiced by farmers with low socio-economic status (Figure. 2), cultivating small or marginal landholdings. The study revealed that 80% of the vegetable farming population had either attempted or completed only primary education, while only 20% had gone beyond primary education (Figure. 2). A majority (50%) of the vegetable growers are women aged between 37- 47 years (Figure. 3) who rely mainly on agriculture for their livelihoods. Apart from a long standing tradition of home gardens, these vegetables are relatively easy to grow and do not require a lot of land (Gockowski and Ndoumbé, 1997). This is similar to observations in some African cities such as Nairobi and Kampala (except Accra and Addis Ababa) due to the high price of a piece of land and the difficulty to access it by women (Prain and Lee Smith, 2010). A few of the respondents to questionnaires (15%) chose to do something different from farming, such as petty trading, so that in times of crop failure there will still be some income for the household to live on. According to Obosu-Mensah (1999), women usually tend to have lower educational status than men, and thus have fewer opportunities for finding suitable wage employment in the formal sector. It therefore becomes imperative for women to find other ways to fill the gap between their cash income and what is needed for household survival. Generally, all family members (women, children and to a lesser extent, men) contribute in the production of vegetables. About 10% and 6.6% of the small scale farmers with farm holdings of about 150 m^2

practice petty trading and animal raring, respectively in addition to farming. These observations are similar to those of Marshall *et al.* (2003) and Berinyuy and Fontem (2011) who reported that, the poorest groups of agricultural wage labourers work on vegetable farms. Among the reasons for this high level of participation are the low capital requirements for entry, which enables the poorest households to participate. Though vegetable farming continues in drier areas of the urban sector in the rainy seasons, in many farming sites, 100% of the respondents indicated that they also cultivate maize, and/or beans, and cocoyams, etc., which are used for subsistence. This form of vegetable cultivation thus supports livelihoods primarily through food provision, income generation and employment. Despite the wide scale cultivation, consumption and contribution of urban and peri-urban vegetables to livelihoods, inhabitants of the Bamenda Municipality would generally prefer vegetables grown at the outskirts to those of the urban setup.

Environmental constraints of the vegetable cultivation

In the wetlands, many economic trees such as raffia *(Raffia farinifera)* existed. These plants were/and are used for economic, social and cultural purposes (Yerima and Van Ranst, 2005a; Kometa, 2013). These raffia bushes have almost all been destroyed (Figure. 4) as well as the areas used for market gardening. Based on estimates made from aerial photographs and satellite images of wetlands along the Bafussam and Bamenda road axis, 16.1 km² of wetlands were used for market gardening before 1985 and by 2005 had risen to 48.3 km² and then to 50.1 km² in 2010 at the expense of raffias. Up to 65% of the respondents did not report any change of vegetation while 30% indicated that there has been a change of the vegetation in this area; these are those who have lived around the area for long. The destruction of these raffias that serve as buffers in flood regulation associated with accelerated run off from diverse urban activities exert additional burdens on the wetlands, especially during the rainy seasons.

Inventory of municipal solid wastes in Bamenda wetland gardens

An inventory of the municipal solid wastes in the wetlands of Bamenda indicates that, they are composed of textiles, batteries, hospital wastes, paints, plastics, metals, plants and animal residues, and sewage from households. Many homes do not have latrines and the streams serve this purpose. A cow slaughter house found in the area discharges its wastes directly into the river channel. These wastes are potential sources of heavy metals that are harzardous to man (Horan, 1990; Montgomery, 1992).

