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A Participatory Soil Research to Assess Geothermal Impacts: A Case Study in Eburru Area

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ABSTRACT

The Eburru geothermal field is located within Eburru forest, which forms parts of the Mau escarpment. The 2.4 MW Eburru geothermal power plant was commissioned in January 2012. Until July 2018, the power plant has had challenges including frequent tripping of the distribution line and mechanical breakdown. Vertical discharge process was mainly applied to resuscitate the well, resulting in discharge of geothermal fluid comprising of silica and other brine constituents to the environment. On several occasions, the neighbouring farmers complained of crop damage as result of operation of the geothermal plant.

Further, in the year 2017 a number of farmers in the plant vicinity complained of low crop yield, attributing it to soil pollution. The farmers attributed the soil degradation to geothermal activities in the area. A participatory research with Eburru farmers, Ministry of Agriculture, Kenya Plant Health Inspectorate Services was initiated to address the concern. The research set up entailed soil sampling in the vicinity of the power station to the North, East, Northeast and South of the power station, soil sampling at the reference points, mapping and analyzing the samples.

The laboratory results indicated high soil pH, and pronounced deficiency in Nitrogen and Phosphorous.

1. INTRODUCTION

The Kenya Electricity Generating Company PLC (KenGen) currently generates approximately 60% of the national electricity. The generation mix includes hydro, wind, thermal and geothermal sources. In the Kenyan Rift Valley, KenGen focusses on generating power from the geothermal resources. Currently the company has an installed capacity of 620.5MW of geothermal power. In Eburru, the Company operates a 2.4 MW wellhead power plant, which is shown in Figure 1. At Eburru geothermal field, KenGen drilled six geothermal exploration wells in the 1990s. One of these wells has a bottom hole temperature of 270°C and serves as the production well for the wellhead power plant which was commissioned in December 2012 (Barasa P, Eburru 60MW ESIA report, 2012).

Figure 1: Photo of Eburru 2.4 MW Geothermal Wellhead Power Plant

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The power plant is surrounded by the forest to the South, West, North West, Southwest and community farms to the North, Northeast, East and South**.** Since its commissioning in 2012 until July 2017, the power plant experienced challenges including frequent tripping of the distribution line and mechanical breakdown. Until July 2017, to resuscitate the well after a prolonged shut down of the plant, a vertical discharge used to be carried out for an extended period of time to off load the water column. As a result the farming community on several occasions were compensated due to silica effect on the crops. The main complaints were from the community to the North of the well head plant, which is in the prevailing wind direction. To address the farmers' complaints and as part of the plant improvement techniques, a larger separator and silencer were installed in July 2017. The modification has reduced plant down time due to minimized brine carryover to the plant and reduced the farmers' complaints as the vertical discharge process is no longer applied.

2. LOCATION OF EBURRU GEOTHERMAL FIELD

Eburru geothermal field lies in Eburru sub-location, Eburru location, Gilgil Division, Gilgil Sub County in Nakuru County as shown in Figure 2 below. In Gilgil sub county, Eburru area has the highest potential in agricultural productivity since it falls under UH2/3 agro-ecological zones i.e. pyrethrum, dairy, maize and wheat agro-ecological zone. The area is very productive and it is considered one of the food baskets of Gilgil Sub County.

