FARMING, EXCRETA AND HEALTH IN TAMALE METROPLITAN AREA-AN ENVIRONMENTAL PERSPECTIVE

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Abstract

Poverty and the rising cost of synthetic fertilizer have compelled backyard gardeners to resort to wastewater irrigation and excreta fertilization in Tamale. Research has indicated that soil texture and nutrients are improved greatly if sludge and wastewater are used for crop production because excreta contain all the nutrients needed for plant growth but may be supplemented for potassium. Infectious organisms such as bacteria, viruses, protozoa and parasites (worms) are found in sludge. Three methods were used by the farmers: Surface spreading method-55%; Pit method-17%; and Spot method-28%. Those who apply four trips of excreta per acre acquired more yield (15 bags/acre of maize) than those who applied less than four trips of faecal sludge.
Keywords: Pathogens, Excreta, Hazardous, Bacteria, Compost, Plough, Cespit tanks

Introduction

People in the pereurban settlement of Tamale may have little or no money, goods, or means of support to satisfy their needs. These needs include food, clothing, shelter, health and education. The effect of poverty may be harmful to the individual and the society. For instance, 70% of energy in sub saharan Africa comes from traditional sources such as wood (DFID et al, 2002) and 80% of more than 2 million annual deaths of women and children are due to indoor pollution (UNDP 2002). Also, nearly1.2 million women and girls under 18 are trafficked every year for prostitution (WHO 2002) for lack of jobs.

To overcome poverty in rural settlements of Tamale, the inhabitants engage themselves in backyard gardening. Crops such as maize and rice are cultivated yearly while vegetables like ayoyo, cabbage, okro and tomatoes are cultivated all year round depending on the availability and accessibility of excreta for fertilization and water from the streams and gutters for watering.

The sources of fertilization of crops are either manure or synthetic fertilizer. However the high cost of synthetic fertilizer (50 Ghana Cedis/bag) has made farmers to shift their attention to human excreta (10-20 Ghana Cedis/trip) which equally has high nutrient value like chemical fertilizer. However, it is suspected that, farmers who use excreta and those who live within a radius of one kilometer of application may be at risk (Lewis and Gattie, 2002). Treated sludge is 95% free from pathogenic bacteria and meant that even treated sludge can be harmful and hundreds of people have fallen ill after been exposed to faecal sludge (Lewis and Gattie, 2002). When faecal sludge is composted, metallic contamination may also be reduced (Lehmann *et. al*, 1983), The lack of protection of the farmer, the closeness of farm lands to water sources

and dwellings of people may be hazardous to the farmer and pose serious environmental risk to neighbours if appropriate measures are not taken.

Potable water for vegetable production is constrained because more than 40% of people living in cities lack good drinking water. Irrigated water available for use comes from different urban sources including gutters which are highly polluted (WHO, 2002).

Research indicates that humans excrete 30g of carbon (90g of organic matter) 10-12g of Nitrogen, 2g of phosphorus and 3g of potassium which are essential for plant growth. Wastewater is used as irrigated water as well as a source of plant nutrients, allowing farmers to reduce or even eliminates the purchase of chemical fertilizer. Faeces contain most of the organic matter while urine contains Nitrogen (70-80)% and potassium. Phosphorus is found between urine and faeces. Micronutrients such as zinc, copper and iron are also present in sludge. The added organic matter enhances soil quality making clayey soils more permeable to water and air and increasing the water and nutrient holding capacity of sandy and gravel soils. Part of Nitrogen however may be lost during storage and treatment through ammonic vitalization so complementary fertilization must be sought. Soil texture is likely to be improved greatly if sludge is used. Excreta therefore serve as a soil conditioner and humus replenishing which is not shared by chemical fertilizers.

The nutrient level of excreta is sufficient for a person to grow its own food (Drangert, 1998) and so the use of sewage for crop production whether legal or illegal is necessary to compensate for scarce or costly freshwater resources and boost crop production. Also the youth in the Metropolis are idling for lack of jobs and so backyard farming is a panacea to their unemployment. Social vices due to lack of jobs would be minimized because backyard gardening engages the youth to get income for their use.

