

MEASUREMENT OF ACTIVITY CONCENTRATIONS OF NATURAL RADIONUCLIDES IN THE TOP SOIL OF UNIVERSITY OF AGRICULTURE, ABEOKUTA, (UNAAB) FARMS

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ABSTRACT

The natural radioactivity levels in the soils of University of Agriculture Abeokuta farms were measured. 20 soil samples were collected to a depth of about 10cm in twelve different farmlands within UNAAB community. The average activity concentrations obtained for the three radionuclides were 520.13 ± 32.06 Bq/kg for ^{40}K , 33.66 ± 23.27 Bq/kg for ^{238}U and 49.83 ± 15.61 Bq/kg for ^{232}Th , respectively. The distributions of these radionuclides were found to be uneven. The value of Uranium-238 was the same at locations 4 and 16 but not detectable at locations 9 and 11, respectively. The average values of the absorbed dose rates in air of each radionuclides were found to be 21.84 nGy/hr for ^{40}K , 14.99 nGy/hr for ^{238}U and 33.19 nGy/hr for ^{232}Th . The baseline average outdoor annual effective dose equivalent in UNAAB farms due to the radioactivity concentrations was found to be 86.92 ± 28.37 mSv/yr. This value can be taken as representing the baseline values of natural radioactivity as no artificial radionuclide was detected at any of the locations visited.

Keywords: Top Soil Samples, Baseline, Activity, Radionuclides

INTRODUCTION

Uranium and radium belong to the group of primordial radionuclides, as they have always been present in the earth. The radionuclides ^{238}U , ^{235}U and ^{232}Th , which decay through three distinct series of radionuclides, are of great importance in the nuclear fuel cycle. Not only are they present in the human body and foodstuffs but some gaseous radionuclides may also be inhaled for example ^{226}Ra , ^{224}Ra and ^{228}Ra (half lives 3.6 days and 5.8 years, respectively), which are usually mixed with uranium ore are of radiological importance because radium behaves chemically like calcium, being depos-

ited on bone surfaces and areas of mineral metabolism (Evans 1974; Bakac, 2003).

There are also certain critical ecosystems, in which the release of radionuclides could lead to particularly high doses. Above all, this can be expected in ecosystems that tend to accumulate different types of material, such as sediments, wetlands and peat lands. However, the radiation dose will not only depend on how much radioactivity that is accumulated, but also on what the exposure pathways are. Since peat lands can be used as source of fuel or for agricultural purposes, peat lands are considered to be one of the most critical ecosystems for the exposure to

man. In the safety assessment project mires were identified as the ecosystem that potentially could cause the highest doses to man (SKB, 1999).

In this paper, measurements of uranium, radium and gamma activity of UNAAB farm area were determined. The aim was to determine the level of natural radioactivity of the farm and determine whether this radiation constitutes any danger to health. NaI (T₁) scintillation detector coupled with a Camberra series 10 plus MCA was used as the detecting device for the gamma scintillation spectroscopy.

Experimental

Soil Samples Collection

The University of Agriculture, Abeokuta (UNAAB) has many farmlands within the community. The UNAAB farms covered for the purpose of this work were that of farm practice year farm (FPY farm), oil palm farm at the main gate of the school campus, cashew farm, BYS farm along University mosque, yam farm along staff's quarter way, food research farm, FADAMA farm, cassava farm behind senate building, livestock farm, lost crop garden, work and service farm and forest nursery land.

Twenty soil samples were collected from each of the farms. Each soil sample was collected in a nylon made of non-radioactive material sealed and labeled to avoid samples been mixed up and contaminated. Each soil sample was dried, ground and sieved under laboratory temperature of 27°C for some days. About 200g of each of the dried, ground soil sample, was put in a plastic container sealed with paper cello tape and kept for over twenty-one days, so that both parent and daughter nuclei would be in a state of equilibrium before measure-

ments were carried out on them.