Pollution from car wash and waste engine oil exchanges

In the Bamenda Municipality, car wash exercises take place in streams leading to the contamination of water with waste oils. In addition, waste oils are often removed from engines at filling stations and garages in the municipality and dispited into the environment without treatment. These oils contain a mixture of chemical substances such as, polycyclic aromatic hydrocarbons and variable quantities of heavy metals (Alloway, 1995, 2004). The metals would owe their origins from the wear and tear of engines and the breakdown of other additive products in fuels such as Pb, which in Cameroon, is often added to petrol as an antifouling agent. These pollutants can easily find themselves into water bodies

either directly through car wash activities or through runoff and subsequently enriching the flood plains in the rainy seasons during overland floods. This would result to pollutant loading of the wetland ecosystems. Some vegetables are also grown in areas close to roads, households or factories including soap production (International Soap Factory) and thus subject to pollution from emissions from vehicles, household discharges, and industries. Despite the administration of punitive sanctions by the Bamenda City Council on defaulters, some wastes are still discharged directly into streams. According to Chiras (2000), effluents from these sources contain acids, alkalis and a mixture of different metals and therefore of dire concern to food security.

Inappropriate pesticide use

Handling and use of pesticides is another source of heavy metals in arable soils. Pesticides use is a common practice in vegetable gardens of the Bamenda Municipality (Figure. 5). Ninety-five percent of the respondents surveyed indicated that they use pesticides. These pesticides are used to control pests which greatly reduce yields. Despite the widespread use of pesticides, the results of this study revealed that only 10% of the farmers know the names of the pesticides they frequently use, though packaging is often the method used by farmers to identify the chemicals. This can be misleading and with disastrous consequences as the manufacturers can change the packaging for commercial reasons. The farmers use a variety of pesticides: Lindane, Endosulfan, Karate (Lamba cyhalothrin), Chlorpyrifos and Cypercot (Figure.4). These pesticides are either systemic or of a contact nature having different half-lives. If sufficient time is not allowed for the pesticides to degrade, when consumed, these vegetables will cause deleterious effects to humans. Pesticide additives and/or their residues in surface waters, soils and the environment have been of growing concern ever since the 1940s (Butler, 1966; Richards and Baker, 1993). These pesticides and heavy metals bioaccumulate and biomagnify in the environment. Although pesticide use containing Cd, Hg and Pb had been prohibited since 2002, there are still pesticides in use today containing copper and zinc based elements. The prolonged misuse and/or inappropriate use of pesticides in these wetland gardens are potential sources of contamination and a threat to human health. Protection measures during pesticide applications for vegetable treatment are often taken lightly by the farmers. Ninety five percent of respondents affirmed that they do not protect themselves during pesticide applications. The lack of physical protection exposes farmers to various diseases of pesticide origin.

Fertilizer use

Heavy metals input to arable soils through fertilizer use is of increasing concern due to their potential risk to environmental health (Lu *et al*., 1992; Zarcinas *et al*., 2004; Yerima and Van Ranst, 2005b). Phosphate fertilizers, for example are generally the major source of trace metals as impurities in inorganic fertilizers, and as such much attention has been paid to the concentration of Cd and Pb in phosphate fertilizers (Lu *et al*., 1992). From this study, all respondents (100%) of the wetland vegetable farmers in the Bamenda municipality, use a variety of these fertilizers (urea, NPK, sulphate fertilizers, etc.,) which are all of unknown purity. Sustained use of these fertilizers would constitute an important source of heavy metals in soils of this ecosystem. In Malaysia, Zarcinas *et al*. (2004) noted that, heavily fertilized agricultural soils with P

fertilizers, showed significant positive correlations of soluble As, Cu, Cd, and Zn in soil with aqua regia soluble P. The situation described above is similar to that observed in the Bamenda wetland areas.

Animal manures

A large number of small pig farms are found in the back yards of many homes of inhabitants of the Bamenda Municipality and manures from these farms are heavily used. All the respondents to the questionnaires indicated that, they use manures from these farms on their gardens. Bopda (2008) and Vaxelaire (2010) reported that 10% of manure produced in Yaounde is also sold in Bamenda, an indication of the very high demand and use of manures in the gardens of this municipality. Additionally, the hills overlooking Bamenda are used for cattle grazing, which are potential sources of contamination of the wetlands given that the streams which collect runoff from these hills flow in a dendritic pattern into the wetlands of the town. During the dry season, because of scarcity of pasture land, the wetlands play a key role in the provision of fodder.