Both rural and urban areas have been using excreta to maintain soil organic fraction. Faecal sludge is collected from septic tanks and public toilets. This practice is common in China and Southeast Asia as well as in Africa (Cross 1985; Visker, 1998. Timmer 1999, Stranss *et al* 2000). Faecal sludge relates to urban rather than rural agriculture because of the volume of excreta generated in urban areas. This has made the urban farmer a recycler of waste for food production. Piped distributed wastewater is recently being used for citons trint farms in Tunis and vegetable farms in Lima (Stranss and Blumenthal 1989). Iqbal (1999) has observed that Duckweed was produced in sewage fed panels for fish and duck feed for 3—40 years in Taiwan. 100% of wastewater from cities of Santiago (Chile) and Mexico are used for irrigation. In South Africa 15 – 20% of the wastewater is reused in Agriculture (Khouri *et al.* 1994). In Morocco, 16% of its wastewater is used (Bendekroun, 1991).

A study conducted in Kumasi, Ghana, showed that Urban and peri-urban agricultural soils are greatly depleted of organic matter and nutrients (N and P) (Leitzinger, 2000; Betevi *et al*., 2000). Reuse of urban wastewater for urban agriculture might cover a substantial portion of water demand for agriculture and save the national water budget for domestic usage. This will ensure income generation, socio-economic equity and urban food security (Shaat, 1998). In seasonally dry zones such as Tamale irrigated water requirement may be between 80 – 90% of natural water while urban water supply is left with a small portion. Wastewater reused is therefore necessary in dry seasons whether regulated or not (Stranss and Blumenthal, 1990; Nunan, 2000).

Farmers in Tamale transport sewage directly to farms in the urban fringe to fertilize their maize and cereal farms. It is not known whether farmers will prefer treated sludge to the direct faecal matter. People who fear chemical pollution are likely to patronize sewage fertilized vegetables than chemically fertilized ones.

Infectious organisms such as bacteria, viruses, protozoa and parasites (worms) are found in sludge and occasionally killed by composting and irradiation. However only heating can kill the eggs of intestinal parasites. Crop irrigation with untreated wastewater may therefore cause excess infection with Intestinal nematodes in both consumers of the irrigated crop and those who work in the irrigated fields. The latter, especially if they walk barefooted, are likely to have more intense infections, particularly of hookworms,

than those not working in wastewater irrigated fields. Crop irrigation with adequately treated wastewater might not have excess intestinal nematode infection among field workers or consumers unless prevalent conditions favor prolonged survival of nematode eggs which may still be contained in the irrigated water. Cholera and probably typhoid can effectively be transmitted by the irrigation of vegetables with untreated wastewater.

Cattle grazing on raw wastewater irrigated fields may become infected with beef tapeworm, but there is little evidence for actual risks of human infection. Even though there is fear of infection there is limited evidence that the health of people living near fields irrigated with raw wastewater may be negatively affected either by direct contact with the soil, or indirectly through contact with farm labourers. High standards of personal hygiene may prevent infections due to exposure to pathogens.

Sprinkler irrigation with treated wastewater may promote the aerosolized transmission of excreted viruses, but disease transmission is likely to be rare since most people have high levels of immunity to viral diseases in endemic communities. Children may become infected by nematodes by getting into contact through work or play with wastewater, which may not have been treated to a near zero concentration of nematode eggs. For viruses, Person to person transmission is the predominant route and immunity is developed at early age in endemic areas (Blumenthal *et al.*, 2000) but may be transmitted through vegetables. Bacterial die-off in urine is rapid (Stenstron *et al.,* 1999) than virus. Pre-application storage contributes to die-off.