The Counting Assembly

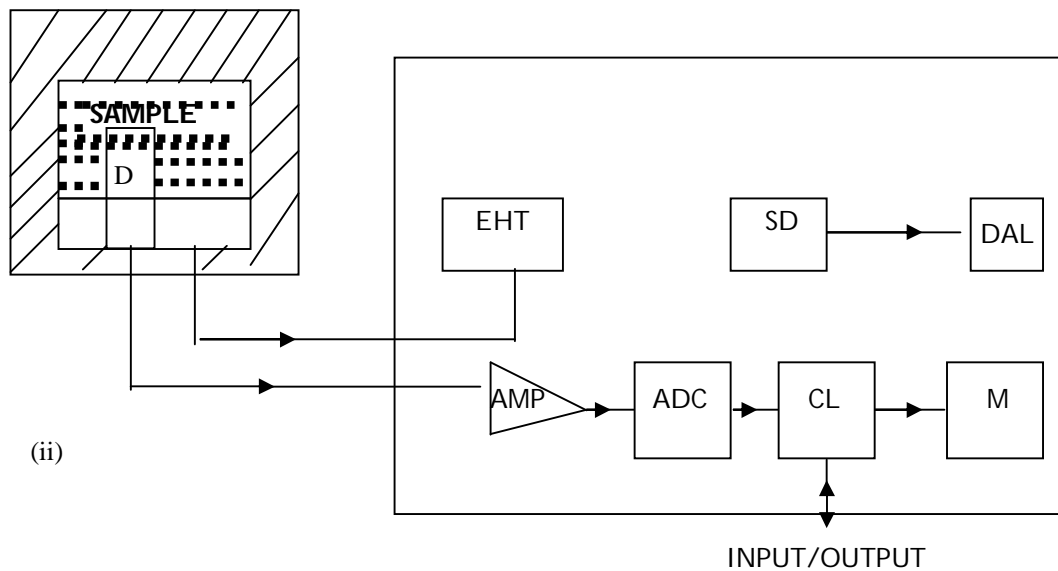
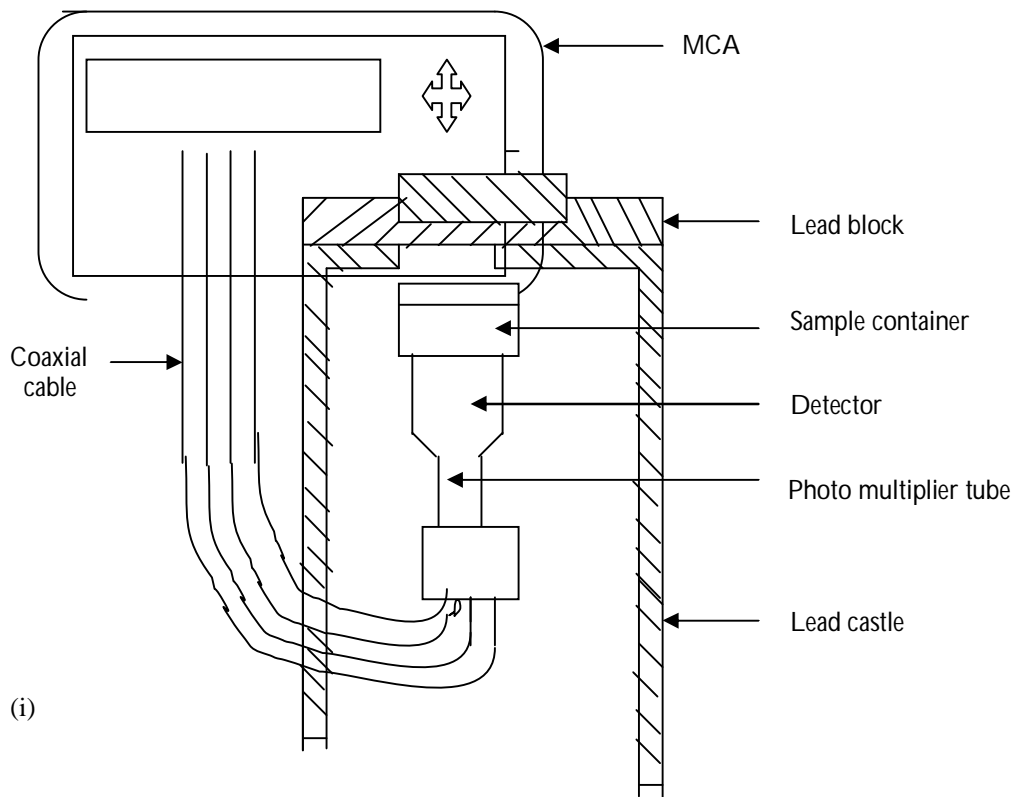
The counting system used in the determination of natural radionuclide contents of the soil samples in Fig. 1, consists of a scintillation detector and a multichannel spectroscopic analyzer (Camberra series 10). A 7.6cm X 7.6cm NaI (T₁) crystal (Model no 802 Series) is the detector D placed in a Lead castle, this detector, is interfaced with the electronic system through 50W coaxial cable. The purpose of the Lead castle was to shield the detector from external background radiation, which can influence readings taken on the multi channel analyzer.

The multi channel analyzer (MCA) electronic system consists of an internal spectroscopic amplifier (AMP), a 100mHz Wilkinson type of Analogue to digital converter (ADC), control logic (Cl) with input and output devices and multichannel scaling input, 4k memory (M), Display and analysis Logic (DAL) and screen Display (SD). The MCA has the facilities to supply a stabilized extra high voltage. The schematic diagram of the counting assembly used to carry out this work is shown in Figures(1) (i) and (ii).

For the purpose of this work, three regions of interest (ROI) were defined on the multichannel analyzer. They were potassium-40, Uranium-238 and Thorium 232. The area under each photo peak was also computed.

