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How safe is organic farming by subsistence farmers from developing countries in the face of persistent organic pollutants in the environment?

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ABSTRACT

Organic farming products are fast gaining acceptance from consumers all over the world due to the perceived belief that they are safe for human consumption. In recent years, there has been an increase in the levels of persistent organic and inorganic pollutants in the environment. These pollutants may be found in materials such as sewage sludge, treated wastewater, farmyard manure (human and animal feaces and urine) that are used for organic farming. The present review examined through literature the presence of these emerging pollutants in crops that are cultivated from farming activities practicing organic farming. The review highlighted and documented various pollutants that may be found in crops due to non-compliance with legislation establishing organic farming. The need to develop a robust method for identifying safe products from organic farming was highlighted. The impact of non-compliance and lack of proper education on the peasant farmers practicing backyard farming was also enumerated.

Keywords: Organic farming, Persistent Organic Pollutants, Crops, Peasant farmers, Education.

INTRODUCTION

Organic farming is fast gaining prominence all over the world due to the perceived believe that products derived from it are safe for human consumption (Mugivhisa and Olowoyo, 2015). Organic farming is also believed to be a safe method of producing food for the nation without having any serious negative influence on the environment since plant, animal and other types of biodegradable waste are used in the process (Seufert et al. 2017). As at present, organic products remains the most recognized safest and easily interpreted food label in most registered stores by consumers (Rigby and Cáceres, 2001).

The main objectives of organic farming are to enhance farmers' livelihoods, increase agricultural production within the less privileged group and also reduce the negative impact of inorganic fertilizers on the environment (Scialabba and Hattam, 2002). Altenbuchner et al. (2017) further mentioned that the goal of organic farming also includes women empowerment with the aim of gaining access to education thereby assisting them to make informed decision that may affect their health and overall wellbeing. Through the introduction of organic farming, it is also possible for women to apply their indigenous knowledge and embrace their role as 'keeper of seeds' which in turn encourages biodiversity (Farnworth & Hutchings, 2009).

What is organic farming?

The definition and guidelines as to what organic farming really stands for varies from region to region and from countries to countries. The European Union Act EC 834/2007c that came into existence in 2009, defined organic farming "*as a way of producing agricultural goods that restrict the use of off-farm inputs in favour of other farming practices (cultural, biological and mechanical) which should be established on any farm after the period of conversion*". The Regulation considers environmental protection, preservation of natural resources (including biodiversity), application of high animal welfare standards and production method based on natural substances and processes. The EU Act principle includes the production of food of high quality with the restriction of the use of external inputs and the strict limitation of the use of chemically synthesised inputs to exceptional cases.

In Africa, according to International Federation of Organic Agriculture Movements (2008), most certified organic product in Africa is mainly towards the export markets. Most of the African countries rely mainly on foreign standards and as such most of the certified organic product have been carried out following the EU regulation for organic products. However, some countries and regions do have existing policy that are developed from EU Act on organic farming.

From East Africa, the policy on organic farming or production (EAS 456: 2007) stated "*the operator (farmer in this case) shall avoid using chemical products that may endanger human health or the environment. Where there are products that are considered to be less harmful, they shall be used".* The policy further stated that the "*operator shall take relevant precautionary measures to avoid the contamination of organic sites and products. Where there is a reasonable suspicion of substantial contamination by, for example, soil, water, air, inputs or ingredients, appropriate actions shall be taken".* It was further stated that "*land converted to organic production shall not be alternated (switched back and forth) between organic and conventional production*".

In South Africa, the policy on organic farming was coined and adopted from policies formulated by international organizations. The policy followed international standards such as the Codex Alimentarius, the European and American regulations and the International Federation of Organic Agriculture Movements, (IFOAM). The policy adopted the definition of organic farming as stated by the FAO/WHO Codex Alimentarius Commission as: "*A holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. The main emphasis was on the use of management practices in preference to the use of off-farm inputs. This is accomplished by using, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system".* However, the South African policy was underpinned by a legal frame work that makes provision for an environment that is not harmful to health or well-being of the populace and also an environment that is not only protected but for the benefit of present and future generations, through reasonable legislative and other measures and the prevention of pollution and ecological degradation. The key goals are similar to the EU Act but with an extension such as the "*protection of consumers against* *false, misleading and unfounded claims and create the obligation for all producers to indicate the levels of inputs used in their produce".* Furthermore, the organic products should improve the health of the populace and environment and improve access to better nutrition for all.