Excreta related diseases are common and faecal sludge and wastewater contains concentrations of excreted pathogens such as bacteria, viruses, protozoa and the helminthes (worms). Excreted pathogens may be classified based on epidemiological and environmental factors (Stenstron *et al.,* 1999). Faecal coliforms are indication of disease causing organisms and when exposed to the sun, survival periods are shortened. Health risks associated with the use of excreta are as a result of the intensity and frequency of pathogenic infections (Shuval *et al.*, 1986; Blumenthal, 1999). Due to insufficient personal hygiene, contracting skin lesions or enteric infections is usually unavoidable.

Consumers may also suffer longer – term effects from consuming untreated wastewater which are chemically contaminated. Chemical contamination is another potential risk associated with excreta use. Chemical constituents such as heavy metals accumulate in soils and may put urban agriculture at risk. The uptake of chemicals by plants is likely to have a long term effects in humans (Chang *et al.*, 1995) and (Birley and Lock, 1997). Chemical constituents must be considered when faecal sludge or wastewater is to be used for soil amendment, to restore soil fertility in damaged soils or for irrigation. Sludge application may be restricted to limit the accumulation of heavy metals or by regulation regarding the maximum yearly load (kg/ha/year) of specified heavy metals (Mathews, 1996).

Treated faecal sludge may be less polluted. Due to pretreatment before discharge into the municipal sewerage systems, heavy metal concentrations in industrialized countries have been declining lately. Apart from domestic sewage all other sewage are likely to contain heavy metals. Chemical exposure to humans is through the food chain and so primary consumers of food should be protected from infection and contamination.

Laws enacted in developing countries e.g. Ghana is hardly enforced because compliance is economically unfeasible and enforcement is institutionally impossible. Therefore wastewater reuse is uncontrolled or may not be prohibited because monitoring and control cannot be implemented. WHO guidelines are based on the objective that there should be no excess infection in the population. This was strongly criticized by critiques who think that there should be a zero-risk and advocated for guidelines which will eliminate pathogenic organisms completely in wastewater.

To minimize health hazards due to chemical and pathogenic infection treated sewage should be adopted (Winblad, 1997; Esrey *et.al*. 1998) especially for dry season gardening. Planners and decision makers must therefore make treated sewage use in agriculture a part of urban strategic sanitation and infrastructure planning policy.

