

# 5<sup>Th</sup> Annual National Biotechnology Essay Writing Contest

**Theme: Biotechnology for Climate Smart Agriculture**

**Category A:** Tertiary institutions

**Topic:** Biotech crops can improve soil, true or false? Explain your answer.

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2015 was named the International Year of Soils by Food and Agriculture Organization according to FAO Director-General, Jose Graziano da Silva. Uganda thought starting the year off with a post on GM crops and soil health, under their theme, “is there a relationship between GM crops and soil?”, MAAIF, 2015. I doubt whether any answers were found, but what struck my instincts, that can mesmerize anyone in the end is; how correctly did we play the cards no wonder Daily Monitor as of Tuesday Feb/28/2017 still proves that Uganda’s soil glory is continually declining without being addressed?

Can biotech crops really improve soil health? The answer is both yes and no claiming the following scrutinized reasons.

As Natural Resources Conservation Service (USDA, 2008) explains: “practices that provide soil cover, protect or result in the accumulation of organic matter, maintain healthy plants, and avoid compaction, improve soil structure and increase macro-pores.” Preserving soil structure increases the range of soil textures acceptable for bioretention.

Transgenic insect resistant Bt (*Bacillus thuringiensis*) crops reduce the need for pesticide since insects and virus resistance traits are cultured in the plants. When little or no insecticides and pesticides are used, there is less soil exposure to chemical threats that would alter soil chemistry (pH). The benefit of this is that less non-target insects are killed (ICSU, 2003), hence, soil composition is maintained.

Fungi that colonize GM legumes and the legumes’ root hairs wrap soil particles into balls (University of Minnesota Extension 2002.), hence, soil aggregation. An important soil aggregation by these crops is water-stable aggregation which is measured by the scope to which soil aggregates resist falling apart when wetted and hit by rain drops. (Gugino, 2007). This improves the soil capacity to sustain its structure during the most extreme conditions (e.g., a heavy rainstorm after weather had dried the surface).

It’s not deceptive to learn by heart that insecticidal protein used for cloning is itself a common soil-dwelling bacterium, *Bacillus thuringiensis* (Bt); this means that its exposure to soil and soil organisms is not unique to GM crop fields, but occurs in every field as any other component of

the soil biota. The benefit of increasing this protein in the soil is that it can be used for biological soil control or bioremediation of soil damages such as oil spills (NRC, 2002), helping in the management and improvement of soil health.

High volume use of Transgenic Herbicide resistant crops available in the markets today, have led to shifts away from more toxic herbicides to less toxic herbicides. (U.S. EPA, 1996). The benefits are that it promotes growth of herbs that provide soil cover, and encourages adoption of no-till farming, resulting to less soil disturbances that would lower soil health by breaking the soil fungal hyphae, increases soil moisture and reduces soil erosion.

Other benefits of adopting conservation tillage or no-till practices encouraged by herbicide resistant crops are that it helps preserve organic matter in the soil, maintain soil composition, water infiltration and soil water retention.

The engineering of toxins in crops to uphold its resistance to insects has also naively helped to control soil disturbances from such organisms that would disintegrate soil. This helps to alleviate unnecessary soil structure disruptions and entropy, and disease causing organisms in the soil.

Correspondingly, destroying soil degrading organisms helps to maintain good soil structure that provides better living conditions for other beneficial soil organisms and roots, because soil will have many large and small pore spaces through which air, water, roots, and living organisms can move freely (FAO 2007).

Genetically Modified (GM) crops with enhanced nitrogen efficiency help to diminish possibility of soil nitrogen pollution by sequestering soil nitrogen content in their bodies reducing nitrogen loss due to pollution.

Crops engineered for amplified efficiency to use minerals help to avert early exhaustion of soil fertility as a result of over usage since minimal soil minerals will be consumed by these plants, assuring a stable potential soil mineral content. Polyvalent cations like  $\text{Ca}_2^+$ , magnesium  $\text{Mg}_2^+$ , and aluminum  $\text{Al}_3^+$  bind together clay particles, hence, water retention capacity attained.

According to UNEP, 2008, Plants such as poplar trees have been genetically engineered in China to clean up heavy metal pollution from contaminated soil (soil bioremediation) helping to

alleviate Soil and groundwater pollution that has continued to be a problem in all parts of the world including Uganda.

Biotech cotton was documented by ISAAA in 2011 to have affirmative effects on a number of diversity of beneficial insects in the US and Australian cotton fields, promoting their reproduction rates, free existence for instance *nitrobacteria* and *Mycorrhizal fungi*. This promotes soil aggregation and porosity (good soil structure) which allows water infiltration and holding capacity.

GM Crops engineered to maximize productivity can subsequently promote field fallowing in agriculture as most farmers attain desirable quantities on small pieces of land, which means that superfluous plots can be left to fallow.

They also encourage crop rotation since they take shorter time to mature, meaning that the same field can be used several times of the year producing different crops engineered for fast maturation.

Unenthusiastically, biotechnology like any other sciences can also pose a number of challenges to the soil when not circumspectly handled, which, unearthing is not very misleading.

Markedly, transgenic insects and pests resistant crops may destroy a large range of non-intended soil biodiversity. (Gabrielle Persley, the ICSU report author, 2001). The accumulation of foreign DNA may lead to a cumulative loss of soil biodiversity over repeated harvests, damaging further the organisms crucial for soil fertility, depreciating soil-aeration capacities. (U.S. Geological Survey, 1999)

Besides the above, fungi are also known to disintegrate organo-phosphorous insecticides (Zidan, Z.H. & Ramadan, E.M. 1980), meaning that when we destroy them by using an extra tone of chemicals; due to the fact that we are able to engineer crop resistance to these chemicals, then we are rather divulging our soils to accumulation of even these insecticides that could be besmirched by just the soil fungi.

Bt and phosphinothricin or glyphosphate herbicide tolerance GM maize (*Zea Mays L*) were assessed in the fields and in pot experiments and the results showed that ammonium ion was significantly higher in soil under the GM maize compared to other maize crops (Gongzhuling,

2003), however, this publication does not indicate the cause of the ions. This if factual, is an indication that biotech crops can alter soil chemistry although the effects may vary with specific modification.

The controversy with espousal of less or no-till farming is that farmers instead use chemicals to destroy the soil vegetation cover and biota, resulting to high level of soil toxin accumulation, and clearance of soil cover giving way to soil erosion, and limiting soil aggregation by root hair. Low biological activity means reduced mineral cycling and competition with pest organisms.

As can be noted from above, biotech crops have gargantuan optimistic implications on the soil health, except that there are a lot challenges to both the government and UBIC, especially in the areas of safety testing, regulation and food labeling, otherwise, crop biotech is a necessary evil we all must embrace and live with.

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*“Learn more about **soils** through our educational booklets for children ages 5 to 14. An educator's guide is also available for teachers”. [www.fao.org/soils-2015/resources/educational/en/](http://www.fao.org/soils-2015/resources/educational/en/)*

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