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Assessment of Heavy Metal Uptake in Edible Vegetable Crops in Aba Urban Farms, Nigeria

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Abstract: This study evaluates the uptake of Cadmium, Nickel and Lead in vegetables: *Telfairia occidentalis* (fluted pumpkin), *Cucurbita maxima* (pumpkin) and *Solanum melongena* (garden egg), planted in farms close to waste dumpsite. Three vegetables gardens were selected from Emelogu, Abayi and Umuogele in Aba, Abia State. The result from the soil in Emelogu shows Lead (Pb) 67 mg/kg, Nickel (Ni) 33 mg/kg, Cadmium (Cd) 20 mg/kg, from Abayi Pb 0.64 mg/kg Cd 2.43mg/kg Ni 0.29mg/kg, from Umuogele Pb 0.49mg/kg, Cd 0.25mg/kg, Ni 0.24mg/kg. The results of the uptake of these heavy metals by vegetables crop from Emelogu show: (*Telfairia occidentalis*) Pb 0.09mg/kg, Cd 0.15mg/kg, Ni 0.001mg/kg, (*Solanum melongena*) Pb 0.01mg/kg, Cd 0.29mg/kg, Ni 0.001mg/kg. from Abayi (*Telfairia occidentalis*) Pb 0.02mg/kg, Ni 0.17mg/kg, Cd 0.02mg/kg, (*Solanum melongena*) Pb 0.03mg/kg, Ni 0.49mg/kg, Cd 0.05mg/kg, (*Cucurbita maxima*) Pb 0.00mg/kg, Ni 0.40mg/kg, and Cd 0.04mg/kg. From the result it can be deduced that the uptake of heavy metal follows in this trend Ni>Cd>Pb, and *Solanum melongena*>*Cucurbita maxima*>*Telfairia occidentalis*. It was observed that values of Cadmium were above the recommended value by EU standard while Pb was within the recommended value. Therefore leafy vegetables cultivated in farms close to waste dumpsite take up heavy metals within their edible parts and should not be consumed because of health implication of heavy metals.

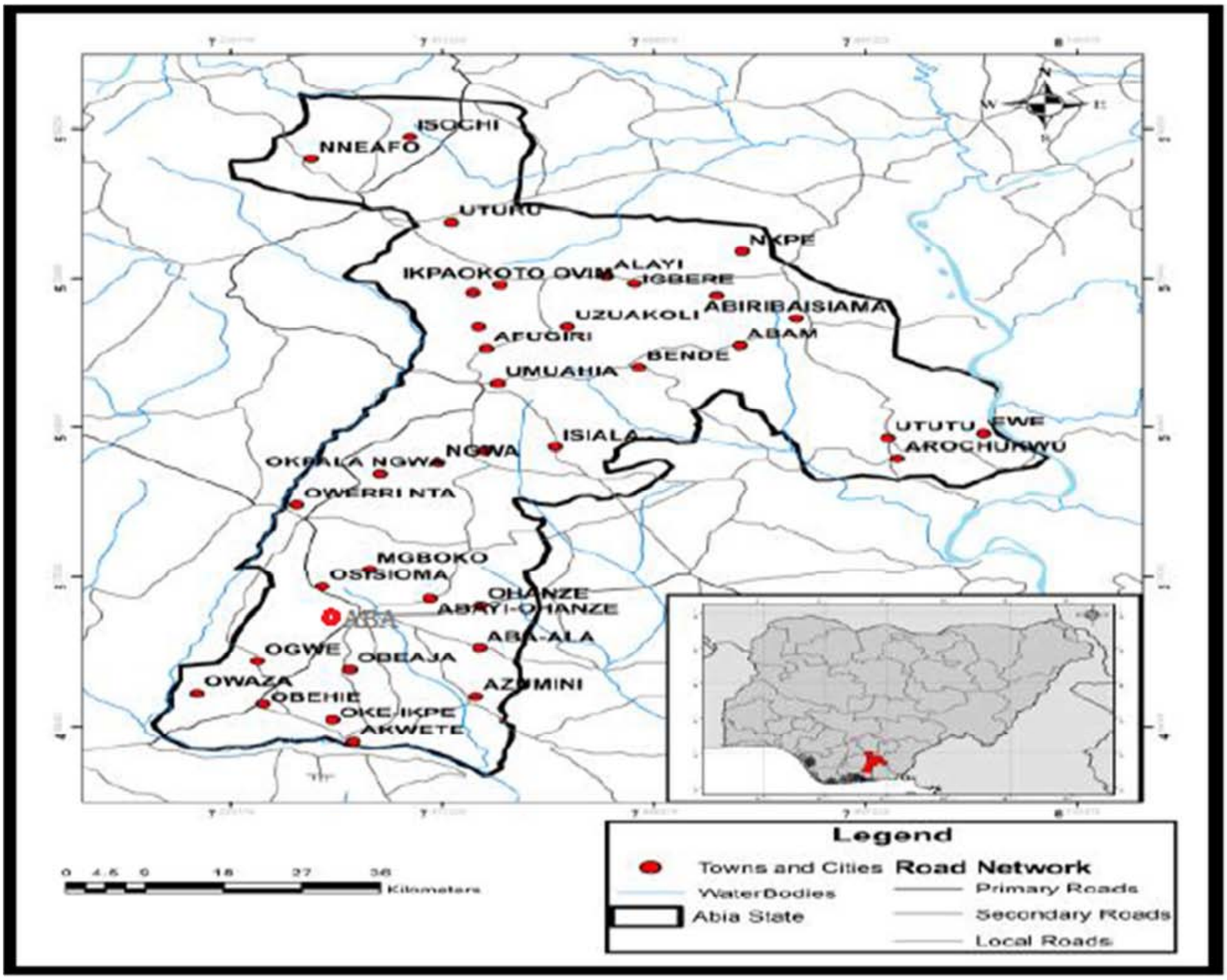
Keywords: Heavy Metals, Leafy Vegetables, Urban Farm, Aba, Abayi