Calibration of Equipment

A uniform distribution of the radionuclides was assumed for the purpose of this work, also all daughters including gaseous ²²²Rn and ²²⁰Rn from the ²³⁸U and ²³²Th series respectively were considered to be in equilibrium with their parents and as such, the effects of the gaseous components were not taken into account.



Figs. (i) and (ii) - Schematic diagrams of the Counting Assembly

^{40}K was measured directly via its 1461 KeV peak, while photo peak of ^{214}Bi at 1761 KeV and ^{208}Ti at 2614 KeV were chosen as the gamma transition lines for the measurements of ^{238}U and ^{232}Th , respectively.

Energy Calibration

The equipment was first calibrated using the gamma emitter source of known energies for student laboratory experiments from the nucleus inc.oak Ridge, TN USA to deter-

mine the linear equation relating the gamma energy E with the channel number. The channel number corresponding to the gamma energies are given in Table 1 below.

The linearity of the system used for this work was examined through the plotting of graph of energy in MeV against the channel number using the data in Figure 2 and Table 1.

Table 1: Energy in MeV with corresponding channel number

Source	Energy (MeV)	Channel Number
Na -22	0,511	45
Cs -137	0.662	59
Co -60	1.173	105
Co -60	1.332	120
Na -22	1.275	112
K -40	1.461	127
Bi -214	1.761	143
Th -232	2.614	226

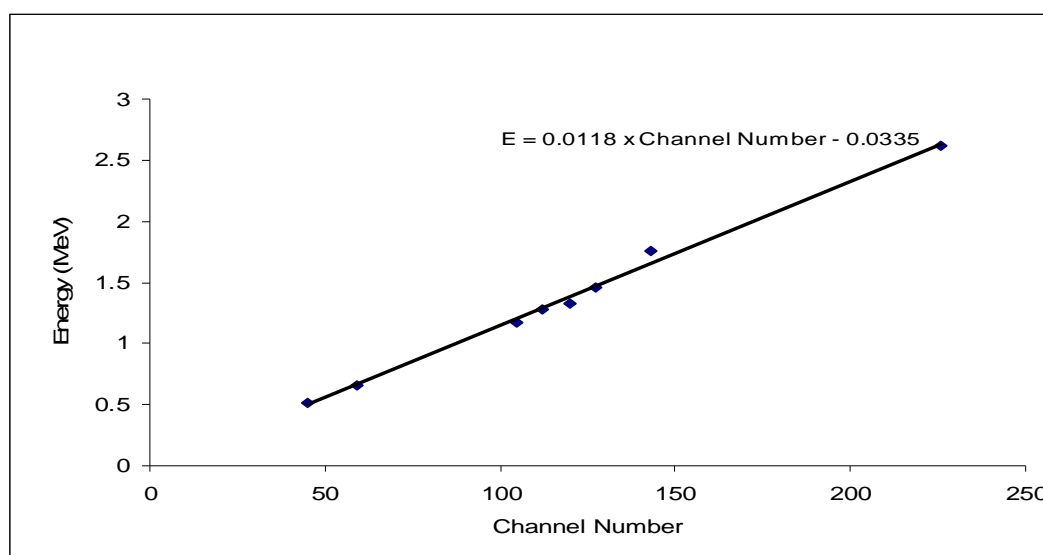


Fig. 2: Energy (MeV) against Channel Number

Measurements Procedure

The gamma ray detection method using NaI (TI) detector coupled to camberra series 10 plus (MCA) was used for this work. Shielding was achieved using camberra 10cm thick lead (Pb) shield. The detector has a resolution of about 8% at 662 KeV of ¹³⁷Caesium. This is capable of distinguishing the gamma ray energies considered during these measurements.

Since the number of pulses displayed under a photo peak is proportional to the intensity of the radiation reaching the detector volume, therefore the radiation source should be placed as close to the detector as possible so that the counting system exhibits high efficiency.

Cylindrical plastic containers (geometry) whose diameters are 7cm were used for the measurement. Three regions of interests (ROI) were created for the purpose of this work using the channel numbers corresponding to their gamma ray energies.

Twenty (20) soil samples of 0.2kg each dried, ground and kept for more than twenty – one days in plastic containers to reach secular equilibrium were placed directly on top of the detector for counting. The counting time was set at 7200 seconds (2 hours), this time was long enough for the detector to collect a spectrum with the peaks of interest clearly shown and clearly distinguished. The areas under each photo peak were computed using the algorithm of the MCA and they represent the numbers of count for each radioactive nuclei in a given sample. The net area after background counting was related to the radioactivity concentration of each radionuclide.

The background radiation due to the natu-

rally occurring radionuclides in the environment around the detector was measured by using an empty plastic container, the empty plastic container was counted in the same manner as the soil samples and for the same counting time (7200sec) as shown in Table 2.

Necessary settings and adjustments were carried out on the MCA and the radiation count per seconds of each sample above background was obtained in Table 3.

