



**Concentration of Heavy Metals in Soils from Farmlands Within Rice Mill in Kogi State,
Nigeria**

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ABSTRACT

Although heavy metals make up the majority of the natural environment, uncontrolled human activity has revolutionized its biochemical equilibrium and geothermal processes. This study aims to ascertain the concentration of Cd, Cr, Fe, and Pb from soil samples of selected farmlands within Ejule-Onu Rice Mill, Ibaji LGA., Kogi State, Nigeria, using atomic absorption spectrometry. The concentration of heavy metals ranged as follows - Cd: 0.004 – 0.576 mg/kg, Cr: 0.006 – 0.346 mg/kg, Fe: 0.381 -0.918 mg/kg, and Pb: 0.003 – 0.116 mg/kg. The concentration of heavy metals in soil were compared with FAO/WHO and USEPA maximum permissible limits and the results showed that Cd from soil samples of farmland I (50 m away from the rice mill) was above USEPA maximum permissible limit of 0.480 mg/kg, and that of the studied metals were below FAO/WHO and USEPA standards. The concentration of the heavy metals at 50 m away were higher than those of 75 m and 100 m away from the rice mill but site 75 m away was higher than that of 100 m.

Keywords: Heavy metals, soil, rice, permissible limit

INTRODUCTION

There are both natural and anthropogenic sources of heavy metals in the environment. Volcanic eruption and weathering of rocks containing metals are sources of heavy metals in the environment. Mining, industry and agriculture are examples of anthropogenic sources of heavy metals in the environment [1]. Considering the effects on the food chain, plant absorption of heavy metals from the soil at high concentrations may pose a major health risk. The primary food chain pathway for exposure of heavy metals is the consumption of food crops tainted with these metals. When heavy metals build up in soft tissue and are not broken down by the human body [2], their

adverse effects on human being and animals could be mild or fatal depending on the quantity accumulated.

Cadmium is a highly poisonous heavy metal to organs such as the liver, placenta, kidneys, bones and brain [3]. Lead and its compound have been used extensively by humans for ages and it's a major industrial hazardous chemical that contributes significantly to environmental pollution. Lead is a very hazardous element that gets into biological systems when it combines with nutrients from soil, water and air [3] Scientific research on lead exposure and cancer risk are inadequate when it comes to carcinogenic effect [3]. Fe^{2+} uptake from roots and translocation to leaves through transpiration are linked to iron toxicity in plants. It decreases from Fe^{2+} to Fe^{3+} by microbial activities which give indicators of iron toxicity [4]. Excess concentration of Fe^{2+} result in the generation of free radicals that affect cellular structure and membrane damage [5]. For both acute and long term exposure Cr(VI) is far more hazardous than Cr(III). Following inhalation exposure via humans, the respiratory tract is the main organ target by Cr(VI). hence, only Cr(VI) should be classified as a human carcinogen according to EPA's conclusion, Studies on animals show that respiratory exposure to Cr(VI) results in lung cancer. According to EPA, Cr(VI) is classified as group A and is known to cause cancer in human when inhaled. Autism spectrum disorder has been linked to disturbance in Zn and Cu metabolism such as low Zn/Cu ratios, low Zn levels or excessive Cu levels [3]. Beans, nuts, chicken, red are excellent sources of zinc.

Studies have shown elevated levels of heavy metals in soil and crops from farmlands in Kogi State. For instance, Cd levels ranged from 0.60 -9.75 mg/kg, exceeding permissible in some areas [2] and Pb levels were 11.80 – 162.48 mg/kg indicating severe anthropogenic influence [2]. However, specific data on farmlands within Ejule rice mill is limited. The key gaps include lack of site specific data on heavy metal concentrations; limited understanding of bioaccumulation and transfer factor in rice crops and insufficient assessment of human health risk in the study area.

The aim of this research was to assess levels of Cd, Fe and Pb from soils of farmlands within Ejule-Onu rice mill.