In some other parts of Asia and African countries, there are few or no proper documented guidelines on the operation of organic farming. Individuals' especially poor farmers have relied on domestic waste without having prior knowledge to their source and composition for agricultural purposes. (Hofmann 2013). In some countries such as India as reported by (Nunan 2000), municipal solid wastes are collected from street bins and markets or purchased from the municipal dumpsite and subsequently sold informally to peri-urban farmers. In this case, the wastes are applied directly (unsorted) and used for farming with the sole aim of increasing productivity. In Kano, Nigeria, 'taki', is widely used, which is a composition of manure, household waste, street sweepings and ash (Asomani-Boateng and Haight, 1999). Waste from tanneries and abattoirs have been used. The composition is unknown and could contain toxic materials since street sweepings is involved. It should be noted that from most of the developing countries in Africa, farmers benefit from composted urban waste and local streams, contaminated with effluents from various industries and household sewage, this may act as a reliable source of water for peasant farmers especially in regions where there is a known low annual rainfall (Binns et al. 2003; Maconachie, 2007). Recently in South Africa, the introduction of urinary diversionary toilets has favoured the use of human urine in agriculture (Mugivhisa and Olowoyo 2015). The use of human faeces as a source of organic amendments is also a common phenomenon and still been investigated (Kutu et al. 2010).

Generally, various guidelines mentioned above, before the preceding paragraph stipulated a proper and strict use of only "safe organic waste" for organic farming. There are new scientific findings which may punctuate the guidelines provided by the EU Act on the effects of sludge on land which may call for a much stricter limits on values for heavy metals and other emerging contaminants, which were not addressed initially (Suciu et al. 2015). On the other hand, peasant and poor farmers

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are unable to deal with the levels and amounts of toxic compounds that might be present in the organic waste due to increasing demand for food and lack of knowledge on the adverse effect of these toxic pollutants not only on the environment but eventually the consumers of the end products mostly locally. The main objective in regulating or controlling the use of organic waste for organic farming should stem from the concerns about human health and the protection of the environment. Regulation and certification might be adopted for farmers intending to export their product internationally. However, this might be difficult with peasant farmers who are only cultivating a handful portion of hectares of land or engaged in backyard farming just for livelihood. Regulations are therefore only useful with commercial farmers and may also favour the understanding of the different organic actors that have been codified and what organic agriculture means today (Rigby and Cáceres, 2001; Mugivhisa and Olowoyo, 2015).

The concept of organic farming contributing to more sustainable agriculture, improving health condition and protecting the environment is of great concern in the light of emerging persistent organic pollutants. Several issues as reported in literature are associated with the use of organic waste in agriculture. For instance, the use of human and animal wastes (faeces and urine) for the production of food, feed or fertilizer may include the possibility of disease transmission, uptake of pharmaceutical drugs by plants, presence of pharmaceutical drugs from animal faeces which may negate the gains derived from the use of the waste (Furedy and Chowdhury 96). Other emerging pollutants have also been reported either in water or in waste that may be used for organic farming. The present review will provide an overview on what has been reported in literature on the occurrence, behaviour and persistence of organic pollutants in waste used for organic farming.

2.3 Evidence of various types of organic pollutants in the environment and fate of organic farming.

2.3.1. Pharmaceuticals in water, soil and plants

Presence of pharmaceutical residues such as antibiotics, analgesic and anti-retroviral drugs in water bodies have been reported in literature (Frederic and Yves, 2014;Prasse et al, 2010; Schoeman et al, 2015; Sui et al. 2015; Shraim et al. 2017). Pharmaceutical drugs are used extensively for mammals (humans and animals). Once ingested or injected, they either become metabolized or unmetabolized and may be excreted through urine and faeces (Paltiel et al. 2016). Though urine accounts for 1% of the conventional wastewater volumetric flow, but it contributes approximately 64% of pharmaceuticals, 80% of nitrogen, and 50% of phosphorus to waste water body. Pharmaceuticals are partially degraded in the environment and as a result are likely to accumulate in water bodies.

