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INVITED SHORT COMMUNICATION

This short communication was invited by the Editor-in-Chief of AJFAND after she read the author's contribution on FARA network on a matter that is becoming increasingly critical to the African farmer, in the wake of evolving climate change impacts on agricultural productivity and continued rising fertilizer prices which hurt smallholder famers.
There is also renewed acknowledgement that soils need biomass and why not source it from the so much waste that goes unutilised!
We would like to thank Prof Sabiiti's acceptance to prepare this piece and express our hope that it receives wide readership.
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UTILISING AGRICULTURAL WASTE TO ENHANCE FOOD SECURITY AND CONSERVE THE ENVIRONMENT

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ABSTRACT

The rapid increase in the world's population coupled by urban migration has resulted into an increased demand for food which has in turn led to the production of large amounts of agricultural wastes, both at the farmer, municipality and city levels. The bulk of the agricultural food in developing countries is transported to cities in its raw forms, thus compounding the net effect on large deposits of waste in urban markets, around homes and in slums as well as in various dumping grounds. In Kampala alone, over 1000mt of waste accumulate in the city and only about 30% of it is collected by the City Council leaving the rest to rot and pollute the environment. Although it is recognized that the accumulation of waste has enormous ill effects on humans and the environment, such wastes, if properly managed could be considered an important bio-resource for enhancing food security in the small holder farming communities that would not afford use of expensive inorganic fertilizers. These organic wastes contain high levels of Nitrogen, Phosphorus, Potassium and organic matter important for improving nutrient status of soils in urban agriculture. Various factors amplify the agricultural waste problem, especially in developing countries where there are limited waste recycling facilities. Most of the nutrients are leached from the dampfills and end up polluting water bodies and this has been associated with the invasion of water weeds. Most importantly, there is lack of planning, poor public awareness, poor government policy and laws, and lack of or insufficient utilization of resources. In Kampala, many small holder farmers have improved milk production by feeding animals with various combinations of agricultural wastes. Others have increased nutrient supply in soils by applying organic compost leading to improved crop yields, especially vegetables and maize which fetch high prices for the farmers thus reducing poverty levels and enhancing food security. This alternate method of removal of these wastes for agricultural production by farmers has also reduced the rate of accumulation with subsequent reduction on environmental pollution thus improving on environmental health. This paper briefly reviews how agricultural wastes can be used to enhance food security and conserve the environment.

Key words: Agricultural waste, food security, environment, pollution

BACKGROUND

Food security (access for all, to sufficient and nutritious food and at all times) encompasses both food production and the ability to access or purchase food [1]. According to [2], it is in Africa where the per capita food production continues to decrease, yet the population is growing at a rate higher than in any other region in the world. Also, while it is recognized that food insecurity is mostly prevalent in the developing world, it is most acute in Africa. If the attainment of food security is intrinsically linked with safeguarding the natural resource base, Africa has the highest rate of land degradation in the world [1]. Therefore, since the bulk of food in Africa is produced on a small-scale basis, to ensure food security, the following should be regarded as interlinked determinants: (i) an enabling environment for the smallholder farming sector, (ii) income generation, (iii) reversion of soil fertility depletion, (iv) protection of the environment, and (v) intensification and diversification of land use with high-value products. The purpose of this article is to review the literature on how agricultural waste can be utilized to enhance food security and conserve the environment.

AGRICULTURAL WASTE

The by-products of agricultural activities are usually referred to as “agricultural waste” because they are not the primary products. These wastes chiefly take the form of crop residues (residual stalks, straw, leaves, roots, husks, shells etcetera) and animal waste (manures). Agricultural wastes are widely available, renewable and virtually free, hence they can be an important resource [3]. They can be converted into heat, steam, charcoal, methanol, ethanol, bio diesel as well as raw materials (animal feed, composting, energy and biogas construction etcetera)(Fig 1.). However, many of the agricultural wastes are still largely under-utilized, and left to rot or openly burned in the field, especially in developing countries. In Kampala City, over 1000mt of organic waste accumulates daily and only about 30% of this is removed and dumped into a dumpfill in Kitezi, yet all these wastes are known to contain high nutrient levels of Nitrogen, Potassium, Phosphorus that would improve soil fertility and increase crop yields such as vegetables, maize that fetch high prices and hence enhance food security. This alternate method of utilisation by farmers for agricultural production has also reduced the rate of accumulation with subsequent reduction on environmental pollution thus improving environmental health. This calls for a greater awareness of the public and farmers of the benefits of proper management and utilization of organic wastes in agriculture to diminish fears and preconceived notions of nuisance problems, decrease in land values as well as environmental degradation [4]. The goal should be to make the agricultural waste a resource that can be utilized and not just discarded. It is also very important to set up institutions that can harness the large potential of agricultural wastes as a resource in farming and in energy production. Using appropriate conversion technologies, animal and crop wastes can be turned into useful resources as below:

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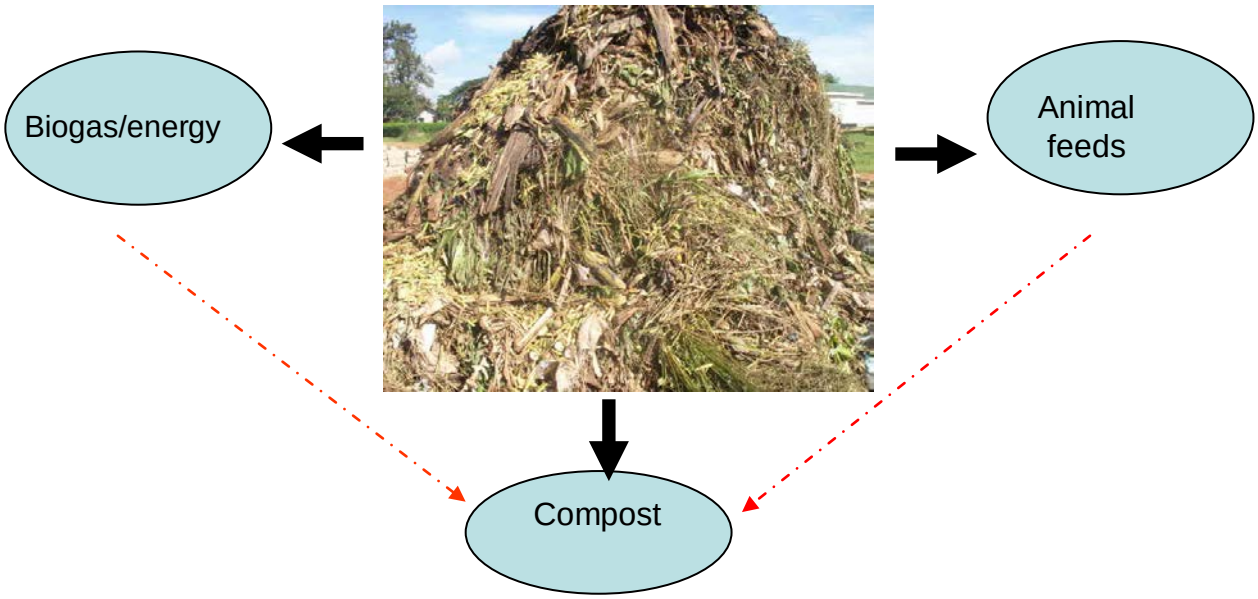

Figure 1: Conversion of Agricultural Wastes into Various Economic Resources

AGRICULTURAL WASTE AND THE ENVIRONMENT

The impact of agricultural waste on the environment depends not only on the amounts generated but also on the disposal methods used (Fig 2). Some of the disposal practices pollute the environment [5, 6]. For example, agricultural waste burning is a common practice in the undeveloped countries, but it is a source of atmospheric pollution. According to [7], agricultural waste burning releases pollutants such as carbon monoxide, nitrous oxide, nitrogen dioxide and particles (smoke carbon). These pollutants are accompanied by the formation of ozone and nitric acid [8], hence contributing to acid deposition [9] thereby posing risk to human and ecological health.