Determination of Radionuclide Concentration In The Soil Samples

The concentration of a given radionuclide in a sample is proportional to the count per second obtained under a gamma photo peak due to that radionuclide. Using the mathematical relationship,

$$C = A \lambda / K \quad \text{.....(1)}$$

where, C is the concentration in Bq/kg and A is the net count per second of samples. K is a constant of proportionality for each radionuclide at constant geometry. The constant, K is determined by the detector efficiency of the assembly. The constant of proportionality for the three radionuclides were calculated using a standard soil sample prepared from Rocket dyne Laboratories, California, USA.

Table 2 below gives the radioactivity concentrations of the certified source 0050 counted for 7200 sec. The Calibration factor for ⁴⁰K, ²³⁸U and ²³²Th were obtained:

$$\begin{aligned} \text{For } ^{40}\text{K}, K_k &= 578.40 \pm 27.30 \\ &= 0.21411 \pm 0.064 \\ &= 2701.42 \pm 150.92 \\ \text{For } ^{238}\text{U}, K_u &= 20.90 \pm 0.92 \\ &= 0.0473 \pm 0.00141 \\ &= 4418.60 \pm 421.039. \\ \text{For } ^{232}\text{Th}, K_{Th} &= 10.47 \pm 0.57 \end{aligned}$$

Table 2: Description of gamma emitter source (standard and the measured radionuclides)

Description	⁴⁰ K (Bq/kg)	²³⁸ U (Bq/kg)	²³² Th (Bq/kg)
Activity concentration of certified standard gamma source.	578.40±27.30	20.90±0.92	10.47±0.57
Area under the photo peak due to background count.	581±24.10	69±8.31	258± 16.1
Count per seconds due to background radiation.	0.08069±0.00335	0.009583±0.001154	0.0358±0.002236
Standard Source plus background count.	2123 ±46.08	103±10.15	440±20.97
Count per seconds due to standard source plus background count.	0.2948±0.0064	0.0143±0.00141	0.0611±0.00291
Count per seconds of standard source minus background count.	0.21441±0.0064	0.00473±0.00141	0.0253±0.00291

Table 3: Radiation Count Per Second of Each Sample Above Background

S/N	LOCATION	⁴⁰ K (cps)	²³⁸ U (cps)	²³² Th (cps)
1	FPY FARM I	0.221±0.00647	0.0159±0.00188	0.106±0.00443
2	FPY FARM II	0.110±0.00515	0.0065±0.00149	0.133±0.00484
3	OIL PALM I	0.118±0.00517	0.0080±0.001	0.166±0.00529
4	OIL PALM II	0.185±0.00608	0.0144±0.00183	0.182±0.0055
5	CASHEW I	0.163±0.00582	0.00181±0.00125	0.067±0.0038
6	CASHEW II	0.190±0.00614	0.0213±0.00207	0.113±0.00456
7	BYS FARM I	0.452±0.00860	0.00138±0.00116	0.0954±0.00427
8	BYS FARM II	0.253±0.00681	0.00167±0.0013	0.072±0.00386
9	FOOD RESEARCH	0.181±0.00603	N.D	0.110±0.00451
10	YAM FARM	0.535±0.00925	0.0039±0.00137	0.191±0.00561
11	FADAMA I	0.093±0.00491	N.D	0.0859±0.00411
12	FADAMA II	0.138±0.0055	0.0072±0.00153	0.172±0.0054
13	CASSAVA FARM	0.058±0.0044	0.0074±0.00153	0.077±0.0039
14	LOST CROP	0.186±0.0060	0.0131±0.00177	0.162±0.0052
15	FOREST (NRY)	0.189±0.0061	0.0104±0.0017	0.149±0.0051
16	W & S FARM I	0.253±0.0068	0.0144±0.0018	0.133±0.0048
17	W & S FARM II	0.279±0.0071	0.0107±0.0017	0.095±0.0043
18	LIVESTOCK (F) I	0.037±0.0040	0.00528±0.0014	0.0755±0.0039
19	LIVESTOCK (F) II	0.074±0.0046	0.00583±0.0015	0.115±0.0046
20	LIVESTOCK (F) III	0.135±0.0055	0.0044±0.0014	0.108±0.0045.

N.D:- This means not detected. This is for location where the value obtained for area under the photo peak due to soil sample plus background for ²³⁸U is less than area under the photo peak due to background only.

$$0.0253 \pm 0.00291$$

$$= 413.83 \pm 52.659.$$

All the calibration factors K_k , K_u and K_{th} were used to multiply the net area under the photo peak to get the corresponding activity concentrations of ^{40}K , ^{238}U and ^{232}Th in the soil samples. Table 4 gives the concentrations of the radionuclides for each soil sample in Bq/kg.

Determination of Gamma Absorbed Dose Rate

The gamma absorbed dose rate in air can be calculated using the Beck et al (1972), Jibirin and Farai (1998) equations given as $D = 0.042 S_k + 0.429 S_u + 0.666 S_{th} \dots (2)$, where D is the total absorbed dose in air due to the specific activity concentration S_k , S_u and S_{th} in Bq/kg, respectively. D is measured in nGy hr⁻¹. The absorbed dose rate in air due to each radionuclide at each collection site was calculated using the equation above. The values obtained are presented in Table 5.

