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Potentials of organic fertilizers in climate change mitigation

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ABSTRACT.
Climate change is a reality in this present time, as inconsistency of climatic factors has shown over the years. Climate change has both negative and positive impacts on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows. Consequently, there is urgent need to do everything possible to mitigate its effects by reducing the emissions of the greenhouse gases (GHGs). Agriculture has great potential to mitigate climate change by reducing the buildup of the GHGs in the atmosphere as organic fertilizers may prove a large depository for excess carbon dioxide. This paper reviewed the performance of some of the several organic fertilizers that had been evaluated by several authors relative to mineral (inorganic) fertilizers and the effect of farmers' adoption and use of organic fertilizers on farm yield and their dependent households. The reports from all the authors in the review showed that the use of organic fertilizers increased and improved yield quality. This compared favourably and sometimes performed significantly better than mineral fertilizers. It was therefore concluded that there is need to encourage farmers to use organic fertilizers in place of mineral fertilizers as this will reduce the emission of CO_2 and N_2O and also mitigate climate change with the resultant effect of sustained and improved crop yields.

Key words: Climate change, greenhouse gases, organic fertilizers, mineral fertilizer.

INTRODUCTION

Background information on occurrence of climate change

Climate change (CC) is a change of climate that is attributed directly or indirectly to human activities that alters the composition of the global atmosphere, which is in addition to natural climatic variability observed over comparable time periods (UNFCCC, 2007). Climate change is largely due to anthropogenic greenhouse gas emissions in the forms of carbon dioxide, nitrous oxide and methane collectively called greenhouse gases (GHGs). Industrialization and combustion of fossil fuels, alongside land-use changes, are primary sources of anthropogenic GHGs emissions; and these changes are generally linked to human activities. The concern is that the mean global level of

GHGs in the atmosphere has increased to a level that had triggered serious climate changes in air temperature and violent weather cycles.

Implication of climate change

Climate change affect all four dimensions of food security which are: food availability, food accessibility, food utilization and food systems stability. The data from FAO (2008); Madiyazhagan *et al.,* (2004); Molua and Lambi (2006) and WMO (1996) showed that CC have impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows. These therefore call for concerted efforts to mitigate the effects of CC by reducing the emissions of the GHGs.

Human activities triggering climate change and global warming: production of mineral fertilizers

In order to combat the challenge of declining soil fertility, mineral fertilizers have become the conventional means of maintaining soil fertility, because they provide readily available nutrients for crops. Their use however especially the nitrogenous ones comes with negative consequences among which is increase in N_2O emission. This is because the production of inorganic fertilizers demand much energy and generate considerable CO_2 emissions. Kongshaug (1998) reported that fertilizer production consumes approximately 1.2% of the world's energy and is responsible for approximately 1.2% of the total GHG emissions. The emission of GHG in CO_2 equivalents from the production and application of nitrogen fertilizers from fossil fuel amounted to 750 to 1080 million tonnes (1 to 2 percent of total global GHG emissions) in 2007. In 1960 (47 years earlier), it was less than 100 million tonnes (Niggli *et al*., 2009). The application of urea to soils leads to a loss of CO_2 that was fixed, in the industrial production process. Urea ($CO(NH_2)_2$) is converted into ammonium (NH_4^+), hydroxyl (OH^-), and bicarbonate (HCO_3–) ions in the presence of water and urease enzymes. Pach (2007) estimated the energy used in global N manufacture as 1% of the world's total energy consumption, and concluded that a typical ammonia plant emits 2.5 kg of CO_2/kg of NH_3-N. Additional emission also occurs from the fuel used for heat, gas turbines and other equipment in the ammonia as well as in other mineral fertilizer production plants (NRCan, 2007).

Potentials of the use of organic fertilizers in climate change mitigation

Agriculture is currently a substantial source of GHGs due to the production and application of mineral fertilizers, and has great potential to reduce the buildup of these gases in the atmosphere (Keith *et al.,* 2006). Organic fertilizers may prove a large depository for excess carbon dioxide (Lal, 2004; Rees, 2009; Fliessbach *et al.*, 2009) because the raw materials composted are mainly consisted of carbon trapped from the atmosphere during photosynthesis and this is sequestered into the soil when the organic fertilizer is applied.

The use of organic fertilizers could reduce industrial N-fertilizer use that emits 6.7 kg CO_2-eq per kg N on manufacture and another 1.6 percent of the applied N as soil N_2O emission. It could also enhance the sequestration of CO_2 into the soils in a considerable way (Niggli *et al*., 2009). The data of Niggli *et al.,* (2009) showed that area-based GHG emissions in the organic systems were 36 percent lower than in conventional systems. Most of these differences were caused by CO_2 and N_2O emissions – both of which are mainly related to mineral fertilizer use in conventional farming. Enhanced-efficiency fertilizers (slow and con-trolled release fertilizers) have been defined as products that minimize the potential of nutrient losses to the environment, as compared to “reference soluble” fertilizers.

Composting is a low emission practice because it reduces methane emissions from landfills (UNFCCC/CCNUCC, 2007). The use of compost to produce food also avoid emissions of nitrous oxide from the production and application of chemical fertilizers; in addition, agricultural soils are a major potential carbon sink that may be used to mitigate climate change (Lal, 2004). Composting one ton of Egyptian organic waste mitigates the greenhouse effect of 0.44 metric tons of carbon dioxide equivalents. The UNFCCC has included composting as an official method for emission reduction projects. Compost trials in the Egyptian desert showed that organic farming practices - recycling of organic waste to compost and adding to the soil in dryland regions have the potential to mitigate climate change by avoiding emissions and sequestrating high levels of carbon; as these systems improved soil fertility and increased food security in the area (Mader *et al.*, 2002; Luske and Kamp, 2009).

