UNIVERSITY OF NAIROBI

EFFECTS OF LONG TERM USE OF INORGANIC FERTILIZERS ON ACCUMULATION OF SELECTED HEAVY METALS AND PRIMARY MACRONUTRIENTS ON MAIZE FARM SOILS: CASE STUDY OF KERITA FARM IN TRANS NZIOA COUNTY, KENYA.

BY

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DECLARATION

I declare that this this thesis is my original work and has not been submitted elsewhere for examination, award of a degree or publication. Where other people's work or my own work has been used, this has probably been acknowledged and referenced in accordance with the University of Nairobi's requirements.

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This thesis is dedicated to the late Michael Mithika

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ABSTRACT

Concern has been raised by researchers over toxic heavy metals which enter the human and animal food chain as a result of application of inorganic fertilizers for food production. The presence of heavy metals in some inorganic fertilizers has raised fears that long term use of these fertilizers could lead to accumulation of these metals to toxic levels that may eventually exceed natural levels in soils. Environmental problems related to fertilizers such as eutrophication, together with their potential bioaccumulation in the food chain have also been of concern. The aim of this research was to analyse and document the effect of long term use of inorganic fertilizers on the accumulation of selected heavy metals and macro-nutrients on maize farm soils in Trans Nzoia.

An Atomic Absorption Spectrophotometer (AAS) was used to determine the concentrations of heavy metals (Cd, Cr, Cu, Pb and Zn) in soil and fertilizer samples. Nitrogen (N), Phosphorus (P) and Potassium (K) in maize farm soils and frequently used fertilizer samples (DAP, Urea and CAN) were determined using Kjeldahl method for nitrogen analysis, UV-visible spectroscopy and flame photometry respectively. Soil characterization was performed to determine the soil pH using pH meter, soil texture using hygrometer method and the Total Organic Carbon using wet chemistry technique. Phosphorus retention capacity was determined using phosphorus adsorption isotherm method.

The study revealed that both the fertilizers and farm soil had significant amounts of chromium, cadmium, lead copper and zinc. DAP fertilizer recorded the highest levels of all the five metals with zinc levels being the highest among the three types of fertilizers as shown: 22.21±0.09 mg/kg, 1.67±0.0.00 mg/kg,16.38±0.06 mg/kg,301.53±0.59 mg/kg and 342.60±0.57 mg/kg for Cu, Cd, Pb, Cr, and Zn respectively. Metal concentrations obtained from the maize farm soils were higher than that of the control site. The mean concentration for Cu, Pb, Cr and Zn in maize farm soils was 8.52±1.56 mg/kg, 37.72±3.44 mg/kg, 42.11±3.25 mg/kg and 29.36±2.74 mg/kg, respectively while the mean concentration for Cu, Pb, Cr and Zn in the control soils was 5.12±0.71 mg/kg, 18.98±0.88 mg/kg, 19.15±1.56 mg/kg and 14.71±0.63 mg/kg respectively. However, the concentration of the toxic elements after long term use of chemical fertilizers did

not exceed the internationally accepted concentration levels such as the USEPA and Department of Agriculture, Forestry and Fisheries (Kenya).

Nitrogen and phosphorus concentrations in major fertilizers investigated in this study were found not to be in agreement with labelled contents reported by manufacturers. The biggest variation was observed in phosphorus in Di-ammonium Phosphate (DAP) fertilizer which had very high concentration of 66.7% above the declared content of range 46 - 54%. The three fertilizers lacked potassium which was in agreement with the declared amount of 0 % on fertilizer label. Phosphorus was found to be sufficient with a mean concentration of 39.33±2.96 ppm above 35 ppm regarded minimum for maize production while Nitrogen and Potassium in maize farm soils were found to be deficient for maize production.

Soil characterization revealed that the maize farm soils had lower pH of 5.034±0.25 compared to that of control site of 6.35±0.21. The pH of both soils was less than 7.0 implying that they were acidic. The Total Organic Carbon in the soil under study was generally low but it was observed that clay textural class of soil had higher total organic carbon compared to sandy clay loam, silty clay loam soils and sandy clay textural classes. Soil texture was found to correlate with TOC. Soils under study portrayed an average soil phosphorus retention ability that highly correlated with soil texture.