1. Introduction

With the tremendous influx of world population to urban areas, the need for fresh and safe food has increased. However, an estimated 800 million people currently practice some form of urban food production globally, with much borne out of necessity for subsistence in the developing world [1], as a result of a recognition of the importance of provision of healthy food, particularly to disadvantage neighborhood in combination with the availability of vacant lots within urban areas [2]. Agriculture is the first major human influence on the soil [3], soil also remains the major sink for heavy metals released into the environment by anthropogenic activities. Most of the soil in urban environment may accumulate one or more of the heavy metals at high values enough to cause risks to human health, plants, animals, ecosystems or other media [4]. According to [5], vegetables and fruits are widely cultivated and consumed as food in urban setting in several parts of Nigeria, they constitute important part of the human diet, essential for body nourishment [6], their consumption is increasing mostly among the urban society, due to increased awareness on their nutritive and herbal values, exposure to other cultures and right gain of education [7]. However, urban consumers of urban agricultural produce may be face with additional health related issues due to increased level of economic growth and pollution as a result of improper dumping of waste and other chemicals from industrial activities [8]. [9], reports heavy metals (HM) content of soil in Aba were high with respect to the FEPA and WHO standards. [10], observed the mean concentration of HM from the municipal dumpsite soil were higher compared to the concentration of HM in the rural dumpsite soil in Uyo. A survey by [11] observed leafy vegetables have higher accumulation of the metals than the fruits. According to [12] vegetable uptake of Pb was below health-based guidance values (WHO standard) virtually all fruits, examined and leafy greens exceed guidance values. HMs in soil of Ido-Osun waste dumpsite is strongly polluted with Zinc, Copper and Lead [13]. Recent studies by [14], show that vegetables (*Talinum triangulare* and *Telfairia occidentalis*) accumulated significant amount of Iron and Zinc in their leaves than other heavy metals examined. Swift industrialization increases the toxicity of urban waste, this makes the use of waste or farmland used as a formal waste dumpsite hazardous for agricultural purpose. However, due to lack of incomes for most poor farmers to procure fertilizer to improve their yield have resulted in the use of waste since it contains high organic matter, there is a possibility for heavy metal from the waste to accumulate in the soil and therefore enter the food chain.