The cattle in turn deposit their droppings on the flood plains. Apart from animal manure application, drivers of the waste management department of the Bamenda City Council indicated that farmers often purchase sewage sludge from them as a fertiliser amendment. The concentrations of chemical elements in such sludge are potentially high given that it is often treated with effective micro-organisms alone. In addition, these free-living bacteria and their extra-cellular macromolecular products (e.g. fibrils) used for such treatment can accumulate trace elements only temporally (Jackson and Leppard, 2002). McGrath (1994) reported worldwide evidence documenting long-term exposure to high concentrations of heavy metals as a result of past applications of sewage sludge and other manures despite treatment with effective micro-organism. The later also noted that Cu added as a contaminant in organic soil amendments was strongly attached to organic materials. Because trace elements in cationic form are not generally dominantly sorbed on the exchange sites of phyllosilicate minerals and organic materials of soils (Fonge, *et al*., 2011) as they are always vastly outnumbered by other cations with which they compete with, Violante *et al.* (2010), they could be made available for plants uptake. Their presence in small quantities in soils would be a food security constraint in the wetland gardens of the Bamenda Municipality.

Irrigation with wastewater

Irrigation with waste water is one of the undesirable means by which heavy metals are added to agricultural farms. This is due to the lack or scarcity of fresh water which has become chronic in Bamenda. Generally, this is a major problem in poor densely populated developing countries where pressure on irrigation water resources is extremely great (Odoh and Adebayo, 2011). The later reported that, irrigation of vegetables in the Makurdi Metropolis with water from River Benue that receives substantial amounts of effluents from households, markets, and many small industries through its course resulted in significant accumulations of heavy metals in soils and consequently vegetables and fruits.

In Bamenda, streams that feed the wetlands pass through the commercial areas receiving untreated effluents from markets, garages, households and slaughter houses. They could therefore be charged with significant amounts of contaminants that would be taken up by the irrigated vegetable farms.

Presently, in Cameroon, new regulations prohibit the production and/or trade in plastics due to their poor aesthetic value. The long half-lives of these plastics and the presence of contaminants in them make them very undesirable. Most of the water bodies used for irrigation are loaded with plastics (Figure. 6), sometimes covering the entire water surface. Such waters would increase the contaminant loads of gardens when used for irrigation.

Haphazard dumping of waste

Waste management in the Bamenda Municipality has serious drawbacks despite the activities of the waste management department of the City Council, which collects and disposes off wastes to improve on the hygienic conditions of the town. In addition to the fact that many localities within the municipality are not included in the collection schedule, collection intervals are not made known to the residents which gives room to the locals to resort to inappropriate methods of disposal (Figure. 6, 7). From this study, only 30% of the respondents fine it easier to deposit their wastes in the Bamenda City Council waste collection vans while 70% of the locals to resort to disposing their untreated wastes into waterways, bushes and at roadsides.

The waterways are thus clogged by wastes and in the event of heavy rainfall, floods occur. Further, wastes around garages and gas filling stations, etc., are not given special collection guidelines. These wastes are usually left to be swept off by runoff into water channels ending up in the wetlands of the municipality. This constitutes a grave danger to vegetable production in the municipality as well as the quality of life. Similarly to other urban areas, the people of the Bamenda Municipality are concerned with the quality of the local environment and issues related to the quality of life. For example, ongoing efforts by the city council have resulted in the erection of sign boards restricting haphazard waste deposition into wetlands as well as their reclamation (Figure. 8).These efforts also lay emphasis on the provision and access to fresh and healthy food for all residents. Despite these efforts, the level of environmental sensitisation is still low. Eighty percent of the respondents surveyed indicated that they have never been contacted by officials of the responsible government agencies directly, except via the posted bill boards. This is a dangerous situation to food quality given that up to 80% of the farmers have barely reached elementary education and have very little reading and understanding ability.

What is the potential to reduce crop contamination and improve food safety?