Even though urine can be regarded as an excellent complete fertilizer of plants, which contains phosphorus, nitrogen and potassium, it also contains residues of pharmaceutical products even after it has been stored for a prolonged period of time as a treatment step (Winker, 2010). Hence the consumption of urine in organic farming goes with the risk of dispersing the pharmaceutical residues onto the agricultural fields (Winker et al. 2008). It has been shown that the pharmaceuticals are mainly excreted through urine (70%) and only partially through the faeces accounting for the overall ecotoxicological risk of 50% (Winker, 2010). Antibiotics were detected in urine that had been stored for more than a period of more than 1.5 years (Winker, 2010). A study conducted in two Hebrew universities on human exposure to wastewater-derived pharmaceuticals confirmed that pharmaceuticals such as carbamazepine was detected in human urine when the subjects consumed agricultural products irrigated with wastewater. Carbamazepine, is an anticonvulsant drug which can be detected in reclaimed wastewater, highly persistent in soil, and can be taken up by crops (Paltiel et al. 2016). The long-term persistence also of some pharmaceutical drugs such as antibiotics at low levels can promote the proliferation of antibiotic resistant bacteria in river base flows and may enhance the drug resistance of microorganisms (.Martínez 2008 and Watkinson et al. 2009).

Despite a significant improvement in water treatment technology, certain pharmaceuticals drugs residue may not be removed totally from wastewater that may be used for irrigation even after treatment (Wood et al. 2015; Schoeman et al. 2015). In South Africa, for example, according to the report from WHO (2013), there are about 2, 150 880 people placed on antiretroviral drugs in the fight against HIV/AIDS which is far more than any other nation. It is then logical to think that the residue of these drugs may be present in the environment. Wood et al. (2015) noted in a study conducted on the occurrence of anti-retroviral compounds used for HIV treatment in South African surface water that, nevirapine, a non-nucleoside reverse transcriptase inhibitor that is widely used for the treatment of HIV as well as the prevention of mother-to-child transmission was detected in all of the surface water samples used in the study and quantified in nine out of the 24 sampling locations. According to Vanková et al. (2010), the presence of this compound can be attributed either to its frequent therapeutic use or also the compound's persistence in the environment. The compound is reported to be non-biodegradable (Coovadia et al. 2012; Vanková et al. 2010). Similar study conducted by Schoeman et al. (2015) showed that concentrations of nevirapine and efavirenz in wastewater before treatment were high as 2100 and 17400 ngL^{-1} respectively. However, upon treatment, 50% of the ARVDs were removed which resulted in the concentrations of nevirapine and efavirenz as high as 350 and 7100 ngL^{-1} respectively. The study further reported that chlorination did not have any significant reduction in the concentrations of the ARVDs from the treated waste water, hence its presence in the wastewater after treatment.

Apart from the antiretroviral drugs, presence of antibiotics in treated wastewater have also been reported. Antibiotics can be released into hospital wastewater due to excretion of used antibiotics and improper disposal of unused or expired antibiotics (Michael et al. 2013). This may pose a significant health risk especially causing antibiotic resistance, by promoting the selection of antibiotic resistance genes and antibiotic resistant bacteria which may pose a serious threat to global public health (Kummerer 2009 and WHO 2014). The study of Lien et al. (2016) on antibiotics in wastewater of a rural and an urban hospital before and after wastewater treatment in Vietnam showed that ciprofloxacin and metronidazole were detected in hospital wastewater before and after the treatment. Similarly, Hussain et al. (2016) quantified the levels of ofloxacin (OFL), ciprofl oxacin (CIP), levofl oxacin (LEV), oxytetracycline (OTC), and doxycycline (DOX) in wastewater and reported that the antibiotics accumulated in wastewater and accumulated in soil and plants and later percolated to groundwater.