The objective of this study is therefore to assess the performance of some of the several organic fertilizers that had been evaluated by several authors compared with mineral fertilizers, and find out if the farmers and their dependent households stand to lose anything in terms of yield through the adoption and use of organic fertilizers while trying to mitigate CC effects.

Some findings on organic fertilizer ability to improve yield

While exploring the ability of the use of organic fertilizers instead of mineral fertilizers to mitigate CC effects, it is also necessary to evaluate the possibility of the adoption of its usage by farmers; as this mainly depend on its ability to improve yield. Below are some of the findings from the data reviewed.

1. In a study conducted to find out the effect of farmyard manure (FYM) and inorganic fertilizers on maize production on Alfisols and Ultisols in Kakamega, western Kenya; Achieng *et al.* (2010) found out that the extra maize yield obtained from the use of inorganic fertilizer over FYM was not substantial enough to justify their use. Also, addition of nitrogen (N) fertilizer failed to increase maize yields in Ultisols apparently due to the decline in soil pH and consequently inefficient utilization of added nutrients. The authors therefore concluded that for smallholder farmers, FYM will be a favourable source of nutrients as it costs less, and is locally available and also effective in reducing exchangeable Al.

2. Olaniyi *et al.* (2010) applied 0, 30, 45 and 60 kg N/ha of unfortified sunshine organic fertilizer to four varieties of okra in Nigeria, to determine their effect on growth, yield and nutritional values. The result showed that application of the organic fertilizer significantly increased the growth, yield and nutritional values of okra varieties

while the 45 kg N/ha treatment gave the highest yield across the four different varieties of okra.

3. In a field study to evaluate the potential of feather meal as organic fertilizer in the production of Amaranth *(Amaranthus caudatus)*, in Nigeria, Adeogun (2010) reported that feather meal treatment (18 t/ha) at 4 weeks after planting (WAP) significantly ($P<0.05$) compared favourably with NPK 15-15-15 mineral fertilizer (20.21 t/ha) and compost (16.54 t/ha) while it resulted in better performance compared to the control treatment (10.03 t/ha) on the fresh weight of amaranth plants during the main planting in the dry and rainy seasons.

4. The data of Tinubu (2007) from Nigeria, on the comparative effects of cocoa pod husk and rice husk ash (RHA) as organic potassium sources on okra (*Abelmoschus esculentus* L Moench) production, effects of organic potassium fortifiers on N and K concentrations in okra fruit showed these trends: the highest percent (%) total N (16.1) was recorded in fruits harvested from the plots where 90% Pacesetter organic fertilizer was fortified with 10% rice husk ash while the lowest (5.53) was in fruits harvested from the control plot with no soil additive. The implication of this is that 10 % RHA fortification has potential for quantitative as well as qualitative yields. The highest concentration of K (67.33 g/kg) was recorded in fruits harvested from the plot treated with 100 % cocoa pod husk while the least (32.44 g/kg) was recorded in fruits from plot treated with Pacesetter's organo-mineral fertilizer grade A.

5. In another research conducted to find out the effect of organic and inorganic nutrient sources on soil mineral nitrogen and maize yields in Western Kenya using plant residues of *Tithonia diversifolia* (Hemsl. A.) as soil amendment; Ayuke *et al.*, (2004) reported that *Tithonia diversifolia* treatment increased mineral N content of soils and maize yields comparably to inorganic fertilizer.

6. Organic residues have also been found to reduce P sorption capacity of soils and increase crop yields in P limiting soils (Nzigurheba *et al*., 1998). The report of Chukwuka and Omotayo (2008) from Nigeria in their own study showed that the application of green manures as soil amendments improved the physical properties and chemical nutrients in nutrient depleted soil. Soil microbial communities have also been shown to benefit from specific farming techniques, including application of green manures to agricultural soil system.

7. Conway and Barbier (1990) identified that improved soil management techniques and green manures application improved the yield of potato crops as against over application of chemical fertilizers which gave reduced yields.

8. Timely applications of organic materials with low C:N ratios such as green manures and compost can synchronize nutrient release with plant demand and minimize the amount of inorganic fertilizer needed to sustain high crop yields for short cycle crops such as maize, rice and soybean; all of which have a high nutrient demand (Lathwell,

1990; Burle, 1992). Organic residues with high C:N ratios often have soil fauna playing a greater role in their decomposition compared to those with lower ratio and high water content in their tissues.

CONCLUSION

The reports from all the research findings reviewed in the paper showed that the use of organic fertilizers improved yield of crops and also compared favourably and sometimes performed significantly better than mineral fertilizers. These imply that the use of organic fertilizers in place of the mineral fertilizers could mitigate CC by reducing the GHGs that could have been emitted during the production and transportation of mineral fertilizers. The small holder farmers could also record yield comparable to what could be obtained under mineral fertilizer application and even sometimes higher. Thus farmers should be encouraged to use organic fertilizers in place of mineral fertilizers as this could sustain their productivity, since the organic fertilizers are readily available and also improve yield while they also mitigate the effects of CC.

Recommendations

The following recommendations could therefore be made to ensure the promotion of the use of organic fertilizers among small holder farmers:

1. Awareness and sensitization on the benefits of the use of compost.
2. Awareness and sensitization on the available organic materials (crop residues, animal dung, agro-industrial waste, plants etc) that could be composited; which is location specific.
3. Government should give policy support for the establishment of compost plants.

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