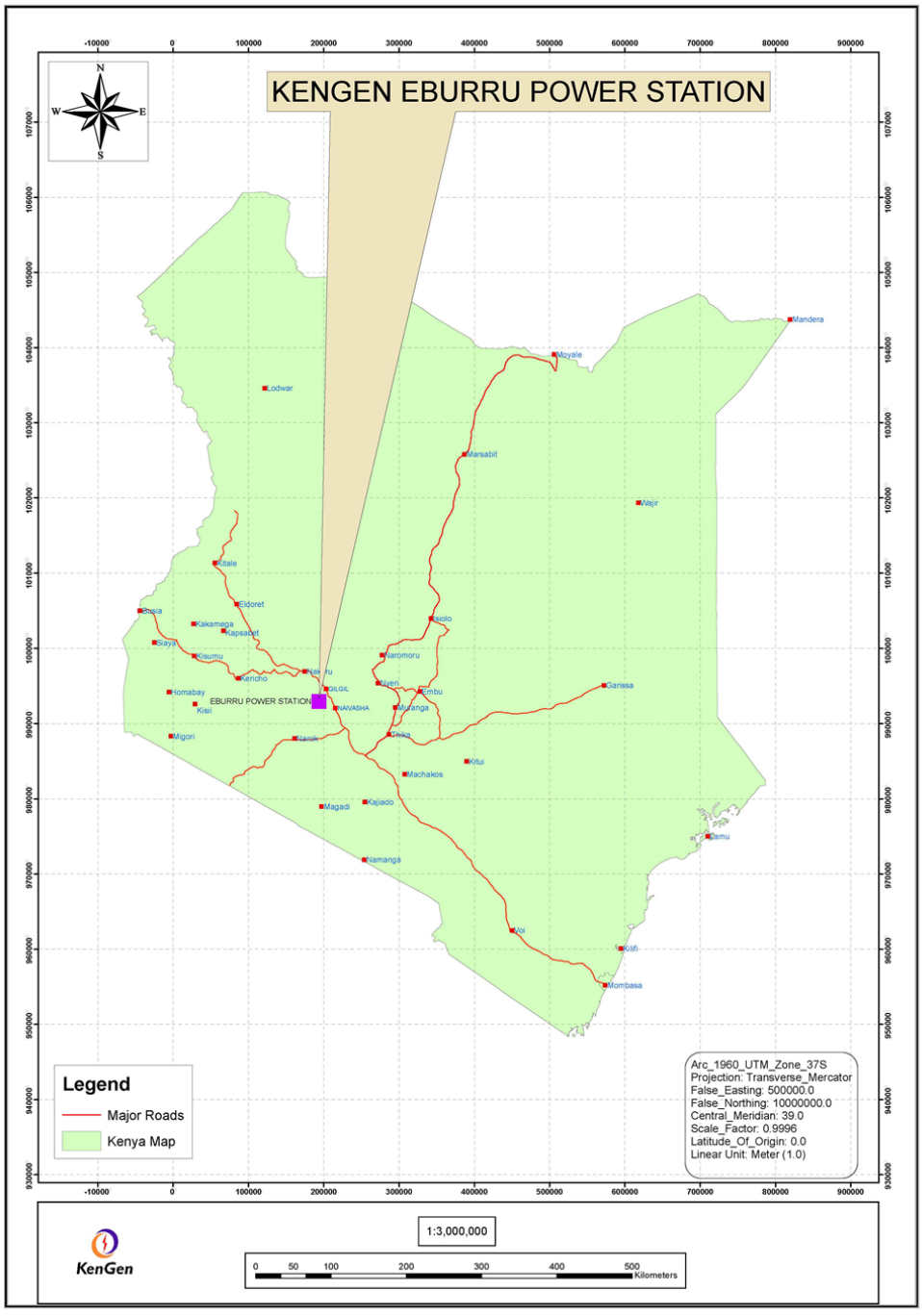

Figure 2 Study area map

2.1 Research setup

The local community, Sub County Agricultural Officer and KenGen set up a soil survey research, where soil samples were collected to the North, Northeast, East and South on the compass directions where farming was being carried out. Five composite soil samples in each of the above listed directions located at intervals of 150 m, 350 m, 550 m, 950 m and 1,350 m from well EW-01 were collected. Thus a total of 21 samples were collected including one control station set 3000 m Southeast of well EW-01.