Several reports have shown advancement in various methods used for the removal of pharmaceutical drugs from wastewater, however, to the best of our knowledge and as at the time of writing this report, there are no methods reported in literature that have completely removed pharmaceuticals residues from wastewater. The study of Watkinson et al. (2007) showed that both conventional and advanced wastewater treatment plants significantly reduced antibiotic concentrations with an average removal rate from the liquid phase of 92%. However, antibiotics were still detected in both effluents from the low-to-mid ngL^{-1} range. Ciprofloxacin, Sulphamethoxazole, lincomycin and trimethoprim were still detected in the wastewater after treatment. Li et al. (2014) in China noted that the advanced wastewater treatment facilities used in treating and removing antibiotics from wastewater did not remove all antibiotics completely. Most of the targeted antibiotics were detected in the secondary and tertiary effluents, with concentrations ranging from 4.8 – 1106. 0 and 0.3 – 505.0 ngL^{-1}. The study further showed that fluoroquinolone showed relatively high concentrations in all samples (782–1814 ngL^{-1}). The study concluded that different tertiary treatment processes showed discrepancy in antibiotics removal. Similarly Becker et al. (2016) also reported that removal of antibiotics in wastewater by enzymatic treatment with fungal laccase did not reduce the load of antibiotics, however, the addition of syringaldehyde enhanced the degradation of 32 out of the 38 antibiotics by 50% after 24 hours.

With the presence of antibiotics in wastewater which may be used for irrigation, there are evidences that plants can bio accumulate and store these compounds in their tissue (Eggen and Lillo, 2012;

Sabourin et al. 2012; Tanoue et al., 2012). The plant uptake, translocation and bioaccumulation of pharmaceuticals in the edible parts of food crops and fodders have been reported (Tanoue et al. 2012; Wu et al. 2013; Christou et al. 2016, 2017). Hussain et al. (2016) conducted a study on accumulation of residual antibiotics in the vegetables irrigated by pharmaceutical wastewater and reported that ofloxacin, ciprofloxacin, levofloxacin, oxytetracycline and doxycycline were detected in soil and vegetables samples in surrounding areas of pharmaceutical industry. The order of pharmaceuticals contamination from the vegetables was in the order leaves > stem/shoot > root > fruit. Also in a study conducted by Zheng et al. (2016) on the reuse of treated wastewater in agriculture, lettuce leaves showed very high bio concentration values for caffeine, carbamazepine, and sulfamethoxazole and hormones, indicating that these three compounds can easily translocate from lettuce roots to leaves and thereby accumulate in plant leaves. From the same study using tomato plants all the pharmaceutical products were only detected in the roots.

However, it is important to note that the translocation and uptake of these pharmaceuticals residue by plants are governed by various factors such as the soil pH, soil organic matter content and the redox potential of the soil. Goldstein et al. (2014), reported that factors affecting the uptake of pharmaceuticals by crops irrigated with treated wastewater, includes the physiological nature of the plant, soil properties and water quality. Sabourin (2012) had initially suggested that there may be little risk of pharmaceuticals uptake into vegetable crops, if produced according to current mandated regulations that specify a one-year offset between biosolid application and crop harvest.

1.3.2 Polycyclic Aromatic Hydrocarbons, PCBs and organic farming

The presence of polycyclic aromatic hydrocarbons (PAH) in the environment may be both natural and anthropogenic sources, with the later acting as the major source of the PAHs in the environment (Ashraf and Salam 2012). PAHs are present in the air, water and soil, and can remain in the environment for months or years (EFSA 2008). PAHs may be as a result of incomplete combustion, due to the burning of fossil fuels during heating processes, waste incineration and from automobile

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exhausts (ATSDR, 2005). They are carcinogenic compounds and many studies have been carried out to identify the human exposure sources. Among those reported in literature to be carcinogenic are benzoanthracene, benzofluoranthene, benzopyrene and dibenzoanthracene (IARC 1983).

Gaseous deposition has been reported to be the main pathway of PAH presence in plants during the opening and closing of stomata, however, a direct relationship between soil and plant PAH concentrations have been observed indicating a possible soil uptake and translocation within the plant tissues from contaminated soils (Meudec et al. 2006).

In Europe, PAHs are frequently found in sludge at relatively high concentrations: 7.8–13.3 mg kg^{1} (Kapanen et al. 2013; Rhind et al. 2013). In China, more than 1.9×10^4 hectares of farmland was contaminated by polycyclic aromatic hydrocarbons (PAHs) after long-term sewage irrigation (Li et al. 2008)). In countries where there are low temperatures and frequent soil freeze-thawing, the degradation of PAHs in soil is usually very slow and this may lead to high toxicity of residual PAHs in surface soil, which is harmful to the ecological environment and may contaminate agricultural products (Zhao et al. 2009). From most developing countries, where waste management is still a serious problem, application and disposal of sludge are done directly on the field which may contaminate the receiving soil intended for agriculture production. In some countires, such as France, Spain and UK, waste from sludge are deposited directly on land and may pose serious danger for farming activities (Kirchmann et al. 2017).