MATERIALS AND METHODS

Chemical and Reagents

Reagents such as concentrated HCl, and HNO₃ used were of analytical grade supplied by British drug house (BDH), May and Baker (M and B) unless otherwise stated. All working samples were prepared using appropriate reagents [6]

Sample Collection and Preparation

The soil samples were collected for thirty (30) sample sites. Six farmlands of 50, 75, and 100 metres away from the rice mill area and a control site (50, 75 and 100 m apart) very far from the rice mill area from anthropogenic pollution activities. Five random samples in each site were collected using clean stainless trowel of 20 cm depth. The collected soil sub-samples were thoroughly mixed, pooled together to make a composite of each soil sample and unwanted debris removed.

Acid Digestion

The soil sample (1 g) was weighed into 50 ml digestion flask. Analar grade of nitric acid and concentrate hydrochloric acid was used for digestion (aqua regia 1:3), that is 5ml of concentrated HNO₃ and 15 ml of concentrate HCl [6] The digest was filtered through Whatman filter No 42. Each filtrate was collected in 100 ml volumetric flask and made up to mark with deionized water [6] concentrations of Cd, Cu, Fe and Pb were determined using atomic absorption spectrometer (model AA350WT)

RESULTS AND DISCUSSION

Figures 1 to 4 show the concentrations of heavy metals in farming soils. The concentration of heavy metals decreased in the following order as each farmland's distance from rice mill grew : 50 m > 75 m > 100 m . Concentration of heavy metals in control site was the lowest amongst the studied sites and didn't significantly change depending on distance. There was no discernible pattern in the total amount of heavy metals based on distance in various farmlands for various metals. For Cr, the order was farmland 2 (0.965 mg/kg) > farmland 6 (0.909 mg/kg) > farmland 5 (0.860 mg/kg) > farmland 3 (0.830 mg/kg) > farmland 1 (0.815 mg/kg) > farmland 2 (0.714 mg/kg); for Cd : farmland 1 (1.397 mg/kg) > farmland 3 (1.375 mg/kg) > farmland 2 (1.176

mg/kg) > farmland 6 (1.136 mg/kg) > farmland 5 (1.105 mg/kg) > farmland 4 (0.888 mg/kg); for Pb, : farmland 2 (0.293 mg/kg) > farmland 5 (0.280 mg/kg) > farmland 4 (0.275 mg/kg) > farmland 1 (0.229 mg/kg) > farmland 3 (0.224 mg/kg) > farmland 6 (0.218 mg/kg) and for Fe, : farmland 4 (2.554 mg/kg) > farmland 1 (2.426 mg/kg) > farmland 2 (2.317 mg/kg) > farmland 6 (2.283 mg/kg) > farmland 5 (2.221 mg/kg) > farmland 4 (2.159 mg/kg). The concentration of heavy metals in the soil were compared with [7, 8] maximum permissible limit of 0.480 mg/kg but the rest of the studied metals were below FAO/WHO and USEPA standard [7, 8].

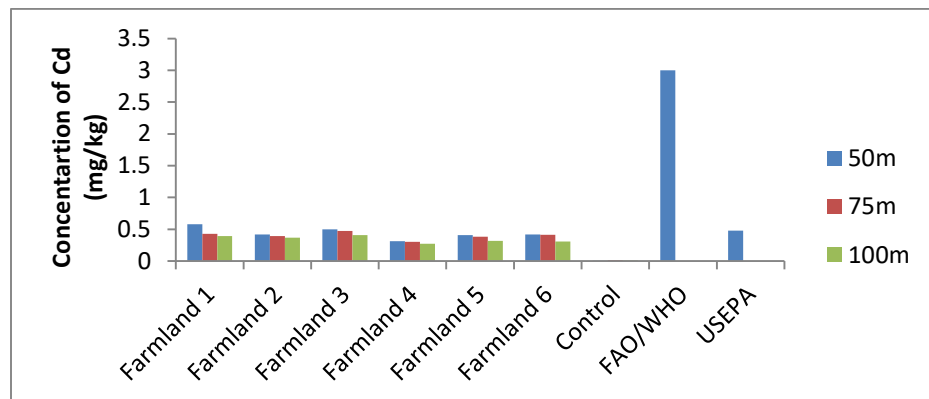


Figure 1: Concentrations of Cd in Farmlands

Table 1: Concentrations of Cd in Farmlands

	Farmland 1	Farmland 2	Farmland 3	Farmland 4	Farmland 5	Farmland 6	Control	FAO/WHO	USEPA
50 m	0.576	0.418	0.5	0.314	0.406	0.417	0.004	3	0.48
75 m	0.43	0.391	0.472	0.301	0.381	0.411	0.013		
100 m	0.391	0.367	0.407	0.273	0.318	0.308	0.009		

