TURNING URBAN WASTES INTO WEALTH: ECOLOGICAL AND PUBLIC HEALTH IMPLICATIONS OF USE OF WASTE WATER AND ORGANIC WASTE IN URBAN AND PERI-URBAN AGRICULTURE IN ZARIA URBAN AREA, NIGERIA

By

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INTRODUCTION

- **Urban and Peri Urban Agriculture (UPA) is an important feature of many urban areas in Africa; because of:**

  - High urban growth and urban primacy problems
  - Increasing food (especially vegetable) demands of urban population
  - Availability of MWW and MSW (as inputs)
  - Enough Cultivable lands
  - Cash flow and employment benefits

- **But the sector is associated with some controversies; e.g:**

  - Negative environmental effects
  - Pollution and contamination problems
  - Land-water use conflicts
  - Aesthetics

INTRODUCTION

- **Zaria urban area is one of the most developed urban centers in northern Nigeria.**

- **The town is strategic because:**

  - Is an educational center
  - Is located near the center of the country
  - Is commercially important
  - There is available land and water for UPA (largely irrigation)
  - Is a traditional political headquarter (of Zaria emirate)
  - Is a major vegetable market in the country
  - UPA is well over 50 years in the town
  - No previous research has documented the effects of UPA there

- **This study thus examines the ecological and public health effects of using Municipal Waste Water (MWW) and Municipal Solid Waste (MSW) in UPA practices in the area.**

METHODOLOGY

- **An integrated methodology was employed, comprising of:**

  - Questionnaire survey (Farmers and crop consumers)
  - Transect walks
  - Interview schedules (Farmers and crop consumers)
  - Soil sampling and analyses (six sites)
  - Crop sampling and analyses
  - Wastes (MWW and MWW) sampling and analyses

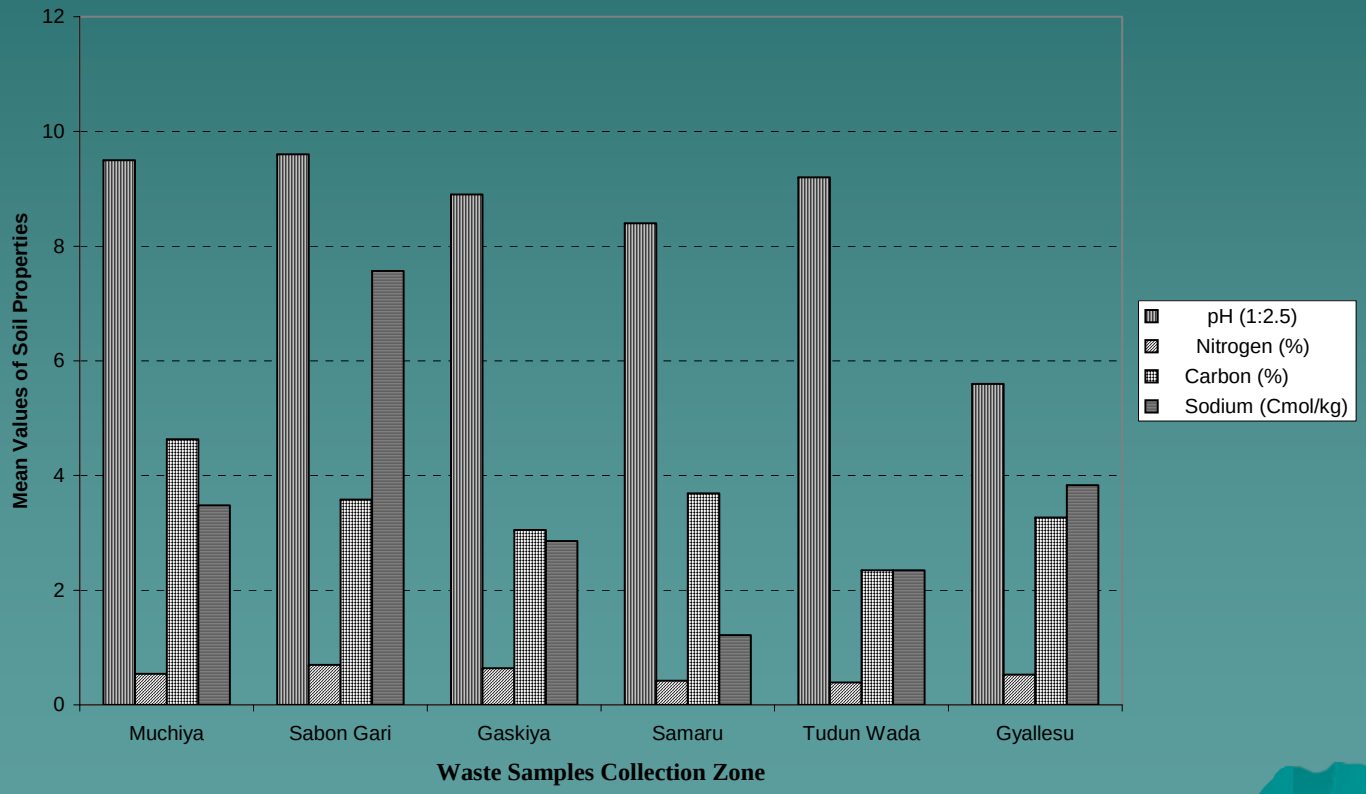
METHODOLOGY (Contd.)