Reports from literature have suggested that soils contaminated with PAH either as a result of sludge application or through anthropogenic sources may pose serious danger for farming activities through the plant uptake of PAHs in soil (Fismes 2002; Meudec et al. 2006; Zhao et al. 2009 and Ashraf and Salam, 2012). The known and reported pathway for the presence of PAHs in plants includes root uptake from soil solution, followed by translocation from roots to shoots during transpiration and absorption by roots or shoots of volatilized organics from the surrounding air by shoots. The other major uptake from contaminated soil and dust may be retained in the cuticle or penetrate through

 doi:10.20944/preprints201807.0370.v1

uptake and transport in oil channels which are found in some oil-containing plants such as carrots (Topp et al. 1986; Duarte-Davidson and Jones, 1996 and Kacálková and Tlustoš 2011).

A study conducted by Fismes et al. (2002) showed presence of PAHs in soil and were detected in all plants grown in contaminated soils but low when compared to the levels in the soil except from peeled potatoes. The study further stated that root uptake was the main pathway for high molecular weight PAHs. Kacálková and Tlustoš (2011) also noted a high phenanthrene concentration in aboveground biomass of sunflower and high concentration of pyrene in maize roots. In a similar study conducted in India on the presence of PAHs in vegetables and fruits, high concentrations of PAH such as benzoanthracene, benzopyrene, benzofluoranthene and benzofluoranthene was recorded in cabbage (8.34 μg kg^{-1}), which turned out to be more than any of the other fruit vegetables. The study further revealed a cumulative dietary exposure of PAHs ranging from 0.20 to 0.85 μg p^{-1} d^{-1} (Ashraf and Salam 2012).

PCBs on the other hand are usually referred to as a group of man-made organic chemicals consisting of carbon, hydrogen and chlorine atoms. They can also remain for long periods recycling between air, water and soil. They have been implicated in causing immune system disorders, dermatological problems, reproductive abnormalities, neuro-behavioral effects and cancer although conclusive cause and effect relationships are difficult to prove (Longnecker et al. 1997). The production of PCBs and many organochlorine compounds has been banned widely for many years in many countries such as America, Europe and other parts of the world, but their residues still remain as contaminants in the environment and food because of their long-term persistence and mobility (Rea, 1996; Lidstrom et al. 2002).

Just like the PAHs, PCBs accumulation in plants can occur through root uptake and translocation to upper plant parts, atmospheric deposition, uptake of both wet and dry contaminated particulates onto exposed plant surfaces and through uptake of airborne vapours by aerial plant parts via the stomata (Lovett et al. 1997). Witczak and Abdel-Gawad (2012) noted in a study on the presence polychlorinated biphenyls residues in vegetables, grain and soil from organic and conventional farming from Poland that PCB residues recorded in the beets from organic farming were high when compared with conventional farming system used.

1.3.3 Toxic trace metals and organic farming

The presence of trace metals in the environment may either come from natural or anthropogenic sources. An increase in the concentrations of trace metals in the environment has been a serious concern recently (Olowoyo et al. 2015). The increase especially from developing countries might be as a result of various developmental programmes that are embarked upon by these countries. With the increase in the amount of trace metals in the environment, they are thus present in air, water and soil. Major problem associated with trace metals in the environment is their non biodegrable nature and as a result they main remain within the ecosystem for a very long period.

According to Jan et al. (2010) food chain is one of the most important human exposure pathways to heavy metals after inhalation and dermal absorption. Several literature have suggested and demonstrated the ability of different plants to act either as an excluder or bioaccumulator of trace metals from the soil (Olowoyo et al. 2010; Nabulo et al. 2011; Lion and Olowoyo 2015). In the case of bioaccumulator, it is possible for plants to uptake or translocate these toxic metals within their tissue and other literatures have also suggested a foliar uptake in some plants (Tomasevic et al. 2010). However, with the bioaccumulators, several factors have been suggested that may affect the uptake of toxic trace metals and these factors include the concentration of heavy metals in soils, soil organic matter content, soil pH , type of the vegetables and species (Rafiq et al. 2014; Xu et al. 2015; Yang et al.2015).