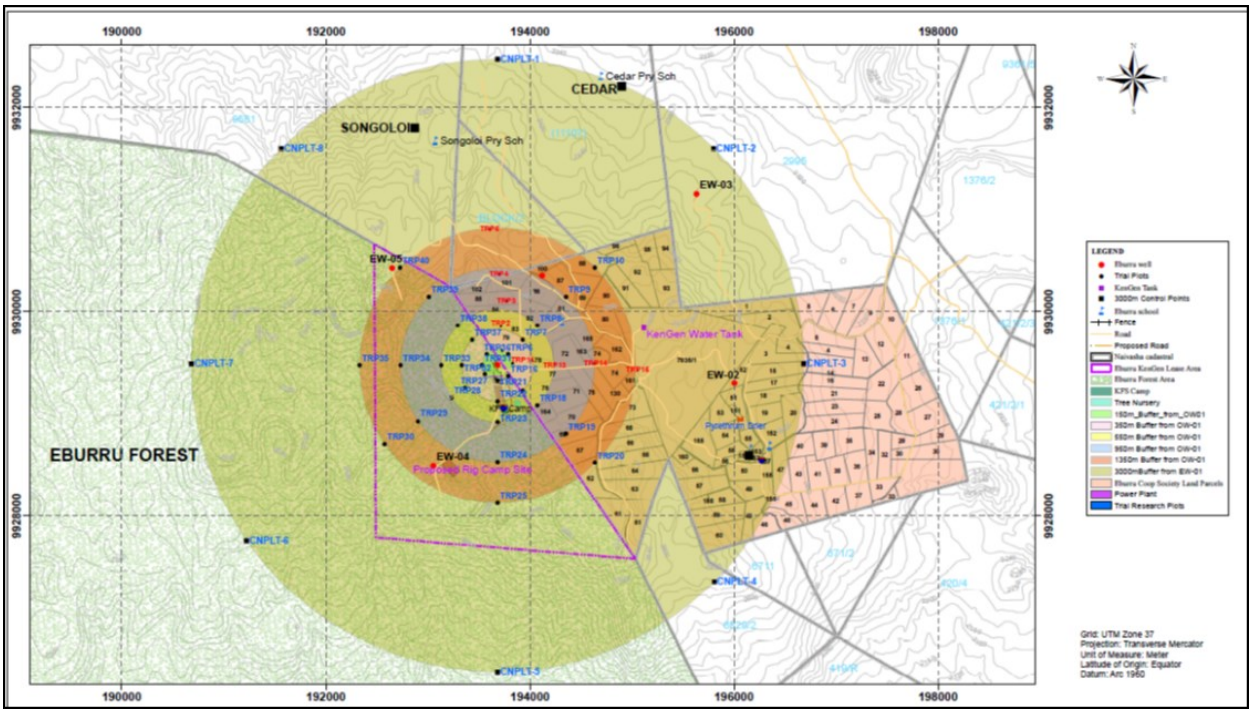

Figure 3: Location of Eburru soil research plots map

2.1.1 Results

As shown in Figure 4 below, the soil nitrogen levels were mainly low ranging from 0.13% for a plot 150 m north to 0.68% to a plot 1350 south of the wellhead. The phosphorus level (Figure 5) were mainly within acceptable limit ranging from 19.37 ppm 550 m south to 55.07 at the control station, 3 km southeast of the wellhead. As depicted in Figure 6 below, the soil pH was mainly acidic with the pH ranging from 4.41 for a plot 550 east of the wellhead to 6.87 for a plot 150 m north of the wellhead. The acidic nature of the soil was attributed to overuse of acidic fertilizers such as Ammonium Phosphate Fertilizer (DAP).