- **The collected samples were analysed for heavy metals (Cu, Mn, Zn, Cr, Cd, Fe, Pb and As)**
- **MSW samples additionally analysed for fertility parameters (C, N, P, CEC, pH, Exchangeable Bases)**
- **Appropriate Statistical tests were employed:**

  - Descriptive statistics (data summary/trend identification)
  - ANOVA (test for differences between sampling locations
  - Correlation technique (compare crop and soil level of heavy metals)

RESULTS AND DISCUSSION

Figure 1: Mean Values of pH, N, C and Na in Waste Samples Collected from Different Sampling Locations in Zaria Urban Area



RESULTS AND DISCUSSION (Contd.)

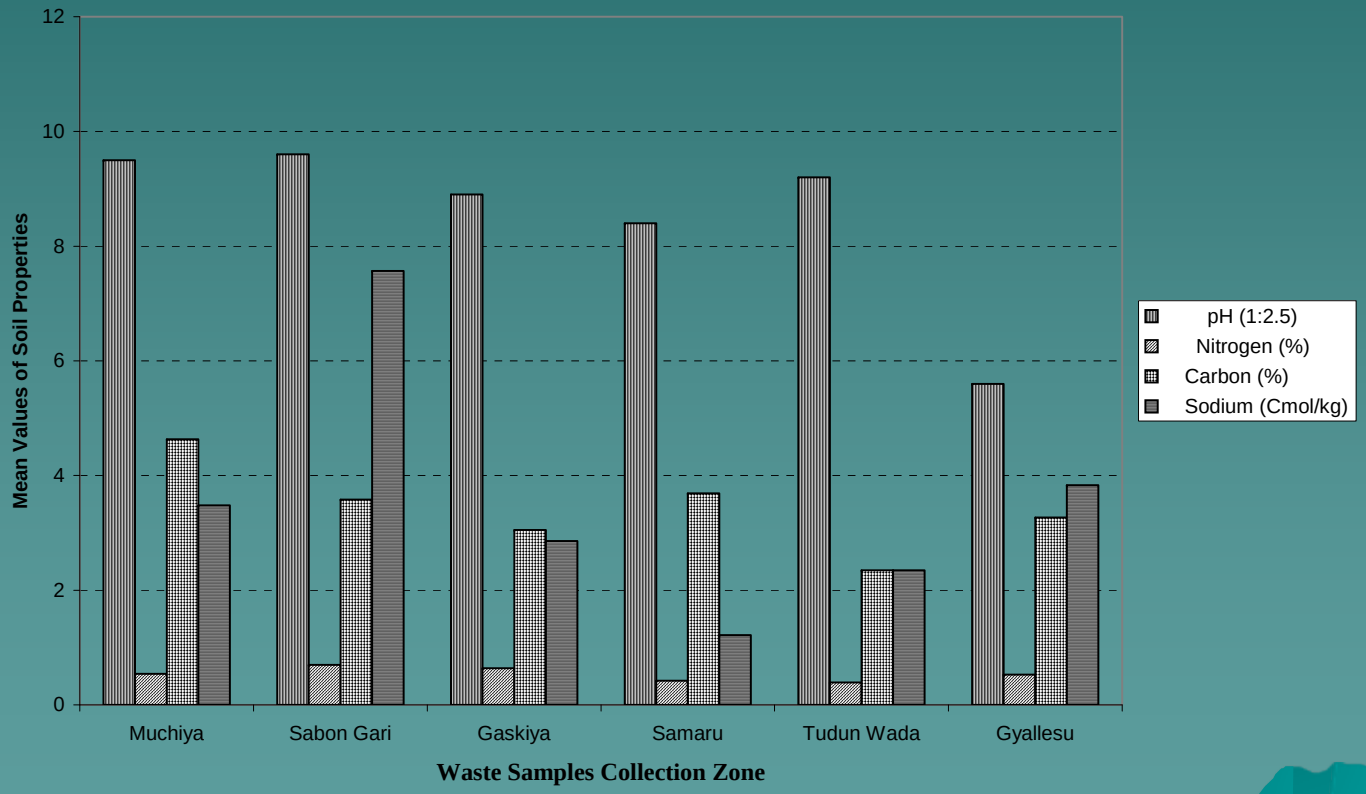
Table 1: Mean Concentrations of the Various Metals (mg/l) in MWW Samples across the different Sampling Locations in Kubanni-Galma River Basin