Outdoor Annual Effective Dose Equivalent In University of Agriculture Abeokuta Farm

The absorbed gamma dose rates in air are usually related to human absorbed dose in order to assess the effectiveness of the gamma dose in causing damage to human tissues. One can make an assessment of the outdoor effective dose equivalent to the population by considering two factors. The first is a conversion factor which converts the absorbed dose rate in air to human effective dose equivalent while the second factor gives a measure of the proportion of the total time for which an individual is exposed to a radiation field either indoors or outdoors. The United National Scientific Committee on Effect of Atomic Radiation (UNSCEAR), has recommended 0.7 Sv/yr as the value of the first factor and 0.2 as the outdoor occupancy factor.

The outdoor annual effective dose equivalents obtained for the samples are presented in Table 6.

Table 4: Activity Concentration of Radionuclides For Each Soil Sample

S/N	LOCATION	^{40}K (Bq/kg)	^{238}U (Bq/kg)	^{232}Th (Bq/kg)
1	FPY FARM I	597.01±37.66	70.26±10.68	43.87±5.88
2	FPY FARM II	297.16±1.58	28.72±7.15	55.04±0.96
3	OIL PALM I	318.76±20.66	35.57±7.70	68.69±1.18
4	OIL PALM II	499.76±32.39	63.63±26.23	75.32±9.85
5	CASHEW I	440.33±29.19	7.997±6.71	27.77±3.86
6	CASHEW II	513.27±33.12	94.12±12.81	46.76±6.24
7	BYS FARM I	1221.04±72.06	0.609±5.13	39.47±9.74
8	BYS FARM II	683.46±22.73	7.380±5.56	29.63±0.57
9	FOOD RESEARCH	488.95±31.79	N.D	45.52±6.08
10	YAM FARM	1445.2±84.50	17.14±6.26	79.04±10.32
11	FADAMA I	251.77±1.48	N.D	35.55±4.83
12	FADAMA II	372.79±25.61	31.90±7.40	71.18±9.33
13	CASSAVA FARM	158.30±14.82	32.52±7.45	32.15±4.41
14	LOST CROP	502.46±32.53	57.88±21.99	67.04±1.16
15	FOREST (NRY)	510.57±32.67	45.95±8.56	61.66±8.12
16	W & S FARM I	683.46±42.37	63.63±10.09	55.04±7.28
17	W & S FARM II	753.69±46.24	47.28±8.68	39.36±0.72
18	LIVESTOCK (F) I	99.14±12.26	23.33±6.72	31.24±4.29
19	LIVESTOCK (F) II	200.72±16.82	25.76±6.91	47.59±6.34
20	LIVESTOCK (F) III	364.69±25.19	19.62±6.49	44.69±5.98

Table 5: Gamma Absorbed Dose Rate Due To Each Radionuclide

S/N	LOCATION	^{40}K (nGy/hr)	^{238}U (nGy/hr)	^{232}Th (nGy/hr)	TOTAL DOSE (nGy/hr)
1	FPY FARM I	25.07	30.14	29.22	84.43
2	FPY FARM II	12.48	13.32	36.66	61.46
3	OIL PALM I	13.39	15.26	45.75	74.39
4	OIL PALM II	20.99	27.29	50.16	98.44
5	CASHEW I	18.49	3.43	18.49	40.42
6	CASHEW II	21.56	40.38	31.14	93.08
7	BYS FARM I	51.28	0.26	26.29	77.83
8	BYS FARM II	28.71	3.17	19.73	79.60
9	FOOD RESEARCH	20.54	N.D	30.32	50.85
10	YAM FARM	60.69	7.35	52.64	120.69
11	FADAMA I	10.57	N.D	23.68	34.25
12	FADAMA II	15.66	13.68	47.41	76.75
13	CASSAVAFARM	6.65	13.95	21.41	42.01
14	LOST CROP	21.10	24.83	44.65	90.58
15	FOREST (NRY)	21.44	19.71	41.07	82.22
16	W & S FARM I	28.71	27.29	36.66	92.66
17	W & S FARM II	31.65	20.28	26.21	78.15
18	LIVESTOCK (F) I	4.16	10.00	20.81	34.98
19	LIVESTOCK (F) II	8.43	11.05	31.69	51.18
20	LIVESTOCK (F) III	15.32	8.42	29.76	53.49

Table 6: Outdoor annual effective dose equivalent for each soil sample and their locations