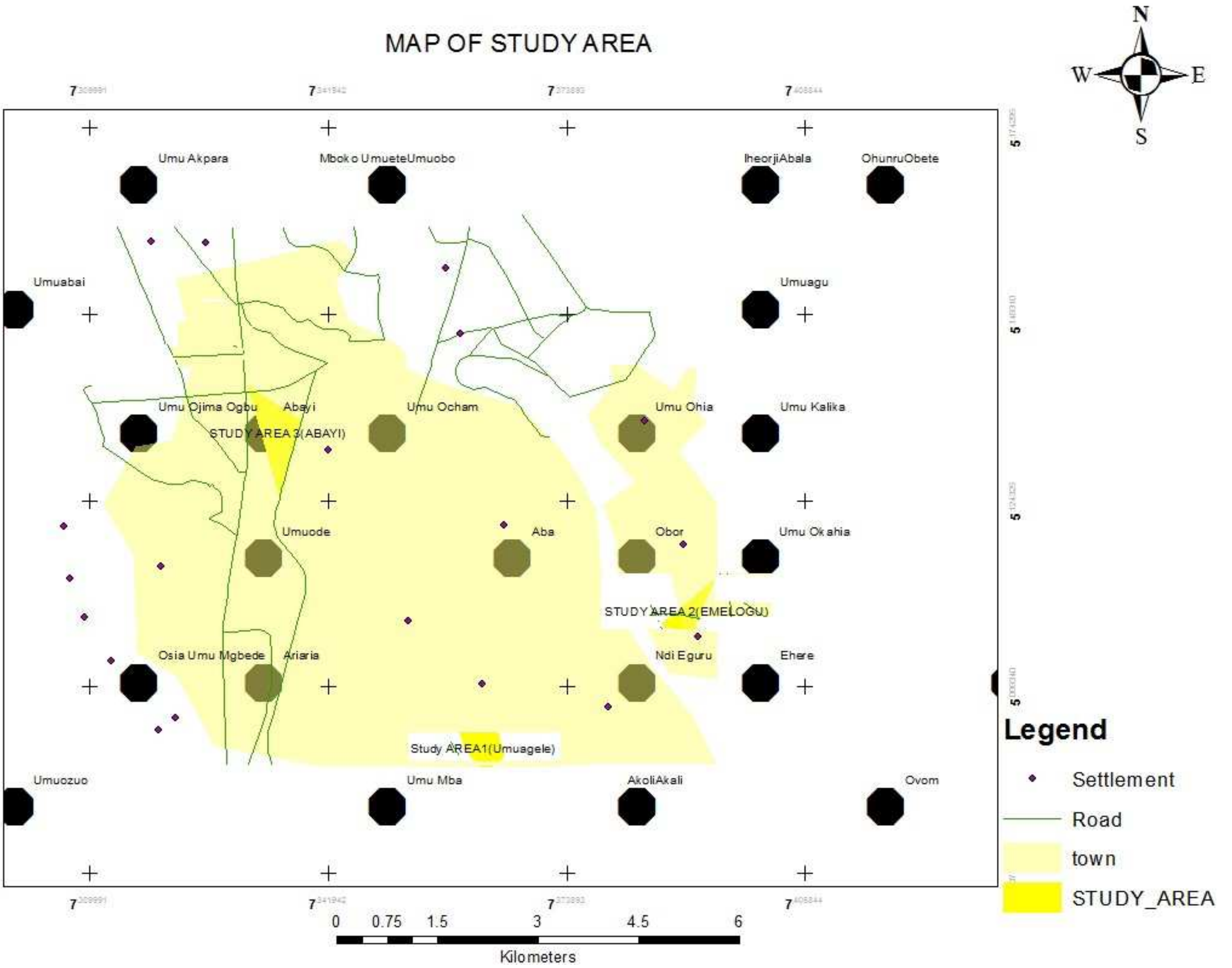
2. Study Area

This study was carried out in Aba, Abia State. The study area is located on the geographical coordinates of latitude 5°7`0``N, 7°22`0``E and longitude 5.177°N, 7.367°E (WGS84). Aba has two local government area; Aba South and Aba North. It is made up villages: Umuokpoji Aba, Eziukwu-Aba, Obuda-Aba, Aba Ukwu and Ohazu. Ohazu is the administrative head of Aba. It covers an area of about 72.507 Sq. Km^2 appropriately 1.5 percent of the total land area of Abia State. According to 2006 NPC, the population of Aba was estimated to be 534,265. Aba has a variety of land forms despite the fact it is dominated by flat and low-lying land, generally less than 120m above sea level. The low-lying plain of Aba is the inland extension of the coastal plain from the Bight of Benin. It is within the forest belt of Nigeria with a temperature range of between 20°C-36°C lying within the tropics. The vegetation is tropical rainforest. The soil fall within the broad group of ferrallitic soil. The major crops grown include: cassava, maize, vegetable and yam, palm oil. Aba has been the melting pot of human activities since 1903 when the District Colonial Office was moved from Akwete in today's Ukwa East Local Council to the area called Aba. So from day one, Aba was constructed to be a city of commerce and trade, Nigeria's own version of the ancient Italian cities of Venice and Florence, and so it has been to date. The Aba-made goods remained a story that went far and wide. The creativity of the artisan and tradesmen and their profound skill in developing local content of all products became a story that transcended many shores.



Source: Adapted from Nnabugwu & Ibeabuchi, 2015. p. 4

Figure 1. *Location map of the study area.*



Source: Field Survey, 2016.

Figure 2. *Map of Aba showing the study area.*

3. Materials and Methods