Heavy Metals	Maximum Permissible	Values for the various zones					Summary of ANOVA		
		HNE	TJK	AGR	GYL	JSH	Cal. F	Crit. F	S.O.D.
Fe	0.01	0.6	0.05	0.4	0.2	0.5	2.15	1.78	S
Cu	0.2	0.03	0.02	0.05	0.04	0.03	1.02	1.78	NS
Zn	Up to 5.0	0.02	0.02	0.03	0.04	0.03	1.32	1.78	NS
Mn	0.2	0.1	0.04	0.08	0.1	0.08	2.32	1.78	S
Pb	-	0.03	0.02	0.05	0.04	0.06	1.17	1.78	NS
Ni	0.2	0.03	0.03	0.05	0.04	0.04	0.96	1.78	NS
As	0.1	0.02	0.02	0.03	0.03	0.05	0.54	1.78	NS
Cr	0.1	0.01	0.07	0.1	0.1	0.1	2.42	1.78	S

- Index to the Sampling Locations: HNE = Hanwa Extension; TJK = Tudun Jukun; AGR = Agoro; GYL = Gyallesu; JSH = Jushi
- S = Significant at 0.005 probability level; NS = Not significant at 0.005 probability level

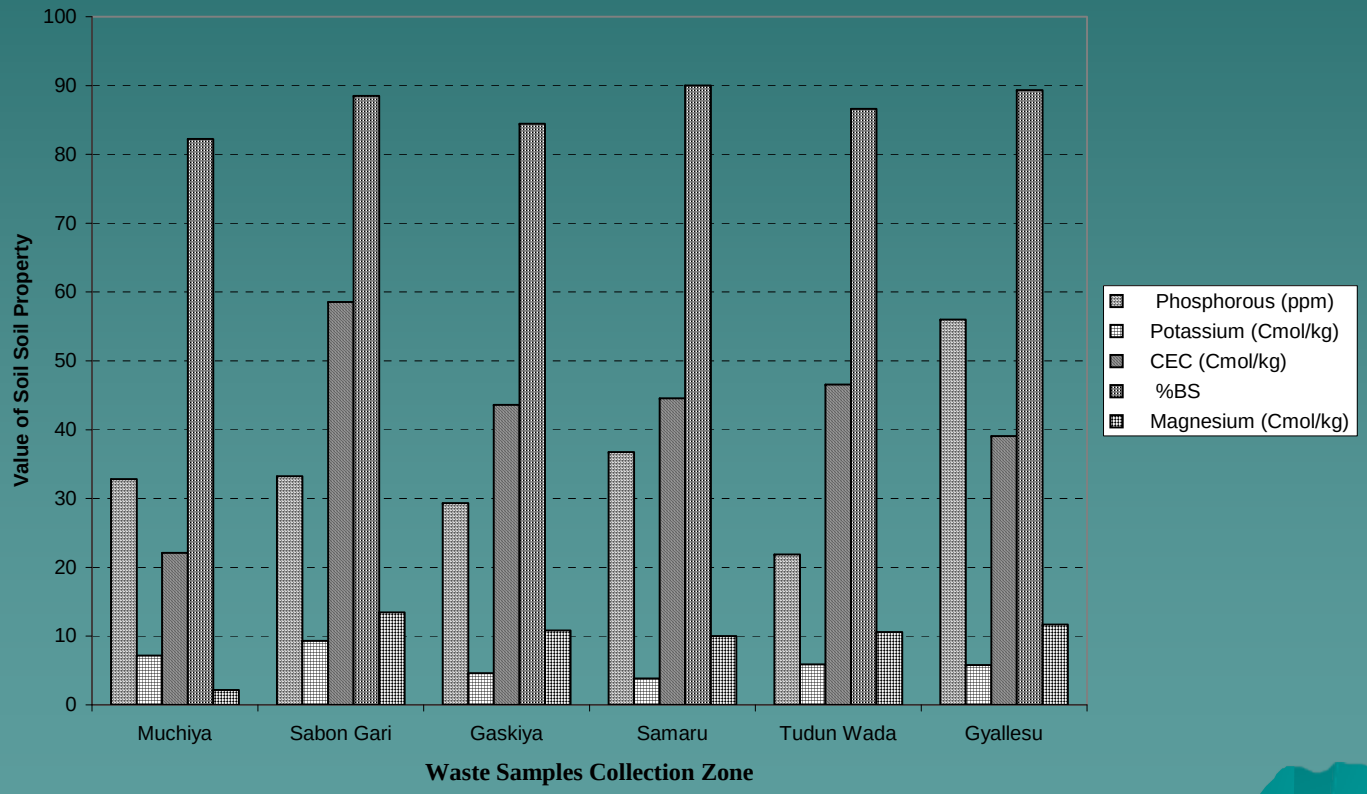
RESULTS AND DISCUSSION (Contd.)