Environmental pollution from animal waste (faeces, urine, and respiration and fermentation gases) is a global concern and is much more acute and serious in countries with high concentrations of animals on a limited land base for manure disposal. Animal wastes are excreted in solid, liquid, and gaseous forms. Respiration and fermentation gases are lost to the environment soon after being produced by the animal. After excretion, solid and liquid animal waste is subjected to microbial conversion (mainly anaerobic), which converts organic substrates into microbial biomass and soluble and gaseous products. Some of these products have an impact on the environment, as well as water quality, soil deterioration, and air pollution. Odour pollution was reported to contribute highly to social tensions among urban livestock farmers in Kampala, Uganda [10].

Additionally, the application of excessive animal wastes on land as fertilizer and soil conditioner is subject to surface run-off and leaching that may contaminate ground or

surface waters. For that reason, nitrate leaching is considered a major nitrogen (N) pollution concern on livestock farms [11]. When phosphorus (P) enters the surface waters from land application of excessive animal manure it can stimulate the growth of algae and other aquatic plants. Their subsequent decomposition results in an increased oxygen demand that interferes with the welfare of fish. Manure decomposition can be a major source of methane (CH_4), ammonia (NH_3) and nitrogen oxides, which contribute to accumulation of greenhouse gases. Volatilization of ammonia causes acid deposition, which contributes to acid precipitation [12, 13]. Emissions of nitrous oxide (N_2O) during the nitrification-denitrification cycle contribute to ozone depletion [14].

Heaps of various agricultural wastes

Mode of transporting waste

Environmental pollution

Figure 2: Typical garbage situation in Kampala City and the surrounding environment

AGRICULTURAL WASTE AND FOOD SECURITY

The target should be to make agricultural wastes a resource that can be utilized and not just discarded. Agricultural wastes can be used to enhance food security mainly through their use as bio-fertilizer and soil amendment, use as animal feed, and energy

production. They contain large amounts of organic matter, and many of them can be directly added to the soil without any risk.

Turning these agricultural wastes (crop residues and animal manures) into organic fertilizers (through composting) is one of the waste treatment technologies that make it possible to use organic waste as a fertilizer even in populated areas. Technology plays a key role in soil fertility improvement, and hence crop productivity [15, 16]. The use of organic fertilizers is particularly important in most parts of Africa, where low availability of nutrients is a serious constraint for food production [17]. Composting also reduces the volume of the waste, hence solving serious environmental problems concerning disposal of large quantities of waste, kills pathogens that may be present, decreases the germination of weeds in agricultural fields, and reduces odour [18]. The compost can be sold for additional revenue or used on the same farm. Besides, the production of composts for agricultural use is gaining popularity as a result of the rising interest in organic products such as goat meats and maize)(Fig. 3).

Figure 3: The wastes are eaten by goats for production of meat while compost applied on soil increases maize production.

Both crop residues and animal waste can be used as animal feed. However, the nutrient content of animal waste depends on the animal species, type of feed, and bedding material used [11]. The use of broiler litter in cattle feeding is a widely applied practice. It is worth noting that animals, especially ruminants are useful in converting crop residues into food, hence contributing substantially to reducing potential pollutants. The rumen contains the microbial enzyme cellulase, which is the only enzyme to digest the most abundant plant product, cellulose [19]. With ruminants, nutrients in by-products are utilized and do not become a waste-disposal problem [20].

The production of energy from agricultural waste has been utilized to varying degrees in different parts of the world [4]. According to [11], besides generating revenue from the energy produced, waste-to-energy schemes offer an alternative and environmentally acceptable means of waste disposal. Additionally, the schemes also provide a valuable by-product: a good quality, agricultural fertilizer that is nearly odourless. With the concern over future energy shortages and increasing costs of conventional fuels and electricity derived from them, there is increasing interest in using anaerobic digestion as a source of renewable energy while providing acceptable

waste management. For instance, in Uganda, the basic source of fuel is wood used in the form of charcoal or firewood for heating and cooking. This dependence on traditional charcoal and firewood is responsible for the prevailing deforestation and soil degradation, the effects of which have manifested in irregular rainfall, floods and violent storms.

CONCLUSION

Agricultural wastes can be a valuable resource for improving food security, however, if not treated, kept or disposed off properly, agricultural wastes are likely to cause pollution to the environment or even harm to human health. This calls for increased public awareness on the benefits and potential hazards of agricultural wastes, especially in developing countries. There is also an urgent need to set up centres of excellence in waste management in Africa; an initiative undertaken at Makerere University.

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