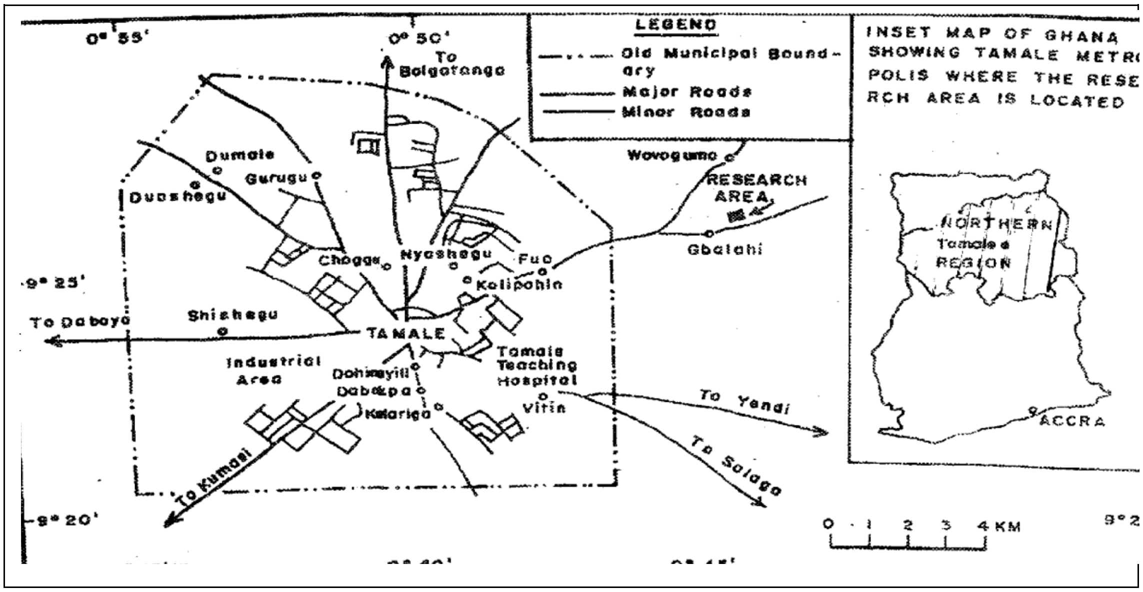
Conceptual Framework of the Research

The main objective was to find interventions to excreta use in farming to minimize pathogenic bacterial infection of vegetable consumers and farmers who use human excreta to fertilize their farms and to assess their level of understanding of sanitation and hygiene. The specific objectives are:

To monitor the volume of sewage generated and transported to the treatment ponds in Tamale
To assess the taste of the people in the use of sewage in Tamale
To suggest appropriate interventions to the users of raw sewage to minimize the exposure to enteric bacteria.

Study Area and Methodology

The population of Tamale Metropolis (Fig 1) is about 400000 (GSS, 2000) and lies between latitude 9^0 18^1 North and 9^0 26^1 South and between longitude 10 $^05^1$ South and 10 $^03^1$ West. Tamale Metropolis covers a land mass of 922 square kilometres. It has distinct raining and dry seasons with rainfall amount of 1000 millimetres per annum (GMSD, 2002). The study communities are: Kpalsi, Dungu, Kpawumo, Nyanshegu and Zagyuri. The people in these areas are peasant farmers. Land uses in the area are challenged with encroachment of farm lands by housing development, Crops are destroyed by animals due to urbanisation. One hundred and forty (140) sets of questionnaires were administered in the selected communities using purposeful sampling alongside physical observations to ascertain baseline information on the impact of on-site application of faecal matter and wastewater irrigation on vegetables and farms.



Kpalsi and Dungu were involved in raw faecal fertilization while Zagyuri, Kpawumo and Nyanshegu irrigated their vegetables (Ayoyo, Cabbage, Okro and Tomatoes) with water from nearby gutters taking their sources respectively from the Kamina barracks, Gariba lodge and Gumbihini areas.

The questionnaires were analyzed using Statistical Package for Social Scientists, Version 16.0 and Microsoft Excel.

Results and Discussion

Out of a population of 139 respondents 45.3% of the respondents preferred crop production using sewage (Table 1). Fish production, composting and irrigation were respectively 19.4%, 18.7% and 16.5%. This showed that, people in Tamale prefer using sewage directly for crop production.

Table 1. Choice of use of sewage by respondents in Tamale

Preferred use	Frequency	Percent
Fish production	27	19.4
Crop production	63	45.3
Irrigation	23	16.5
Composting	26	18.7
Total	139	100.0

It was noted that majority of the respondents (38%) in their productive age (Between 20 and 40) would prefer the use of excreta for crop production (Table 2).

Table 2. Preference of sewage use by ages in Tamale

Age	Fish production	Crop production	Irrigation	Composting	Total
Less than 20	8	17	3	3	31
Between 21-30	9	20	11	14	54
Between 31-40	3	18	6	9	36
Between 41-50	4	4	1	0	9
Between 51-60	1	3	1	0	5
Others	1	0	0	0	1
Total	26	62	22	26	136

No fertilizer supplement is added because the water is made up of suspended faecal matter. Insecticide is however used to protect the vegetables from being invaded by insects. Vegetable production is done all year round. Kpalsi and Dungu engage in annual farming of maize and rice after the fields are fertilized with excreta for at least three months before ploughing.

Faecal sludge is acquired illegally at a cost between 10-20 Ghana cedis from the Tamale Metropolitan assembly, Prison Service and University for Development Studies septic tanks. The cost is depended on the relationship between the driver and the farmer. The use of raw sewage and sludge from toilets and homes saves treatment cost but have the tendency to transfer disease causing organisms to farm workers and consumers.