Figure 1: Mean Values of pH, N, C and Na in Waste Samples Collected from Different Sampling Locations in Zaria Urban Area



RESULTS AND DISCUSSION (Contd.)

Figure 2: Mean Values of P, K, CEC, %BS and Mg in Waste Samples Collected from Different Sites in Zaria Utban Area



RESULTS AND DISCUSSION (Contd.)

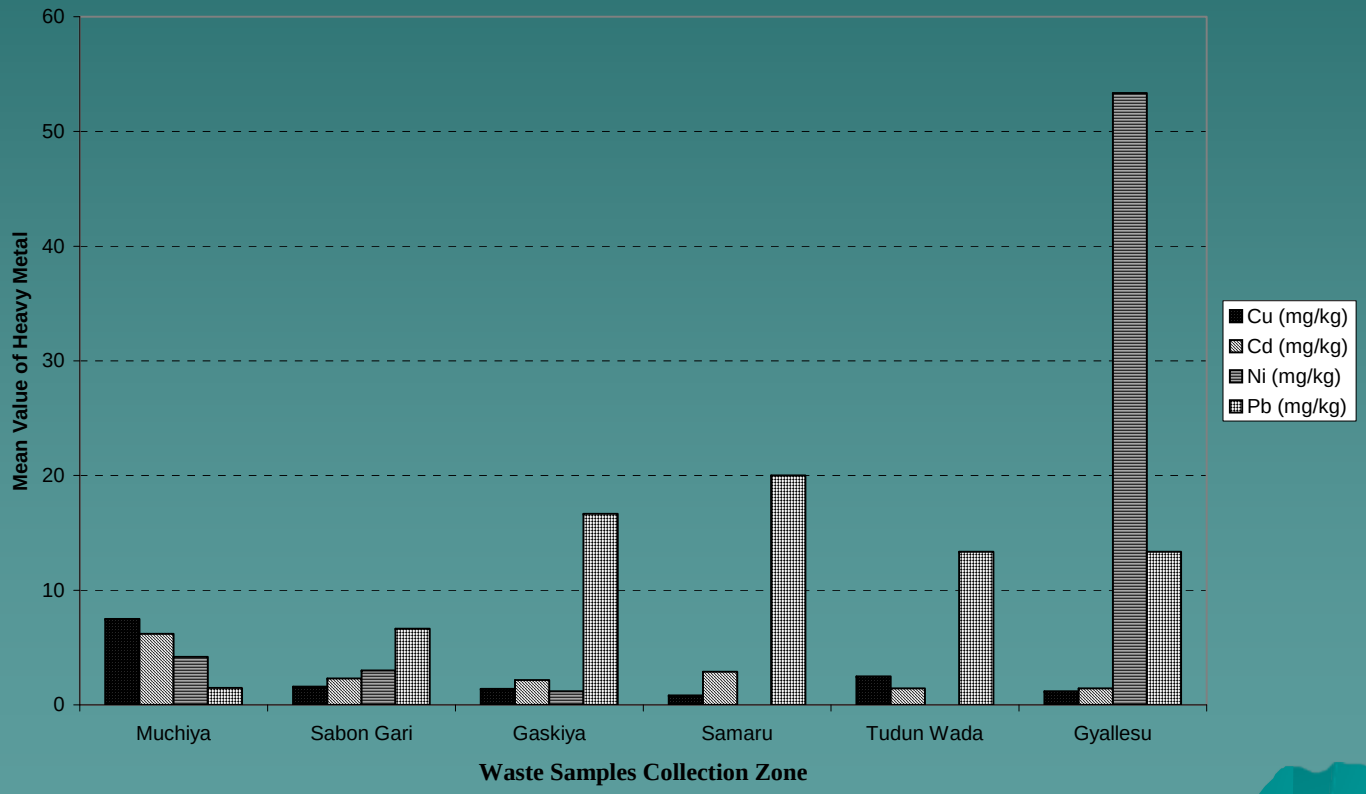
- **Table 2: Descriptive Statistics of the Heavy Metals Determined in MWW Samples across the Kubanni-Galma River Basin**