Regardless of a specific farm land, the Cd concentrations shown in Figure 1 and Table 1 ranged from 0.004 – 0576 mg/kg. the mean concentration of Cd from the six farmland was 1.180 mg/kg. this was higher than 1.141 reported by Augustine et al [12], 0.068 mg/kg by Muhammed et al [9] but lower than 3.88 obtained by Tian et al [10].

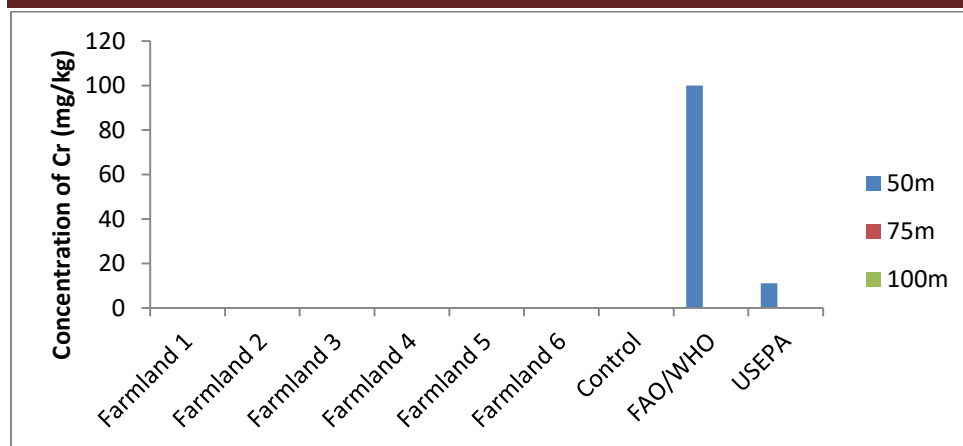


Figure 2: Concentrations of Cr in Farmland

Table 2: Concentrations of Cr in Farmlands

	Farmland 1	Farmland 2	Farmland 3	Farmland 4	Farmland 5	Farmland 6	Control	FAO/WHO	USEPA
50 m	0.3	0.297	0.303	0.346	0.315	0.34	0.011	100	11
75 m	0.274	0.236	0.284	0.317	0.292	0.308	0.014		
100 m	0.241	0.181	0.243	0.302	0.253	0.261	0.006		

The concentration of Cr as given in Figure 2 and Table 2, irrespective of a particular farmland ranged from 0.006 – 0.346 mg/kg. the mean concentration of Cr from six farmlands was 0.848 ma/kg. This was higher than 0.555 mg/kg obtained by Augustine et al [12] but lower than 2.59 mg/kg [11] and 153. 33 mg/kg by [10]