S/N	LOCATIONS	N(degrees)	E(degrees)	Dose Equiv.($\mu\text{Sv}/\text{yr}$)
1	FPY FARM I	7.22525	3.42578	103.45
2	FPY FARM II	7.22478	3.42889	75.37
3	OIL PALM I	7.22566	3.45133	91.23
4	OIL PALM II	7.2099	3.44245	120.72
5	CASHEW I	7.2257	3.43425	49.57
6	CASHEW II	7.22717	3.43456	114.15
7	BYS FARM I	7.22754	3.44304	95.45
8	BYS FARM II	7.22675	3.4434	97.62
9	FOOD RESEARCH	7.2224	3.43052	62.36
10	YAM FARM	7.22304	3.43038	148.01
11	FADAMA(F) I	7.23471	3.43635	42.01
12	FADAMA(F) II	7.23568	3.43774	94.12
13	CASSAVA FARM	7.2362	3.43745	51.52
14	LOST CROP	7.22748	3.44814	111.08
15	FOREST (NRY)	7.22718	3.4494	100.84
16	W & S FARM I	7.23312	3.44258	113.63
17	W & S FARM II	7.23395	3.44894	95.85
18	LIVESTOCK (F) I	7.22282	3.42481	42.89
19	LIVESTOCK (F) II	7.22444	3.42461	62.76
20	LIVESTOCK (F) III	7.22564	3.42458	65.6

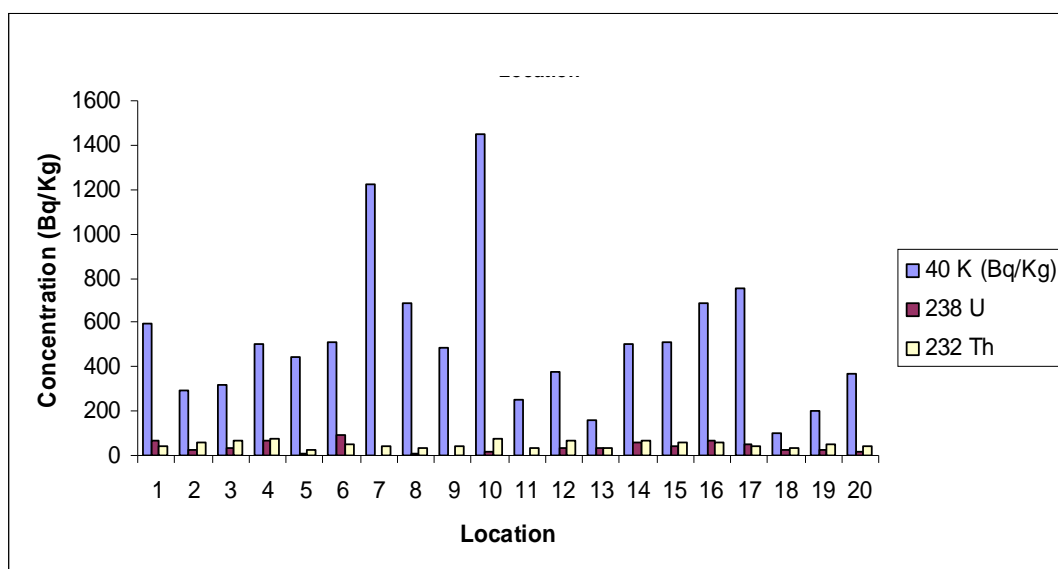


Fig. 3: Histogram Showing Concentration (Bq/Kg) of the Radionuclides Against Location