Heavy Metal	Maximum Permissible	Descriptive Statistical Parameter			
		Range	Mean	Stan. Dev.	Percentage Coeff. Vari.
Fe	0.01	0.05-0.6	0.35	0.02	6.7
Cu	0.2	0.02-0.05	0.03	0.01	33..3
Zn	Up to 5.0	0.02-0.04	0.03	0.007	23..3
Mn	0.2	0.04-0.1	0.08	0.02	25.0
Pb	-	0.02-0.06	0.04	0.007	17..5
Ni	0.2	0.03-0.05	0.04	0.007	17..5
As	0.1	0.02-0.05	0.03	0.01	33.3
Cr	0.1	0.07-0.1	0.09	0.01	11.1

Note: The range and means are for all the six Sampling Locations indicated in Table 1.

RESULTS AND DISCUSSION (Contd.)

Figure 3: Mean Values of Cu, Cd, Ni and Pb in Waste Samples Collected from Different Sites in Zaria Urban Area



RESULTS AND DISCUSSION (Contd.)

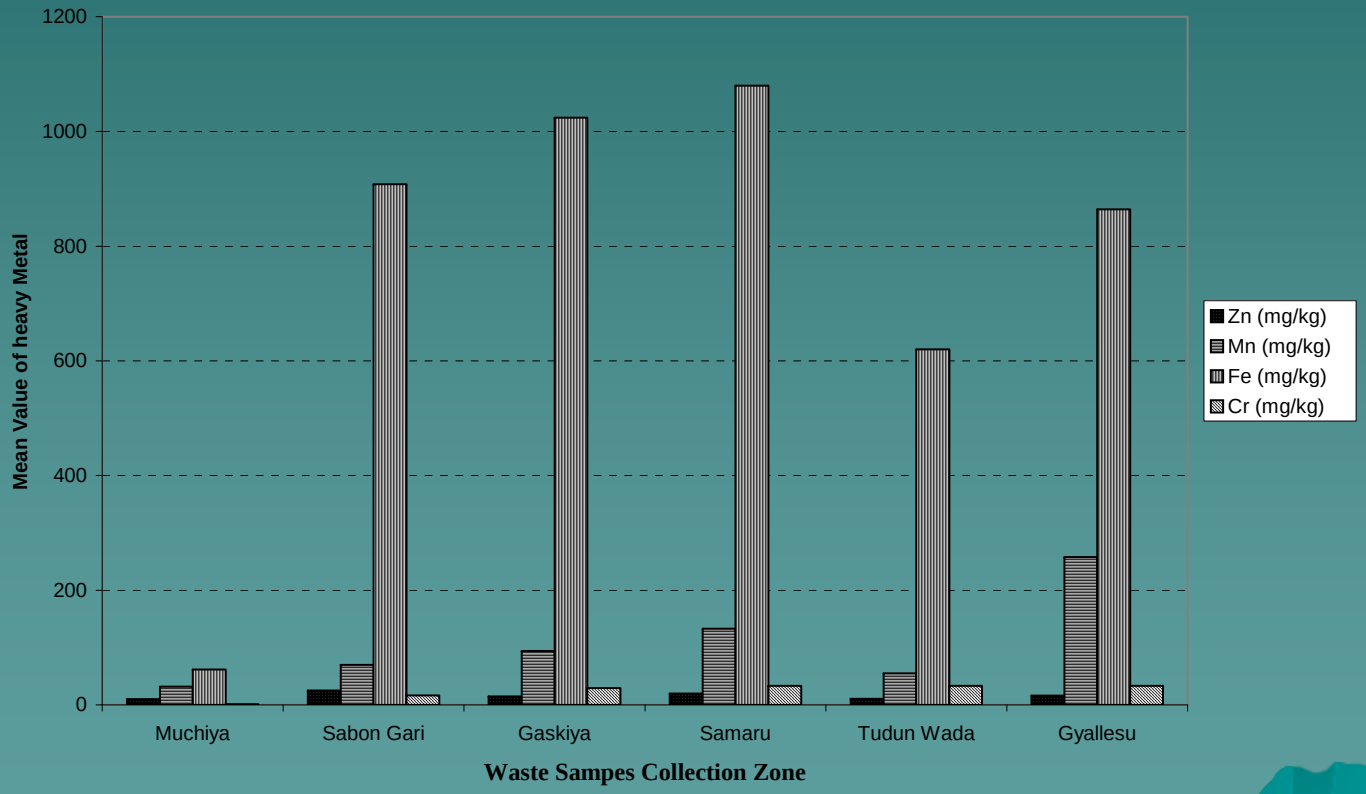
Table 3: Descriptive Statistics of the Heavy Metals Determined in Shallow Well Water Samples across the Kubanni-Galma River Basin