The study was carried out in farm close to waste dumpsite at Emelogu, Abayi and Umuogele (control). Soil samples collected in the farm underwent pre-treatment process of air drying at room temperature for four days, after collected samples were taken to laboratory for analysis. The pH and heavy metal were analysed. Seeds of the vegetables *Telfairia occidentalis, Solanum melongena* and *Cucurbita maxima*, were purchased from Ahia Ohuru Market in Aba, Abia State. After the soil samples were analysed for heavy metals, the vegetable seeds were planted. The vegetables were harvested after 6 weeks (42 days) of planting. The plugged vegetables leaves were washed, air dried for seven (7) days and blended using electric blender, stored in an air tight container for analysis. Soil pH was determined according to Onyeike and Osuji (2003). The blended samples were analyzed for Cd, Pb and Ni using the Atomic Absorption Spectrophotometer (AAS).

4. Result and Discussion

Table 1. *Mean Values of Heavy Metal Analysis from Emelogu, Umuogele and Abayi (mg/kg).*

Parameters	Sample X_1 Emelogu	Sample X_2 Umuogele	Sample X_3 Abayi
Lead	67.0	0.49	0.64
Cadmium	20.0	0.25	2.43
Nickel	33.0	0.24	0.29

Source: Field Survey, 2016

Table 1: shows the results of the heavy metals analysis of soil in the farms close to waste dumpsite. A total of three (3) soil samples from Emelogu, Umuogele and Abayi were analyzed. Lead was highest in sample X_1 with a mean value of 67.0mg/kg. This level was higher compared to other heavy metal analyzed in other soils, the level of Nickel and Cadmium was found to be highest in sample X_1.

***Table 2.** Result of the Soil pH from Emelogu, Umuogele and Abayi.*

Sample X_1 (Emelogu)	6.2
Sample X_2 (Umuogele)	5.5
Sample X_3 (Abayi)	7.9

Source: Field Survey, 2016

Table 2 shows the mean concentration of the sample soil pH from the farms sample X_1 (Emelogu) has a pH of 6.2 (slightly acidic) and X_2 (Umuogele) 5.5 (acidic) and X_3 (Abayi) is 7.9 (slightly alkaline).