Irrigation of effluents provides plants with nutrients. Use of sewage to reclaim soil nutrients must be carefully managed to minimize risks to public health and to the environment. Both primary and secondary treatments produce solids or sludge. The solids are digested by micro organisms that grow well without oxygen in an anaerobic pond. Under anaerobic conditions the process kills a lot of disease carrying organisms in the sludge, stabilize it and remove most of the odor.

Farmers at Dungu and Kpalsi subject sewage effluent to irradiation to kill pathogenic organisms. However the length of waiting (three months) for the complete die offs of the bacteria is too short. At least one year application before farming is ideal to kill all pathogenic bacteria (Jane, 1986). The usage of sludge on

farmlands may vary. Some of these uses besides crop production are: Applying to forest, Reclaiming disturbed land and Landscaping.

These three other uses are not practice in Tamale and policy and decision makers must take steps to access their viability in reclaiming the disturbed lands as a result of sand winning and to green Tamale.

Sludge contains heavy metals, toxic organics and harmful organisms. High nitrogen content can also contaminate groundwater or surface waters. There may also be bad odor, which could have an impact on land value. Public acceptance may be questionable to the success of sludge application. Effective management practices and monitoring are essential to mitigate any health risks. Dirt and disease causing organisms may get directly into the system of human beings through transmission vectors such as the housefly. Sludge sprayed on plants may dry and adhere strongly to the leaves and may not be washed off even by rain. Metals may be absorbed by the roots of plants eg. Mushroom, carrots and radishes. Grazing animals may take in toxins. Ingested toxins accumulate in the liver, kidneys or the bone. Dirt may be ingested during play activities. Lead, mercury or arsenic poisoning may lead to brain damage, behavior problems, poor learning, irritability and depression.

Water monitoring should be part of sludge application because metals may be washed into rivers during run off or leaching. Dosage of sludge to sandy soils, land treatment, irrigation or recharging of groundwater may contaminate ground or surface water. Green leafy vegetables and root vegetables such as beets and carrots may absorb cadmium. More cadmium is taken in soils with pH less than 6.5. Cadmium accumulates in the kidney and cause irreversible kidney damage. Bacteria present in sludge are salmonella and bovine tuberculosis. Sludge also contains hepatitis A and poliovirus. Protozoa such as those causing amebic dysentery, giardiasis and balantidiasis may be present in sludge. Management techniques can prevent virus and bacterial infection but more research needs to be done to find their concentration in sludge.

In the treatment process of sewage the solid part or sludge is collected on a wire mesh. This sludge could be used for composting or even direct application as organic fertilizer for crop production. The effluent in the discharge pond undergoes anaerobic digestion for about a month. Sludge continues to break down and most disease causing organisms also die. The effluent is released into the primary facultative pond where further digestion of solid particles and decomposition takes place. Effluent in the primary facultative pond is release for irrigation since it contains very high nutrients such as N, P, K or its released to the secondary facultative pond. Effluent in the secondary facultative pond can be used for fish production or be released into the aerobic pond for further treatment for domestic use or be released into existing water bodies.

A range between two to four septic tanks per acre was common among the farmers. Those who apply four trips per acre acquired more yield (15 bags/acre of maize) than those who applied less than four trips of faecal sludge. The farmers usually acquire the sludge and allow the high savanna temperatures to dry it before the start of the rains in April. Exposure to the Savanna temperatures reduce survival periods of pathogenic organisms (Feachem *et al.*, 1983) as temperature contributes to die off. However, some organisms are able to survive higher temperatures (Feachem *et. al*, 1983) and the safety of the farmer and the vegetable consumer cannot be guaranteed.

The costs of sludge utilization as fertilizer may be less than the costs of disposal even if District and Metropolitan Assemblies will have to pay for some or all of the costs of transportation and application to the land. Extension service workers of the Ministry of Food and Agriculture must educate farmers on the safe use of excreta in farming. The Ministry of health through their community health programmes must also educate consumers on the usage of vegetables produced from sewage fertilized farms. Periodic screening of farmers by the Ministry of health is also necessary to ensure that, the farmers are healthy to provide their valuable service to the nation.