Heavy Metal	Maximum Permissible	Descriptive Statistical Parameter			
		Range	Mean	Stan. Dev.	Percentage Coeff.Vari.
Fe	0.01	0.001-0.005	0.0025	0.000	14.0
Cu	0.2	0.002-0.007	0.0045	0.0006	13..3
Zn	Up to 5.0	0.0001-0.0004	0.0002	0.00008	22.85
Mn	0.2	0.0003-0.0008	0.00035	0.00006	17.14
Pb	-	0.001-0.005	0.0035	0.00045	12.85
Ni	0.2	0.0025-0.0046	0.0032	0.0007	21.85
As	0.1	0.002-0.007	0.005	0.001	20.0
Cr	0.1	0.0003-0.0005	0.0004	0.0001	230.0

Note: The range and means are for all the six Sampling Locations indicated in Table 1.

RESULTS AND DISCUSSION (Contd.)

Figure 4: Mean Values of Zn, Mn, Fe and Cr in Waste Samples Collected from Different Sites in Zaria Urban Area



RESULTS AND DISCUSSION (Contd.)

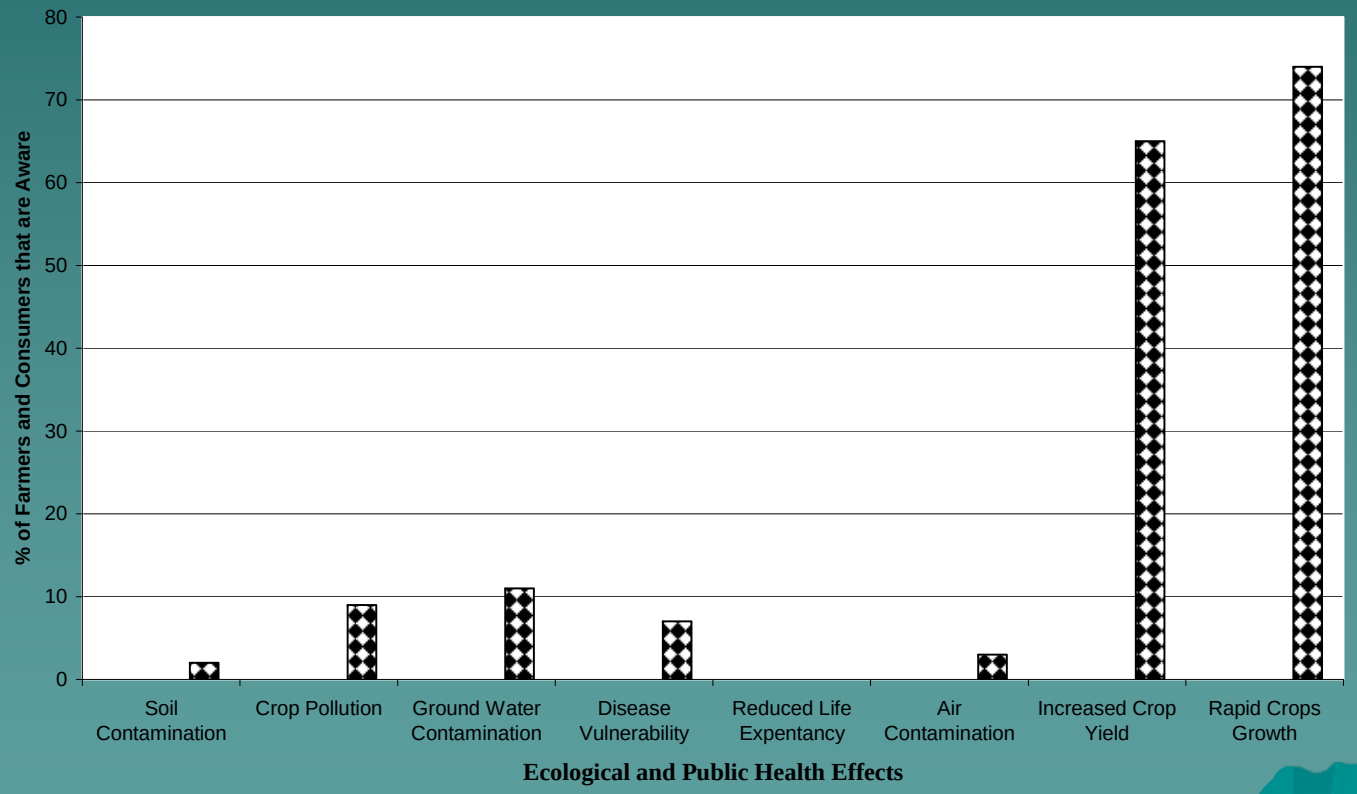
Table 4: Fertility Rating used in Characterising the Fertility of Urban Waste Samples Analysed in Zaria Urban Area