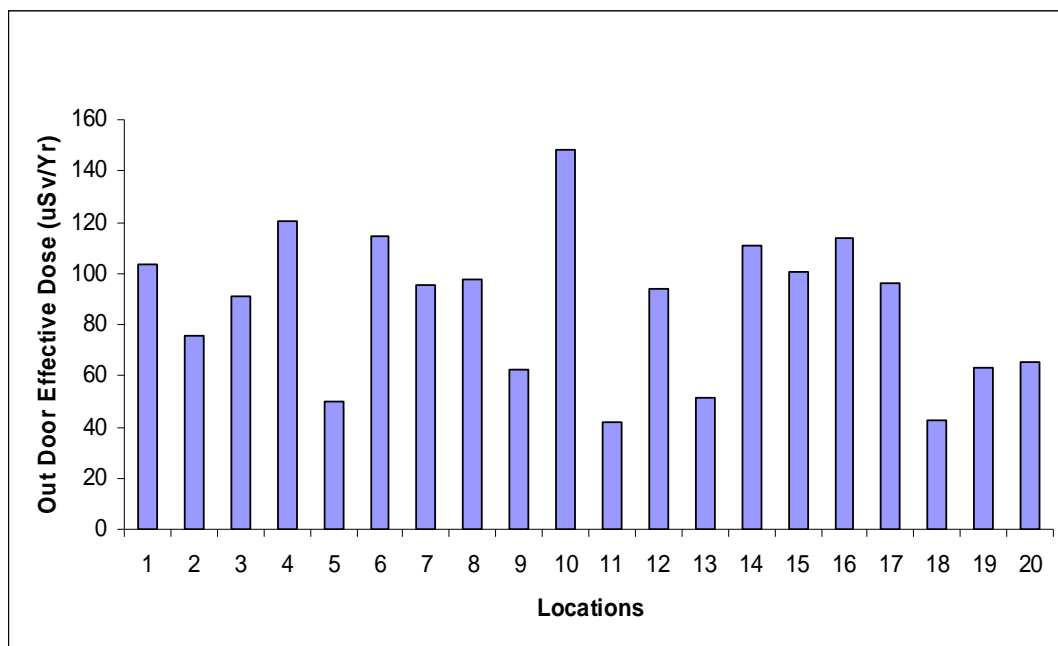


Fig. 4: Bar Chart Showing Effective Dose Equipment (US/Yr) Against Location

DISCUSSION

Environmental radioactivity measurement is usually based on the evaluation of radionuclide distribution in the soil. In this work, the three primordial radionuclides ^{40}K , ^{238}U , and ^{232}Th were detected and measured in twenty soil samples collected from different farmland locations within University of Agriculture, Abeokuta campus. No artificial radionuclide was detected in any of the samples. This indicates that the environment has not been contaminated by radioactive pollutions. In the natural environment, the intensities of gamma radiations of terrestrial origin are strongly influenced by local geology, and other modifying factors in the environment such as soil utilization pattern, population density, extent of rainfall and so on.

The concentrations of each radionuclide of ^{40}K , ^{238}U , and ^{232}Th in each soil sample are presented in Table 4. From this, it could be seen that ^{40}K had the highest value of concentration in Bq kg^{-1} out of the three radionuclides in the 20 soil samples. This is due to the presence of quartzite rock types within UNAAB campus. Also out of the major and secondary nutrient elements, ^{40}K is usually the most abundant in soil. It could also be due to presence of potassium bearing minerals in soil such as biotite, muscovite, orthoclase, microcline feldspars and so on.

Location with the highest specific activity of ^{40}K , was found at yam farm location along staff Hostel Quarter, (7.22304 °N, 3.43038 °E),

with activity value of $1445.2 \text{ Bq kg}^{-1}$. This could be due to reasons such as well drained soil samples, presence of abundant radioactive minerals such as Smectite, kao-

linite, feldspars and so on. High value of activity of ^{40}K at this location could also be due to the fact that yam, being a tuber crop helped in transforming mica minerals and ensuring high release of exchangeable potassium.

The highest value of ^{238}U concentration was found at location Cashew farm II behind COLNAS building (7.22717 °N, 3.43456 °E), with activity 94.12 Bq kg^{-1} while the highest value of ^{232}Th activities was found at yam farm location along staff quarters (7.22304 °N, 3.43038 °E), with activity 79.04 Bq kg^{-1} . High value of ^{238}U concentration at the Cashew farm II could be due to high presence of Uranium minerals such as Uraninite, Zircon, Sphene, Monazite and so on, it could also be due to high presence of sand fraction in the soil sample (Sand fraction contain Zircon) with moderate silt-sized fractions which increase surface areas of soil and enhance release and availability of Uranium. Yam farm along staff Quarter's also had the highest value of thorium concentration due to presence of abundant radioactive thorium minerals such as monazite, Zircon and Thorianite.

The lowest specific activity of ^{40}K (99.14 Bq/kg) was at livestock (F) I farmland in front of piggery pen (7.22282 °N, 3.42481 °E). This could be due to absence of clay size fractions, which contains mineral calcite/mica, and small content of feldspar in the soil sample. Also farm manure of pig excretory wastes contains high presence of arsenic and copper but low amount of potassium. Location BYS farm I (7.22754 °N, 3.44304 °E), along Staff Quarter (plantain and cassava farm) had the lowest specific activity of uranium (0.609 Bqkg^{-1}) due to small amount of uranium forming minerals in the sample and very low sand size fraction in the sam-

ple. The lowest specific activity of ^{232}Th was 27.77 Bq/kg at Cashew farm I location (7.2257° N, 3.43425 °E), beside main entrance to farm center. The reason for this low activity could be due to low amount of thorium minerals in the sample.

The mean and standard deviation of the radioactive concentrations of the three radio nuclides were found to be 520.13 ± 323.06 Bq/kg for ^{40}K , 33.66 ± 23.27 Bq/kg for ^{238}U and $4.9.83 \pm 15.61$ Bq/kg for ^{232}Th . The range of ^{40}K concentration was found to be 1346.06 Bq/kg, 93.51 Bq/kg for ^{238}U and 51.27 Bq/kg for ^{232}Th .

It was also noticed that the amount of ^{40}K concentration in each soil sample was higher than both ^{238}U and ^{232}Th concentration in each soil sample because potassium is the most abundant elements of all the three primordial radio nuclides in soil, high potassium content could be due to the fact that farm manure, herbicides, fertilizers such as NPK fertilizer, phosphate fertilizer were often used to improve fertility of the soil hence increased the potassium in the soil.