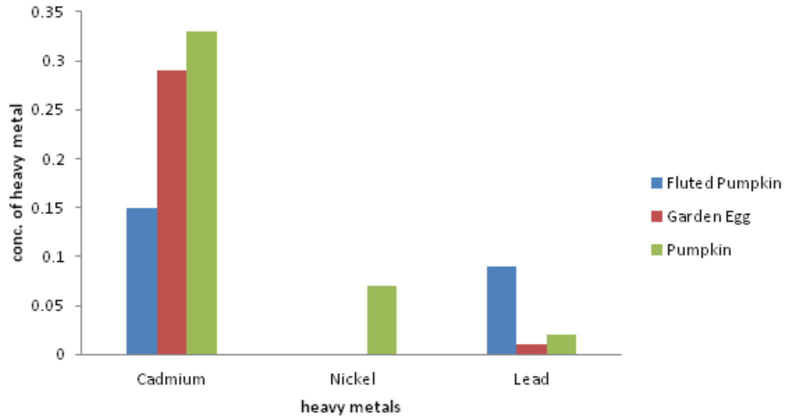


***Figure 3.** The concentration of heavy metals in leafy vegetables from Emelogu, dumpsite (mg/kg).*

Figure 3 shows the uptake of Cadmium in pumpkin as the highest concentration with 0.33mg/kg, followed by Garden egg with 0.29mg/kg and Fluted pumpkin 0.15mg/kg. Nickel was highest in Pumpkin with 0.07mg/kg, it was insignificant in Garden egg and Fluted pumpkin. Lead was highest in Fluted pumpkin with 0.09mg/kg, followed by Pumpkin with 0.02mg/kg and 0.01mg/kg in Garden egg.

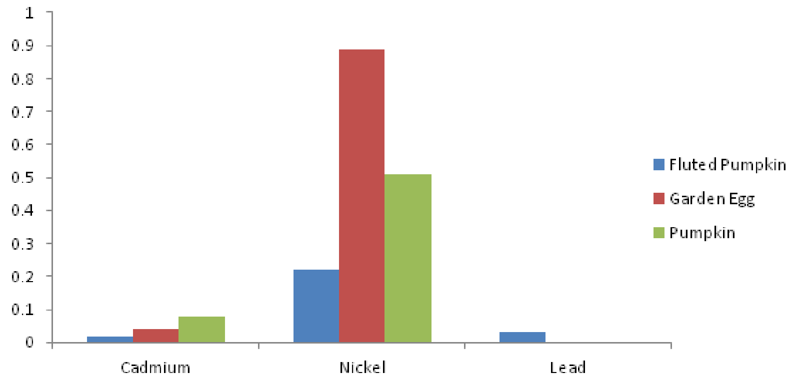


***Figure 4.** The concentration of heavy metals in leafy vegetables from Umuogele dumpsite (mg/kg).*

Figure 4 shows the uptake of Nickel was highest in Garden egg with 0.89mg/kg, followed by Pumpkin 0.51mg/kg and 0.22mg/kg in Fluted pumpkin. Accumulation of Cadmium was highest in pumpkin with 0.08mg/kg, followed by Garden egg with 0.04mg/kg and 0.02mg/kg in Fluted pumpkin. Lead uptake was highest in Fluted pumpkin with the concentration of 0.03mg/kg, it was insignificant in Garden egg and Pumpkin.

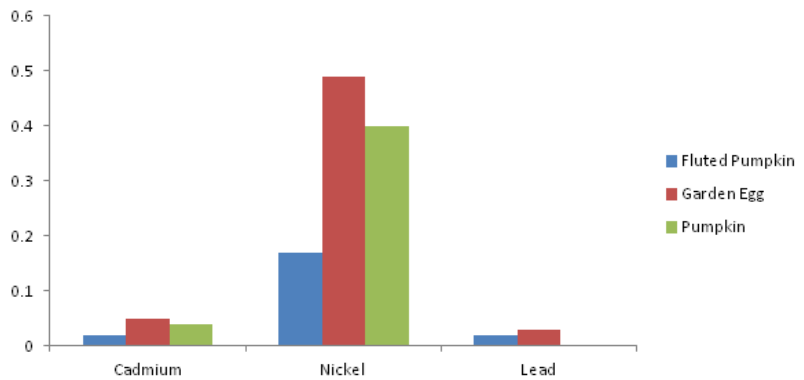


***Figure 5.** The concentration of heavy metals in leafy vegetables from Abayi dumpsite (mg/kg).*

Figure 5 shows the uptake of Nickel was highest in Garden egg with 0.49mg/kg, followed by Pumpkin 0.40mg/kg and 0.12mg/kg in Fluted pumpkin. Cadmium was highest in Garden egg with 0.05mg/kg followed by Pumpkin with 0.04mg/kg and 0.02mg/kg in Fluted pumpkin. Lead was highest in garden egg with 0.02mg/kg and it was insignificant in Pumpkin.