Property	Fertility Rating			
	Low	Medium	High	Very High
pH	4.1-5.2 [1]	5.3-6.5 [2]	6.6-7.4 [3]	7.5-0.3 [4]
N	<0.10	0.10-0.45	>0.45	
P	5-15	15-30	30-50	>50
C	<1.5	1.5-4.5	>4.5	
Ca	2-5	5-10	10-20	>20
Mg	0.3-1.0	1-3	3-8	>8
K	0.2-0.3	0.3-0.6	3-8	>8
Na	0.1-0.3	0.3-0.7	0.7-2.0	>2.0
CEC	5-15	0.3-0.7	0.7-2.0	>2.0
%BS	20-24	40-60	60-80	80-100

Note: [1]pH strongly acidic; [2]pH acidic; [3]pH near neutral; [4]pH alkaline

RESULTS AND DISCUSSION (Contd.)

Figure 5: Knowledge of Ecological and Public Health Effects of Using MWW and MSW Among Farmers and Consumers of UPA-Produced Crops in Zaria Urban Area



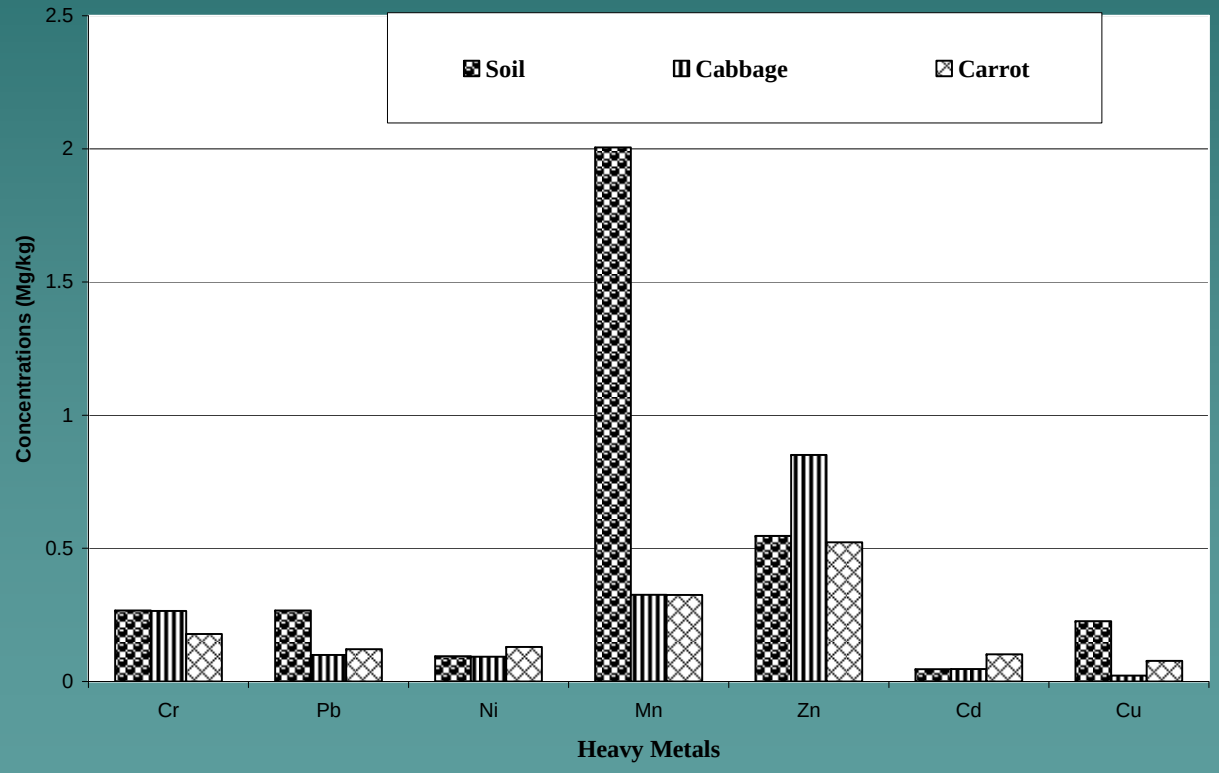
RESULTS AND DISCUSSION (Contd.)