Excreta is usually dumped untreated on farm lands be it an open ground, ditches or water sources and this could lead to pollution of water bodies during runoff. The volume of excreta that is used for farm fertilization cannot be quantified because it is illegally acquired. Faecal sludge is forbidden to be sold by

the Metropolitan assembly but no attempt is made to monitor its conveyance to the treatment ponds. This is normal because laws are hardly enforced in the country especially in Tamale. Three methods were used by the farmers: Surface spreading method-55%; Pit method-17%; and Spot method-28% (Plate 1a-c).

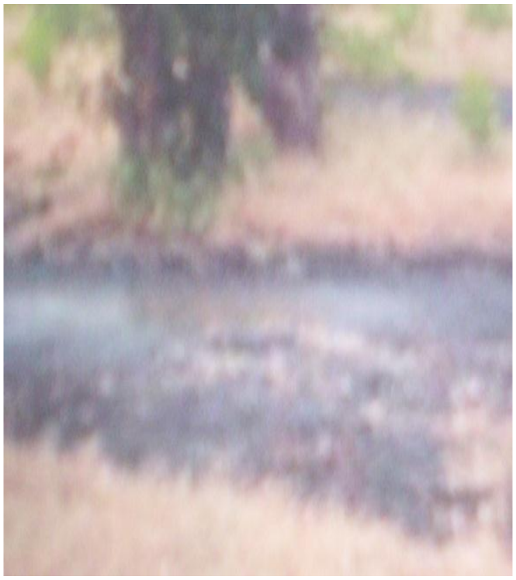


Plate 1a- Surface Spreading Method
Source: M. Issah, 2009.

Plate 1b-Pit Method
Source: M. Issah, 2009.

Plate 1c-Spot Method
Source: M. Issah, 2009.

Plate1d-Children Playing Around Pit
Source: M. Issah, 2009.

In plate 1d, children in one of the villages were spotted playing around a faecal pit. Apart from the possibility of falling into the pit, they were exposed to bacteria in the soil because they were barefooted. They also breathed in the sting scent emanating from the excreta that could give them headache.

Sewage discharge was highest during the wet months (September and November) and lowest during the dry months because normally water related domestic activities increase in the rainy reason. Also it is in the dry season that sewage is acquired and used to fertilize farms in readiness for the next farming season. The discharge of sewage to the plant was regular and varied throughout the months (Fig 3), an indication that sewage treatment ponds would always have water for irrigation and treated sludge for fertilization.