Because farming in urban and peri-urban areas plays a very important role in providing the city with fresh vegetables of highly nutritious value, and that small-scale farmers in particular, and agricultural labourers in general, derive a livelihood from this activity, it is essential for the government to encourage this activity. However, consultations with stakeholders indicate that, current awareness levels about heavy metals contamination of vegetables amongst key policy agencies responsible for public health, pollution control, food safety inspection, horticulture and nutrition is very limited. Equally, presently, there is no program for regular testing of heavy metals concentrations in vegetables by the designated health authorities.

All respondents of the survey indicated that, they would be willing and available to collaborate with the government to take sound measures geared towards environmental protection and food security.

Thorough and transparent food testing inspections and dissemination of results by well-qualified government and non-government organisations are thus needed. Regular monitoring will also help to raise awareness about the food safety issues and strengthen consumer demand for anti-pollution measures and better quality foods for all. Because of the absence of a solid scientific base, many policy makers are reluctant to act on heavy metal pollution issues. Partners who could assist in increasing awareness would include NGOs, schools and public and private sector organisations working on environment, health, and nutrition issues, etc. Reduced emissions of pollutants from industry and vehicles, by enforcing restriction of waste deposition into environmental compartments such as soil, water, and air will prevent high concentrations of contaminants such as cadmium and lead from entering the food chain.

There is also potential to reduce further accumulation of heavy metals in soils through monitoring and controlling the heavy metal contaminations that may be associated with the use of wastewaters for irrigation, sewage sludge and municipal compost and certain classes of pesticides.

In order to provide firm agricultural recommendations, additional locally based field research studies are required in the Bamenda Municipal area to fully understand the amount and nature of contaminant uptake of commonly grown crops and vegetables, in relation to the concentrations found in the local soils, irrigation water and in other external inputs.

The conclusion of the study is urban and peri-urban vegetable gardening is growing in popularity in the Bamenda Municipality. It is an integral component of the push to produce food while improving food security in neighbourhoods where healthy food is not readily available. The production of leafy vegetables though tedious plays a major role in supporting the livelihoods of the poor by providing about 750.000 FCFA (US $1500) of income for a small farmer cultivating a 150 m^2 piece of land, other input inclusive. Unfortunately, in Bamenda, the vegetable gardens have sprouted up in the most unlikely places: near garages, near residences, near roads with heavy vehicle traffic, in poorly managed wetlands, etc. The waste management situation in the town is disturbing.

There is indiscriminate use of chemical fertilizers on vegetables throughout the urban and pri-urban areas of Bamenda. The study equally observes the lack of training and sensitization of gardeners on pollution issues as well as the non-compliance to the legal texts governing the safe use of chemical fertilizers and chemicals, as the aggravating factors and causes of environmental damage around rural-urban and peri-urban gardens of Bamenda. Due to limited land, the local population often have little choice but to farm in potentially polluted areas, as they have limited access to advice and support from the government, non-governmental organisations and philanthropists. For Cameroon to meet her developmental goals, there is a dire need for sensitisation on issues and aspects of food security from a scientific stand point.

Table.1 Common Vegetables and associated crops cultivated in the wetland gardens of Bamenda

Vegetable	Crop(s) in association	Remarks
Huckle berry *(Solanium scarbrium)*	Maize (*Zea mays*), beans *(Phaseolus vulgaris)*, cocoyams *(Colocasia spp.)*	Maize is the secondary permanent crop. Few stands of other vegetables accompany this vegetable.
Green *(Amaranthus spp.)*	Maize (*Zea mays*), beans *(Phaseolus vulgaris)* cocoyams *(Colocasia spp.)*	*Amaranthus spp*. is rarely cultivated as the main crop. Maize is the secondary permanent crop.
Bitter leaves *(Vernonia amygdalina)*	Maize (*Zea mays*), beans *(Phaseolus vulgaris)* cocoyams *(Colocasia spp.)*	Maize is the secondary permanent crop. Few stands of other vegetables accompany this vegetable.
Tomato *(Lycopersicon esculentum)*	Often grown in monoculture.	Maize is the secondary permanent crop after harvesting.
Eggplant *(Solanum melongena)*	Maize (*Zea mays*), beans *(Phaseolus vulgaris)* cocoyams *(Colocasia spp.)*	*(Solanum melongena)* is rarely cultivated as a main crop.
Cabbage *(Brassica oleracea)*	Often grown in monoculture	Maize is the secondary permanent crop after harvesting.
Pumpkins (*Cucurbita. moschata*, Duch)	Maize (*Zea mays*), beans *(Phaseolus vulgaris)* cocoyams *(Colocasia spp.)*	*Cucurbita. moschata*, Duch is rarely cultivated as a main crop.
Pepper (Capsicum chinensis L.)	Lettuce (*Lactuca sativa L.)*	Pepper (*Capsicum chinensis* L.) is rarely cultivated as a main crop
Cow pea (*Phaseolus spp*.)	Maize (*Zea mays*), beans *(Phaseolus vulgaris)* cocoyams *(Colocasia spp.)*	Cow pea is hardly cultivated as the main crop.
Water leaf *(Talinum triangulare)*	Lettuce (*Lactuca sativa L.)*	Water leaf (*Talinum triangulare*) is rarely cultivated as a main vegetable
Lettuce *Lactuca sativa L.*	Often grown in monoculture	Maize is the secondary permanent crop after harvesting.