Table 5: Summary of ANOVA Comparing Mean Values of the various Properties of the Waste Samples Analysed over the Six Sampling zones

Property	Calculated F-value	Critical F-value	Degree of Freedom	Significance of the difference
pH	0.39	2.26	44	NS
N	1.03	2.26	44	NS
P	2.45	2.26	44	S
C	0.76	2.26	44	NS
Ca	3.12	2.26	44	S
Mg	2.45	2.26	44	S
K	2.41	2.26	44	S
Na	2.33	2.26	44	S
CEC	4.12	2.26	44	S
%BS	1.56	2.26	44	NS
Cu	3.22	2.26	44	NS
Zn	2.67	2.26	44	S
Mn	16.33	2.26	44	S
Fe	23.16	2.26	44	S
Cr	5.34	2.26	44	S
Cd	2.36	2.26	44	S
Ni	3.31	2.26	44	S
Pb	5.47	2.26	44	S

RESULTS AND DISCUSSION (Contd.)

Figure 6: Heavy Metal Contents (Mg/kg) in Soil, Cabbage and Carrot Crop Samples in Areas Under UPA in Zaria, Nigeria



RESULTS AND DISCUSSION (Contd.)

Table 6: Correlations between Soil and Carrot (*Darcus carota*)Crop Levels of the Various Metals

Crop Levels of the Various Metals	Soil Levels of the Various Metals						
	Cu	Cr	Cd	Mn	Zn	Pb	Ni
Cu	0.3410*	-	-	-	-	-	-
Cr	-	0.41122	-	-	-	-	-
Cd	-	-	0.6705*	-	-	-	-
Mn	-	-	-	0.4165*	-	-	-
Zn	-	-	-	-	0.3211	—	-
Pb	-	-	-	-	-	0.4952**	-
Ni	-	-	-	-	-	-	0.2163

Note: The asterisks denote the correlations that are statistically significant

RESULTS AND DISCUSSION (Contd.)

Table 7: Correlations between Soil and Cabbage (*Curbita amaranthus*) Crop Levels of the Various Metals

Crop Levels of the Various Metals	Soil Levels of the Various Metals						
	Cu	Cr	Cd	Mn	Zn	Pb	Ni
Cu	0.1176*	-	-	-	-	-	-
Cr	-	0.5620**		-	-	-	-
Cd	-	-	0.2714	-	-	-	-
Mn	-	-	-	0.4043*	-	-	-
Zn	-	-	-	-	0.5211	—	-
Pb	-	-	-	-	-	0.4624**	-
Ni	-	-	-	-	-	-	0.2307

Note: The asterisks denote the correlations that are statistically significant

MAJOR FINDINGS

- The wastewater being used in irrigating soils under UPA in the area contain some amounts of As, Fe, Cr, As, Cu, Zn, Mn and Pb
- The fertility rating of the MSW is high to very high, but contains high proportions of Zn, Fe, Cr and Pb
- The farmers make use of the MSW due to its positive effects on crop yield and also because access to inorganic fertilisers is increasingly becoming difficult for them
- Levels of Pb, Cd, Cr, Zn and Cu in ground water in shallow wells around the UPA fields are 4-5 times higher than those in shallow wells located way from such fields
- There are evidences of heavy metal accumulation in two major vegetable crops being cultivated in the area
- The farmers and consumers of the crops generally have low level of perception of public health consequences of doing so

CONCLUSIONS AND RECOMMENDATIONS

- The MSW being used in the area is nutrient-rich and very high in fertility rating but contains potential pollutants
- There are valid reasons to be concerned about the possibility of occurrence of sodicity and heavy metal contamination problems in food chain cycles in the area
- There is high level of ignorance of these problems on the both the side of the farmers and crop consumers in the area
- Public enlightenment on the public health consequences is therefore necessary
- There is also the need to raise the capacity of the farmers for them to be in a position to carry out screening and treatment of wastewater and municipal waste before use in UPA.

CLOSING

THANK

YOU

FOR

LISTENING