The practice of organic farming is usually carried out with the use of farmyard manure, sewage sludge and also the reuse of treated wastewater for irrigation (Sarwar Qureshi et al. 2016; Nookabkaew et al. 2016 and Kirchmann et al. 2017). The farmyard manure (cow, pig and poultry) has been noted to contain various amount of different trace metals depending on the source and area where collected (Mortvedt 1996 and Gupta and Charles 1999). Over a prolonged period of time and with continuous application of farm yard manure that are contaminated this may result in land contamination by some potentially toxic elements such as arsenic (As), cadmium (Cd), and lead (Pb) in agricultural soils and water resources. Zhao et al. (2014) demonstrated that the application of cattle manure increased soil organic matter content of the soil leading to high productivity but with an accumulation of heavy metals in corn that was fertilized with that cattle manure. The study conducted by Nookabkaew et al. (2016) also showed that concentrations of As and Cd in pig manure were higher than their levels in cattle manure. The study further showed that the use of pig manure as soil supplement resulted in high Cd contamination in G*ynostemma pentaphyllum* a herbal tea used for the study. It was further noted that there was a positive concentration for Cd in plants and the soil. Hence, the study concluded that the application of some organic fertilizers or animal manures to agricultural soil could increase some potentially toxic elements in soil, which may bedetrimental.

The use of treated and untreated wastewater in the urban and peri-urban areas of many developing countries use for irrigation is a common phenomenon (Tyagi et al. 2009; Singh et al. 2010). Farmers believed that undiluted wastewater provides nutrients and is cheaper than other water sources. However, the use of improperly treated and untreated wastewater for irrigation may come with serious problems such as the accumulation of heavy metals in agricultural soils and their uptake by food crops, which might be a potential health risk to the local inhabitants and, thus, increase the risk of contamination in agricultural products (Nabulo et al. 2010). In municipal wastewater treatment plants, human excreta are mixed with other effluents containing metals, organic residues, pharmaceuticals and pathogens (Östman et al. 2014). Khan et al. (2008) conducted a study in China, and reported that there is a build-up of heavy metals in wastewater – irrigated soils and this also increased the concentrations of trace metals in plants grown on the soil and the values recorded for some trace metals in the plants exceeded the permissible limit for human consumption. Weldegebriel et al. (2012) also reported in a study carried out in Ethiopia on the concentrations of trace metals in vegetables that the concentrations of Pb and Cd in the vegetables used for the study were above the permissible limit for human consumption. In the same vein, Sarwar Qureshi et al. (2016) also reported that higher concentrations of iron (Fe), copper (Cu), chromium (Cr) and zinc (Zn) were found in lettuce, radish and carrots irrigated with treated wastewater. The study of Wang et al. (2012) though reported that the levels of Cd exceeded the acceptable limit for agricultural land, however, the concentrations of the trace metals in soils and vegetables were all below the permissible limits set by the Ministry of Environmental Protection of China and World Health Organization.

On the other hand, the application of municipal sludge to agricultural land is an attractive option for disposal because of the possibility of improving soil properties and increasing plant productivity with the recycling of valuable components including organic matter (Liu et al. 2013). However, the use of sludge may also pose a serious danger for consumers of products coming from soil fertilized with sludge. Sludge has been known in some instances to contain high amount of toxic metals (Nabulo et al. 2006, 2010; Khan et al. 2007). Sewage sludge, is a byproduct of sewage treatment processes and made up of pathogenic microorganisms, organic and inorganic components Bourioug et al. 2016). Due to the presence of trace metals in sludge, several documented reports have suggested that it may be necessary to consider differences in metal affinity shown by specific vegetables and fruits before its application on agricultural lands and the soil pH (Bigdeli and Seilsepour, 2008; Li et al. 2007; Lion and Olowoyo 2015). Though concerted efforts have been made to optimize disposal practices by improving sludge treatment, concentrations of pathogens and other pollutants is still a matter of concern (Kelessidis and Stasinakis, 2012). The report from a study conducted by Adekunle et al. (2009) in Nigeria showed that the values of Pb in vegetables planted on soil after the application of sludge exceeded recommended values for human consumption. Similarly, Chary et al.

(2008) and Singh et al. (2010) observed large Zn and Cd hazard quotients arising from consumption of vegetables grown on soil ligated with sewage in India.