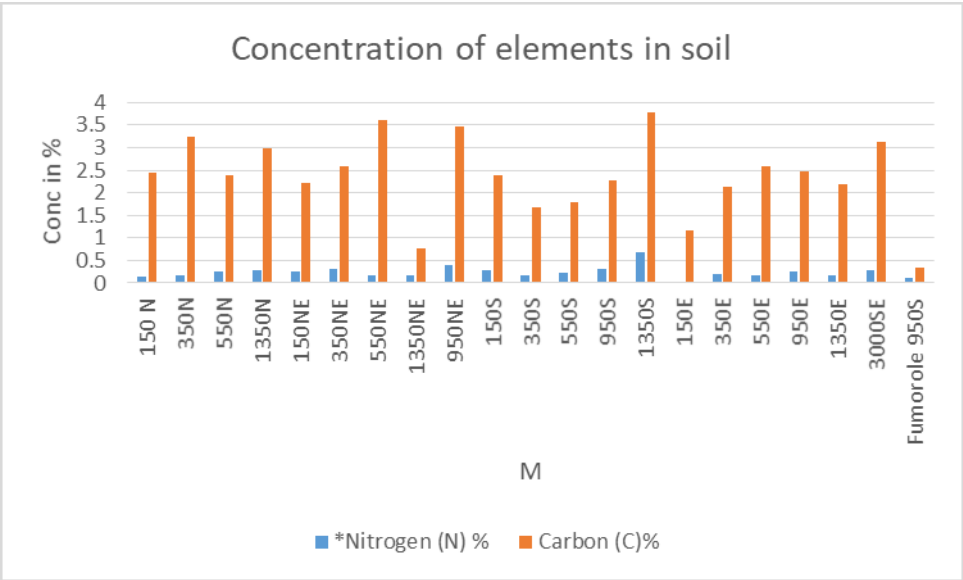

Figure 4: Concentration of Soil nitrogen and carbon in percentage

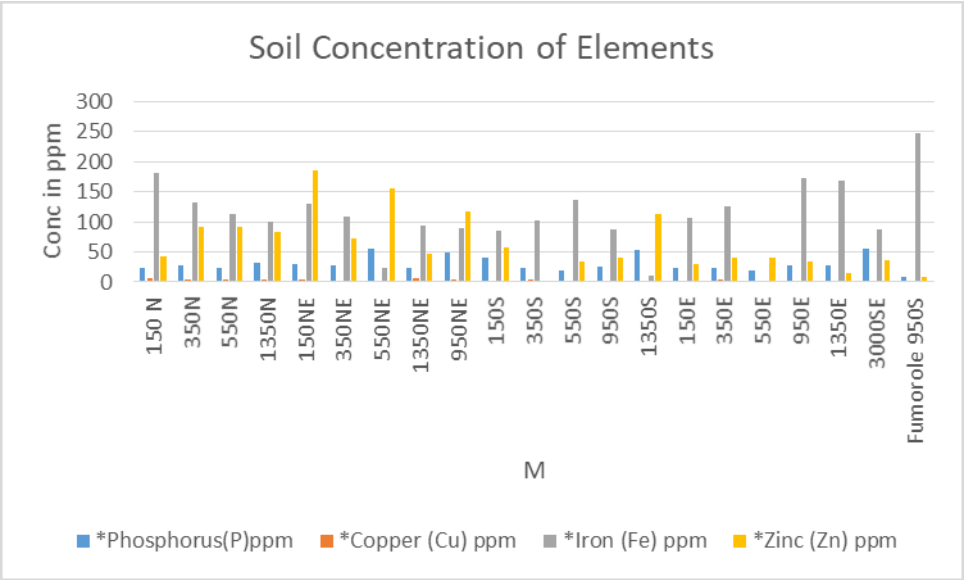

Figure 5: Soil elements concentration

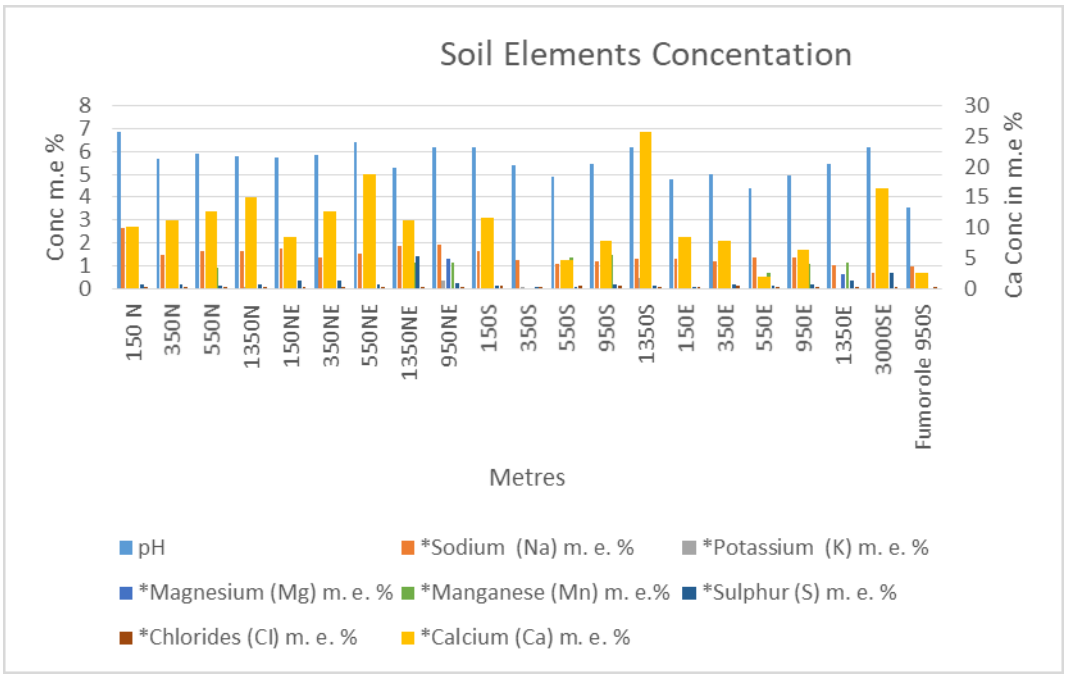

Figure 6: Soil pH and other elements concentration

As per Figure 7 below, the lead concentration ranged from 20.55 mg/kg at 1350 m south and 50.56 for a fumarole 550 m northeast of the wellhead. For the Boron concentration ranged from 6.12 mg/kg at 1350 m northeast to18.2 mg/kg 1350 m south of the wellhead. As per Figure 8 below, mercury concentration ranged from 0.09 mg/kg at 250 m north to 3.06mg/kg for a plot 550 m northeast of the wellhead.