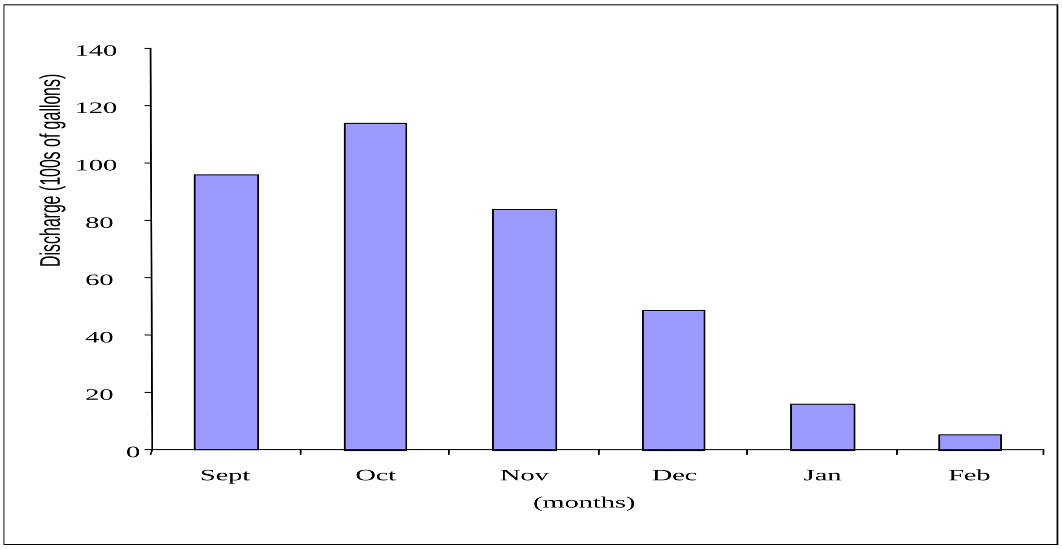


Fig 3. Discharge into the ponds from September 2006-February 2007

The survey indicated that 62% of the farmers use wellington boots, 30% use gloves while 8% used nose mask to ensure personal safety. It is therefore obvious that farmers who use faecal sludge fertilizer were inadequately protected and were at risk of viral and bacterial contamination. Moreover personal hygiene was not adequately observed before interacting with family members from the farm and so family members were at risk of contamination.

Table 4. Complaints by farmers using human excreta as fertilizer

Complaints	Collection (%)	Spreading (%)	Weeding/Harvesting (%)	Total (%)
Diarrhoe	5	5	5	15
Vomiting	5	5	0	10
Skin sores	0	0	10	10
Skin rashes	25	25	25	75
Foot rot	2	55	55	112
Headache	63	10	0	73
Scabies	0	0	5	5

Vegetables such as tomatoes produced from excreta fertilized farms may not be properly washed before use especially in the dry season when cooking is mostly done at the farms, as a result, some farmers' complaint

of body disorders (Table 4). The exposure to human excreta and contamination of farmers could have led to the acquisition of various forms of diseases (Strauss *et. al* 2000). The complaints associated with human

excreta users are diarrhea, vomiting, skin sores, skin rashes, foot rot, headache and scabies. Further research is needed to establish that these complaints are as a result of excreta use (Table 4).

To safe guide the situation treated sludge that has minimal pathogenic and chemical contamination should be used for farming. Farmers are advised to wear protective clothing when dealing with excreta. Consumption of crops must be restrictive since crops produced out of excreta fertilize farms must be washed thoroughly or be disinfected before use.

Conclusion

Excreta may be cheaper, rich in nutrients and gives higher yield as compared to chemical fertilizer. However, the use of excreta could lead to outbreak of diseases if not managed properly. To minimize the health risk as a result of the use of excreta by farmers a multisectorial approach could be adopted, guided by legislation and given education by the ministry of food and agriculture. The developmental partners in the water and food sectors should be given the necessary capacities to assist farmers in order that the scarce water sources in poor countries would not be contaminated. Also the use of excreta for farm fertilization should be legalized so that appropriate interventions could be adopted to help protect farmers.

Recommendations

Towards reducing health risk, water and environmental pollution incidents from sludge fertilization:

1. EPA should provide guide lines on:
- The quality of sludge.
- Soil characteristics eg. pH and cation exchange capacity for given volume of sludge.
- Drainage patterns and crops that can be cultivated on sludge fertilizer farms.
- Application rates of sludge.
2. Water sources should be sited up streams beyond 50m from farm lands that use excreta.
3. Communities and stool lands should be willing to release more land at appropriate sites for such developments.
4. Indiscriminate use of excreta in communities should be discouraged.
5. Regular cleaning of the body with disinfectants should be extremely valued and practiced.
6. Use of protective clothing such as nose mask, boots, cover alls and hand gloves should be encouraged by farmers who use human excreta.
7. Ministry of food and agriculture should train farmers on the effective use of excreta for crop production to avoid health risk.
8. A treatment plant should be established by government, Nongovernmental organizations and the local authorities to enhance treatment of excreta.
9. Farmers should be educated not to use faecal sludge every year since organic manure has a residual period of at least 5 years depending on crop type.
10. There should be a collaborative effort between the Ministry of health, Ministry of agriculture, and the Ministry of water resources works and housing to ensure that the use of faecal sludge by farmers should be devoid of any health risk.

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