Conclusion

With well documented information from literature, there is an overwhelming evidence that plants may uptake different types of both organic and inorganic pollutants from soil when cultivated on soils that are polluted or irrigated with polluted wastewater. Despite this evidence, the practice of organic farming involving the use of sludge, farm yard manure (animal faeces, human urine and faeces) treated and untreated wastewater and the collection of waste from different sources by peasant farmers is on the increase all over the world. Poor farmers and members of their immediate family may be at greater risk especially when organic materials are collected from sources that are unknown and are used for organic farming and production of food to sustain livelihood in all these households.

The legislation that establishes organic farming in most regions of the world provided guidance on how it should be practiced. For instance, the legislation mentioned the use of standard practice in the production of the organic products. Such standard practices includes strictly the use of non-hazardous materials for the farming purpose. However, this is mainly done with large scale farmers who intend to sell their products to any of the European countries. The question one tends to ask is the followings: who examines the products at the local levels especially for the poor farmers that collect waste on the streets? Are there any regulations or information that may guide these peasant farmers on the appropriate use and handling of sludge and waste collected on the streets? How equipped is the present technology as regards the removal of organic pollutants either from the sludge or wastewater? When the products are not for sale at the international market, who examines their safety for human consumption locally?

The techniques involved in organic farming such as mulching, use of farm yard manure and integration of crops and livestock are not entirely new to various agriculture practices. However, organic farming was established based on various laws and certification programs, which prohibit the use of almost all synthetic inputs, and health of the soil is recognized as the central theme of the method. Due to the presence and increase in the levels of emerging pollutants in the environment as established in this review, it may be necessary to provide holistic and adequate information on the pros and cons of organic farming if contaminated materials are used. The study of Mugivhisa and Olowoyo (2015) showed that the majority of respondents in their study had previous knowledge of organic farming but had failed to practise it because they could not afford it. In addition, they thought organic fertilizers, such as dry sewage, human faeces and human urine were unacceptable because of their smell, their unhygienic nature and the respondents' fear of disease epidemics. None of those interviewed had knowledge on the emerging pollutants and their impact on human health. However, half of those interviewed in the study are willing to convert to organic farming, if there are adequate information and education. It seems there are no adequate information as to safe handling and the use of these organic manures in agriculture within these groups of individuals.

Several proposals have been made on how to improve the use of sludge, wastewater and other materials used for organic farming. This should be intensified in order to minimise the risk that may be associated with organic farming. For instance, FAO (1992) revealed that sewage sludge should be subjected to biological, chemical or thermal treatment, long-term storage or other appropriate process designed to reduce its fermentability and health hazards resulting from its use before being applied in agriculture as fertilizer (FAO, 1992). Carnus (2006) also mentioned that when sludge is applied there should be an intensive monitoring of ecosystem components such as plants, soil, water and fauna to identify any possible positive or negative impacts of sludge on plant productivity, on the environment and on human health.

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The use of human urine or excreta as reported by Andersson (2015) may be safe but collection methods and storage capacity should be improved in order to promote safe use especially for peasant farmers. South Africa and other countries have urine diversionary toilet which facilitates the collection and safe use of urine (Mugivhisa and Olowoyo 2015). Since studies have also shown that human urine may contain traceable concentrations of antibiotics or analgesic, it will then be advisable that urine of those on antibiotics or analgesic should not be used for organic farming (Jin 2010; Zhi et al. 2011 and Wang 2014). An ongoing study from Mugivhisa and Olowoyo (2016) have shown that spinach fertilized with urine that contains antibiotics have a traceable amount of the antibiotics in the vegetable. Similar observation had earlier been made by Wu et al. (2013) where antibiotics were detected in the vegetable used for the study.

Generally, it was never the intention of the authors to discredit organic farming especially looking at the enormous advantage posed by it for poor people, however, strict guideline and adequate information should be provided by government agency on the safe practice of organic farming so that the unexpected negative impact will not overshadow the positive aspect of the farming method.

Improved and renewed efforts need to be geared towards the removal of persistent organic pollutants in the environment. This may include the introduction of new technology within the waste treatment plants and research into the ability of different plants that can bioaccumulate these pollutants from the soil.

It is also the view of the authors that concerted effort should be placed on the awareness, training and education of the peasant farmers on how, when and the type of organic materials that should be used for organic farming in line with the legislation.

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