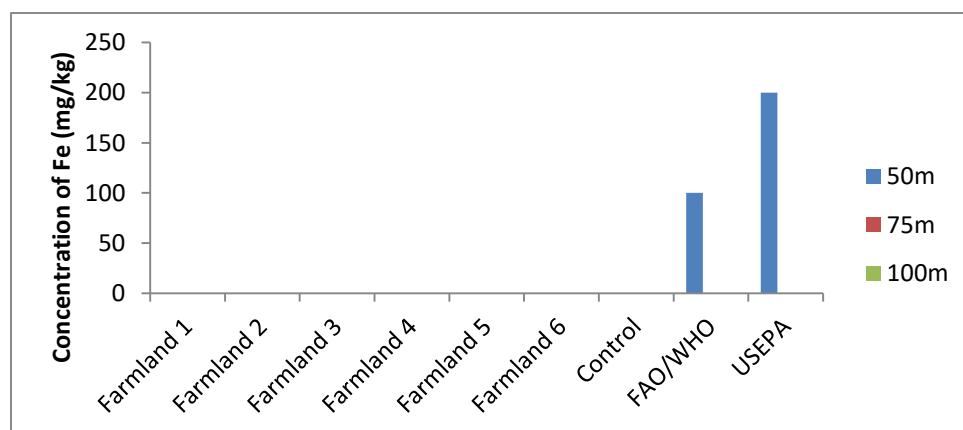


Figure 3: Concentrations of Fe in Farmlands

Table 3: Concentrations of Fe in Farmlands

	Farmland 1	Farmland 2	Farmland 3	Farmland 4	Farmland 5	Farmland 6	Control	FAO/WHO	USEPA
50m	0.1	0.116	0.097	0.1	0.105	0.099	0.003	100	200
75m	0.078	0.099	0.081	0.097	0.098	0.083	0.008		
100m	0.051	0.078	0.046	0.078	0.077	0.036	0.005		

The concentration of Fe as given in Figure 3 and Table 3 irrespective of a particular farmland ranged from 0.381 – 0.918 mg/kg. The mean concentration of Fe was 2.525 mg/kg and was higher than 2.427 mg/kg obtained by Augustine et al. [12].

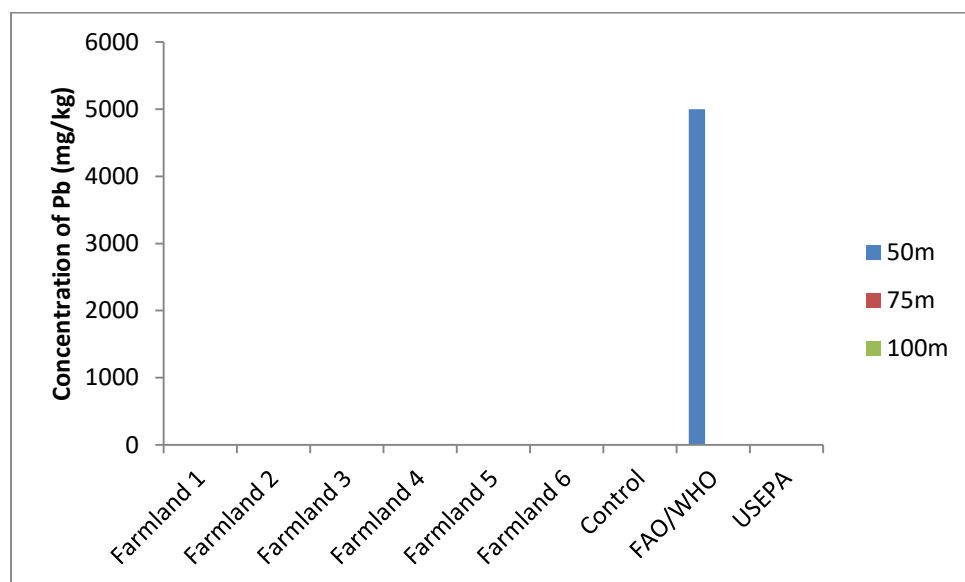


Figure 4: Concentrations of Pb in Farmlands

Table 4: Concentrations of Pb in Farmlands

	Farmland 1	Farmland 2	Farmland 3	Farmland 4	Farmland 5	Farmland 6	Control	FAO/WHO	USEPA
50m	0.918	0.9	0.766	0.9	0.877	0.817	0.416	5000	0
75m	0.808	0.8	0.703	0.808	0.716	0.766	0.392		
100m	0.7	0.617	0.69	0.746	0.628	0.7	0.381		

The concentrations of Pb as given in Figure 4 and Table 4 irrespective of a particular farmland ranged from 0.003 – 0.116 mg/kg. The mean concentration of Pb was 0.253 mg/kg. This was similar to the results obtained by Augustine et al [12].

CONCLUSION

Except for Cd which was 0.576 mg/kg greater than the US EPA (2020) standard maximum permitted limit of 0.480 mg/kg, all the other heavy metals under study were below the FAO/WHO and USEPA maximum permissible limits. To track the buildup of heavy metals in soil, the study area should routinely be investigated because it will assist in determining when to reduce levels of these heavy metals in agricultural soil. It can be concluded that the levels of Cd, Fe and Pb from soils of farmlands within Ejule-Onu rice mill were assessed and Cd was discovered to pose immediate danger, necessary steps are need by environmental policy makers to be taken to ameliorate the situation

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