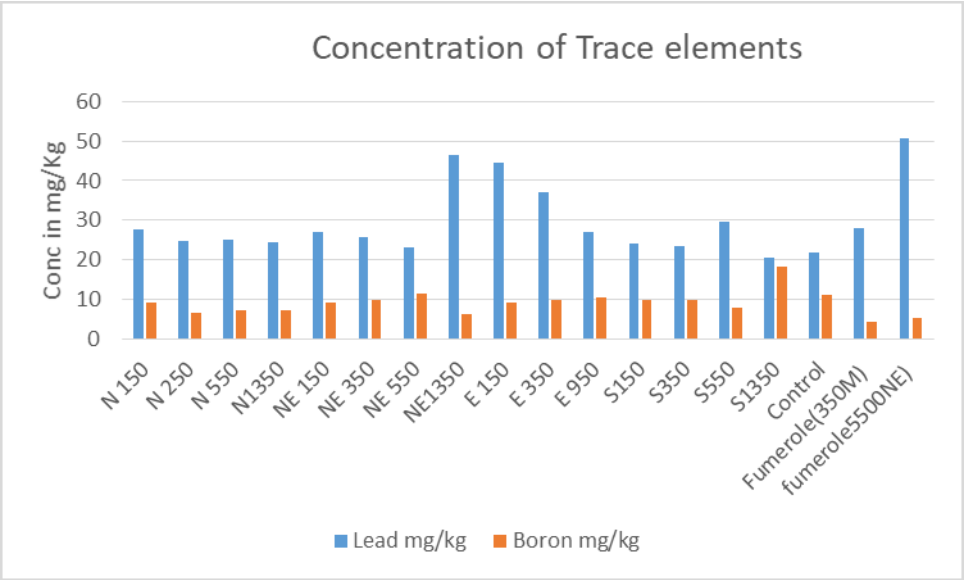

Figure 7: Concentration of Soil Lead and Mercury in mg/kg

Figure 8 below shows that, the cadmium concentration ranged from 0.11 mg/kg at a fumarole 550 m northeast to 50.56 for a plot 1350 s of the wellhead. For the arsenic concentration ranged from 2.93 mg/kg at 1350 m north to 8.26 mg/kg 1350 m northeast of the wellhead. For mercury, the concentration level ranged from 0.09 mg/kg at a farm at 250 m north to 3.06 for a plot 550 m northeast of the wellhead.