Table.2 Common vegetable cultivation preferences by small scale farmers in the Bamenda Municipality

Vegetable type	Scoring of the vegetables	Number of farmers	Remark
Huckle berry (*Solanum scarbrum)*	Xxx	60	/
Bitter leaf *(Vernonia amygdalina)*	Xx	57	Farmers who did not prefer bitter leaf at the second position preferred green
Green *(Amaranthus spp)*	X	57	Farmers who did not prefer green at the third position preferred bitter leaf

Figure.1 Map of the study area in wetlands of Bamenda Municipality. Adapted from the 1980 land use map of the Bamenda City Area: Source Bamenda City Council

Figure.2 Educational levels of vegetable farmers in urban and peri-urban wetlands of the Bamenda Municipality

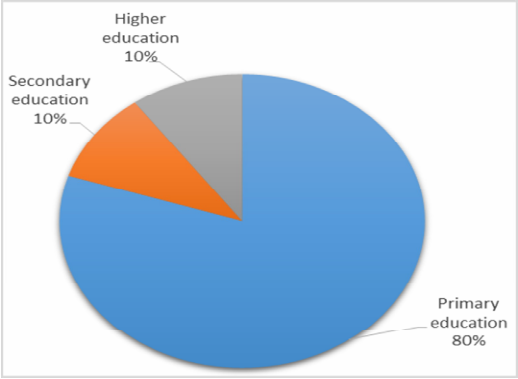

Figure.3 Distribution by age group of vegetable farmers in urban and peri-urban wetlands of the Bamenda Municipality

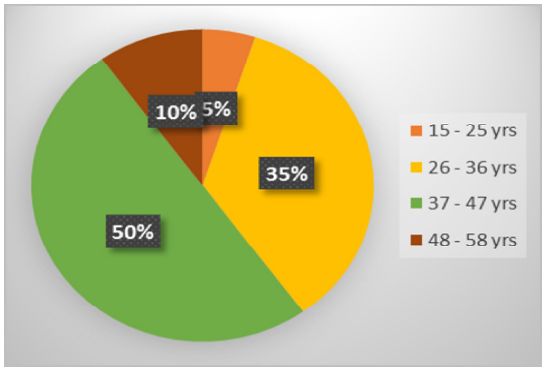

Figure.4 Flood control capacity by raffia palms in urban and peri-urban wetlands of Bamenda Municipality is lost as the raffias are destroyed for vegetable. cultivation and other crops

Figure.5 One of the pesticides used by the vegetable farmers in urban and peri-urban wetlands of the Bamenda Municipality

Figure.6 River Mezam, at Ngomegham, the Last Pole area, completely covered by plastics and a variety of municipal solid wastes from the Bamenda Municipality

Figure.7 Haphazard waste deposal in streams of the urban and peri-urban wetlands of the Bamenda Municipality

Figure.8 Efforts prohibiting land reclamation in urban and peri-urban wetlands of the Bamenda Municipality

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