The values of concentration presented in Table iv showed that oil palm farm II (at the south end of oil palm farm at the main gate of the school campus), (7.2099 °N, 3.44245 °E), and work and service farm I (behind petrol station), (7.23312 °N, 3.44258 °E), had the same value of uranium content of value 63.63 Bq/kg⁻¹. It was also seen that the value of ^{238}U concentration was not detected at the farm in front of the food research (7.2224 °N, 3.43052 °E), and commercialization building and in Fadama farm I (Vegetable farm),(7.23471 °N, 3.43635 °E). This could be due to absence of uranium minerals in these soil samples or

very low sand-size fraction of soil in these two locations.

The absorbed dose rate deduced from the distribution of these natural radioactive element varied from one location to the other, see Table 5. The radionuclide that had the highest value of the absorbed dose rate of 60.69 nGy/hr is ^{40}K , followed by ^{232}Th with 52.64 nGy/hr, then ^{238}U with the value 40.38 nGy/hr at yam farm location along staff Quarter road, (7.22304 °N, 3.43038 °E), and at Cashew farm II behind COLNAS building,(7.22717 °N, 3.43456 °E), respectively. The average values of the absorbed dose rate of each radionuclides were found to be 21.84 nGy/hr for ^{40}K , 14.49 nGy/hr for ^{238}U and 33.19 nGy/hr for ^{232}Th .

The range of the absorbed dose rate for ^{40}K , ^{238}U ,and ^{232}Th were 56.53, 40.12 and 34.15, respectively, while their standard deviations were found to be ± 13.56 for ^{40}K , ± 9.96 for ^{238}U and ± 10.39 for ^{232}Th .

The outdoor effective dose equivalent in University of Agriculture, Abeokuta farms visited had its highest value to be 148.01 m Sv/yr and this was found in yam farm location along staff Quarters(7.22304 °N, 3.43038 °E), and the lowest value was found in Fadama I location(7.23471 °N, 3.43635 °E), where, vegetables were planted with the value 42.01 m Sv/yr.

The baseline average outdoor annual effective dose equivalent in UNAAB farms was found to be 86.92 ± 28.37 m Sv/yr. From Table 6, it could be seen that 12 locations had their values higher than this baseline average while only 8 locations had their values below the baseline average.

The baseline of UNAAB farms was found to

be higher than the recommended unit of 70 m Sv/yr which is the world's average outdoor effective dose equivalent (UNSCEAR, 1988) it is the value for the terrestrial habitat. In spite of the fact that some of these data might have been taken from disturbed locations, this study still provides data helpful for future assessments in case of gross contamination in the area in the future. (Arogunjo 2007). The reason for this high value baseline average of the outdoor annual effective dose equivalent in UNAAB farms was due to the fact that UNAAB was situated on elevated natural background area of Abeokuta.

The city of Abeokuta in which UNAAB is located is characterized by extrusive granite rock. The Abeokuta area of southwestern part of Nigeria comprises mainly granite gneisses of varied composition. Biotite granite gneiss occurs as one of the prominent member of the series. This biotite granite gneiss is composed of quartz, microcline plagioclase feldspar and other minerals. (Anthony and Bolanrinwa, 2004)

The high value of the average outdoor annual effective dose equivalent in UNAAB farms supports the fact that soil radioactivity is to a great extent determined by local geology and other modifying factors in the environment.

CONCLUSION

The environmental monitoring of natural background radiation in UNAAB farms using sodium Iodide detector revealed the distribution of the natural radiation level in all the farms visited. From the obtained results, one could see that the distribution was not uniform. Also no artificial radionuclide was detected at any of the farms visited.

The baseline average dose equivalent of UNAAB farms was found to be 86.92 ± 28.37 m Sv/yr. This was higher than the World's Outdoor Value of 70 m Sv/yr specified by UNSCEAR. Although this baseline average value of UNAAB farms was high, it must be remembered that 70 mSv/yr is the world's average while Abeokuta is just a city out of the whole word. The University of Agriculture Abeokuta (UNAAB) farms were just a small point location out of the whole Abeokuta. Thus this high value can be said to be in agreement with the baseline studies of terrestrial outdoor gamma dose rate level in Nigeria in which only Abeokuta (where UNAAB is located) and Jos city had dose rate values which were four order of magnitude higher than the world's average value. Abeokuta city had 273 m Sv/yr while Jos city had 284 mSv/yr as the baseline average dose equivalent (Farai and Jibiri, 2000).

High average dose equivalent is expected in places with many outcrops like Abeokuta (UNAAB farms) with expected higher concentrations of primordial radionuclides and presence of abundant radioactive minerals.

Therefore, for all practical purposes, the value obtained in this study for UNAAB farms can be taken to represent the baseline of natural radioactivity in the area. This baseline value provides the essential yardstick for evaluating the extent of any pollution in the UNAAB farm environment due to any future accidental release of radio nuclides.

The baseline level can be kept constant by keeping the environment free of radioactive pollution or wastes and making a proper disposal of radioactive sources. This baseline can still serve as a check and balance for the UNAAB farms.

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