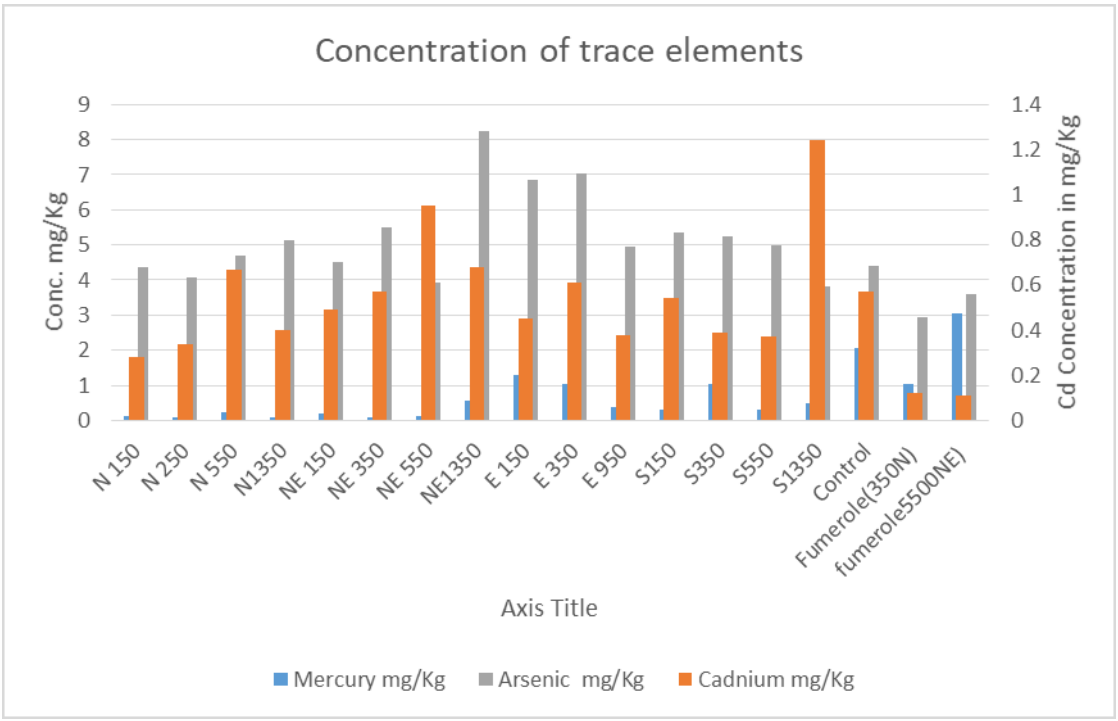

Figure 8: Concentration of Hg, Cd and As in mg/kg

2.1.2 Discussion.

In the research area, the soil pH was found to be mainly acidic, which was attributed to application of acidic fertilizers like DAP. For elements associated with geothermal development such as lead, boron, cadmium, arsenic and mercury there was no evidence of elevated concentrations for farms near the wellheads including the north direction, which is the prevailing wind direction.

For lead, the highest level was recorded from a natural source, which was a fumarole, implying the natural contribution for lead in soil is significant. For the farms that registered high concentration of lead, it was recorded at 150 M and 350 M in the East direction area, which is not located within the prevailing wind direction and also at 1300 NE which is a quite far from the wellhead.

For boron, the highest concentration was recorded at 1350 m south of the wellhead. Similarly, the highest concentration of mercury was recorded at 550 northeast of the power plant.

From the findings there was no evidence of elevated concentration of elements near the wellhead and neither was there any evidence for marked elevation of elements in the prevailing wind direction.

The major finding from the study was that the soils within the study area were mainly moderately acidic to acidic. Similarly the nitrogen was noted to be at moderate to low levels.

The acidic nature of the soil was attributed to continuous use of inorganic fertilizer mainly Diammonnium Phosphate Fertilizer. On the other hand the low levels of nitrogen can be attributed to leaching of the nutrient beyond the root system as the soils in the study area are porous and the area receives rainfall almost throughout the year. From the above background, the farmers may experience low yield since the acidic soils affects crop root formation and leaves implying nutrients uptake may be compromised as well as crop yield due to low photosynthesis rate.

3. CONCLUSION

- The acidic nature of the soil may reduce crop yield since the acidic soils affects crop root formation and leaves, implying nutrients uptake may be compromised as well as crop yield due to low photosynthesis.
- To address the farmers' perception about geothermal impacts there is a need to educate farmers on soil management and crop husbandry.
- A written grievance mechanism needs to be developed in collaboration with the local community and disclosed.
- The next phase of research needs to incorporate analysis of food grown in the area.
- On the other hand, on short term measures KenGen needs to create awareness on the process improvements undertaken on the plants to ensure minimal impacts on the farmers while long term measures should be to create a buffer between the farming community and the well head by procuring farms in the vicinity of the plant.

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