Table 3. *EU guidance value for maximum levels for certain contaminants in foodstuffs.*

	Foodstuffs	Maximum level (mg/Kg wet weight)
Cadmium.		
3.2.15	Vegetables and fruit, excluding leafy vegetables, fresh herbs, fungi, stem vegetables, pine nuts, root vegetables and potatoes	0.05
3.2.17	Leafy vegetables, fresh herbs cultivated fungi and celeriac	0.20
Lead		
3.1.10	Vegetables, excluding brassica vegetables, fresh herbs and fungi. For potatoes the maximum level applies to peeled potatoes.	0.10
3.1.11	Brassica vegetables, leafy vegetables and cultivated fungi	0.3

Source: Adapted from Official Journal of the European Union 2006. p. 14 & 15

Among the soil samples tested Lead (Pb), Nickel (Ni) and Cadmium (Cd) were found to be present in the soil samples with the following concentration 67.0mg/kg, 33.0mg/kg, and 20.0mg/kg respectively for soil sample (Emelogu X1), 0.49mg/kg, 0.24mg/kg, and 0.25mg/kg for soil sample (Umuogele X2 Control) and 0.64mg/kg, 0.29mg/kg, and 2.43mg/kg for soil sample (Abayi X3). From the result obtained soil from Emelogu recorded higher concentrations of heavy than their corresponding levels of heavy metals at Abayi and Umogele. The obtained values from Emelogu exceeded the New Dutch list Intervention value of heavy metal in soil. The obtained results is agreement with similar studies carried out by [13, 10] which recorded Zinc 1133.90mg/kg, Nickel 26.3mg/kg, Copper 110.90mg/kg, Lead 137mg/kg and Chromium 3.63mg/kg and Iron 1711mg/kg, Lead 43.28mg/kg, Zinc 88.34mgg/kg, Nickel 12.18mg/kg, Cadmium 14.10mg/kg and Copper 56.33mg/kg respectively. This could be as a result that Emelogu dumpsite has been used longer as a dumpsite with more population of people residing in that area. Waste from the dumpsite normally leaches to the underlying soil as an outcome of the topography of the dumpsite. The uptake of heavy metals by leafy vegetables varies: pumpkin have the highest concentration with 0.33mg/kg, followed by garden egg 0.29mg/kg and fluted pumpkin 0.15mg/kg, Lead was highest in fluted pumpkin with the concentration of 0.09mg/kg, followed by pumpkin 0.02mg/kg. At Emelogu Pb uptake in all the vegetables were within the EU guidance value for leafy vegetables while Cd uptake in garden egg and pumpkin were above the EU recommended standard for edible leafy vegetables. Vegetables from Emelogu dumpsite were found to have higher concentration of heavy metal than control vegetable samples at Umuogele and at Abayi. The varying concentration levels of the heavy metals were due to the differences in location, population, type of waste and age of the dumpsite, there were significant differences in Cadmium, Nickel and Lead in the different leafy vegetables (garden egg, fluted pumpkin and Pumpkin) in different study areas. In all the three location, the uptake of heavy metal in the vegetables does not follow in same trend. For Emelogu dumpsite (X1) Cd>Pb>Ni but in Umuogele (X2 control) and Abayi Ni>Cd>Pb.

5. Conclusion

The disposal of waste is a major environmental concern in most urban areas especially in Aba metropolis. Wastes are disposed indiscriminately in open and vacant land. This work revealed the heavy metal content of farms/soil close to waste dumpsite and plot of land recently used in dumping waste. Soil from farm close to waste dumpsite was found to have a higher concentration of heavy metals than farms used to dump waste. Leafy vegetables planted in these farms take up these heavy metals in their edible parts. The contaminant levels found in urban garden produce some were above health-based guidance values which are not consistent with levels associated with foods that can be sold. Urban consumers of urban agricultural produce may be face with additional health related issues due to increased levels of economic growth and pollution. Some urban farms have become threatened with heavy metal pollution as a result of improper dumping of waste and other chemicals from industries. As a result, we recommend: [a]. Proper education and legislation on handling of waste should be advocated to avert waste related problem along the food chain. [b]. Farmers should not be encourage to cultivate on these locations since agricultural produces from these farms are harmful to humans and should not be consumed. [c]. Government through Town planners should ensure that proper dumpsite are selected and managed. This should be far away from residential/farms with legislation and regulation on the use of land close to the dumpsite for any purpose. [d]. The municipality should thrive to establish properly engineered landfills with proper Environmental Impact Assessment as stipulated by the Environmental management laws of Nigeria.

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