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Importance and Applications of Human Waste could be Help the Shortage of Chemical Fertilizer in India

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INTRODUCTION

Nowadays, one of the greatest problems in agriculture is the depletion of fertilizers. To replenish the essential macro elements in the soil, alternative methods should be utilized. Using human excreta instead of artificial fertilizers may be a viable option, but it requires treatment before application. Several existing methods can achieve this. Human urine can be used as a fertilizer without any treatment, although some minor preparations are necessary before application (Pradhan *et al*., 2007). However, people need to change their attitude towards the use of flush toilets since the waste water infrastructure of flush toilets has many harmful environmental effects, such as eutrophication or water pollution when waste water treatment is insufficient, and it wastes the nutrients (such as nitrogen, phosphorus, and potassium) of human excreta. Using dry toilets could eliminate many environmental problems caused by flush toilets (Anand & Apul, 2011). Composting toilets, urine-diversion toilets, and incinerating toilets are among the many types of dry toilets available. By using a composting toilet, the human excreta can be composted. Urine-diversion toilets separate human urine from feces immediately after excretion. Incinerating toilets burn the excreta and can also generate electricity. It is also a good idea and possibility to use these types of dry toilets in developing countries.

Up to 60-70% of nutrients discharged from fields end up in toilet waste. Following sustainable development principles, nutrients in feces should be used in plant production instead of ending up in wastewater treatment plants. In Nordic countries, less than half of sewage sludge is utilized in agriculture due to negative attitudes and concerns about environmental and health hazards. Attempts have been made to improve this situation by enhancing the quality of sewage sludge and finding new treatment methods and functions for it.

Composting toilets and toilets with urine separation make it possible to reclaim and utilize human excreta in the home, reducing water consumption significantly. Since little or no black water is produced, nutrient releases and intestinal bacteria fail to spread in the environment.

Composted toilet waste is suitable for soil conditioner and urine for liquid manure in the yard and garden. However, composting and separating toilets and the recycling of fecal nutrients have not gained enough popularity due to device malfunctions, public prejudice, and lack of information. Human feces are considered a valuable nutrient source in several countries, such as China, Japan, Korea, Africa, and South America, where nutrients of feces are utilized in agriculture. In the Nordic countries, plant nutrients are collected in wastewater treatment plants, and a significant portion pollutes the environment depending on the system used. Recirculation of nutrients from urban areas to agricultural land is one of the major challenges of our time. The annual amount of toilet waste is approximately 520 kg/person, including 7.5 kg of nitrogen, phosphorus, and potassium and some micronutrients in a form useful for plants. If the nutrients in the feces of one person were used for grain cultivation, it would enable the production of the annual amount of grain consumed by one person (250 kg). Composting and separating toilets have enabled the reclamation of human excreta and the use of its nutrients as fertilizers and soil conditioners. In Sweden, organic farmers have expressed interest in using human urine as liquid manure due to its macronutrient content and low heavy metal content. However, if the circulation of human feces between urban and rural areas increases, it must be ensured that the quality and fertility of soils are not negatively affected in the long term. This requires research on the efficiency and environmental impacts of these organic fertilizers.

Human waste can indeed help to alleviate the shortage of chemical fertilizer in India. As mentioned earlier, India is heavily dependent on chemical fertilizers to maintain agricultural productivity. However, the overuse of chemical fertilizers has led to soil degradation and reduced crop yields. This, coupled with the high cost of chemical fertilizers, has led to a shortage of affordable fertilizers for Indian farmers. Human waste, on the other hand, is a rich source of nutrients such as nitrogen, phosphorus, and potassium, which are essential for plant growth. By using human waste as fertilizer, farmers can reduce their reliance on chemical fertilizers and improve soil health. Moreover, human waste is often readily available in rural areas where sewage systems are absent, making it an accessible and cost-effective alternative to chemical fertilizers.

Several initiatives have already been taken in India to promote the use of human waste as fertilizer. The government of India launched the "Swachh Bharat Abhiyan" (Clean India Mission) in 2014, which aims to improve sanitation and promote the use of composted human waste as fertilizer. Moreover, several non-governmental organizations (NGOs) are also working towards promoting the use of human waste as fertilizer.

Application of sewage sludge in agriculture

In the Nordic countries, agriculture utilizes between 30 to 48% of sludge. This sludge is rich in organic matter and nutrients, primarily nitrogen and phosphorus, making it an ideal fertiliser and soil conditioner. While sludge contains low levels of other macro-nutrients, lime-stabilised sludge does contain substantial amounts of calcium and magnesium. Approximately half of the micro-nutrients present in sludge, such as copper, zinc, and manganese, are beneficial to plants. However, the nutrient balance in sludge does not entirely match the nutrient needs of plants, as sludge is low in nitrogen but high in phosphorus. As nitrogen removal from wastewater becomes more efficient, the amount of nitrogen in sludge will increase. The fertilizing impact of

the nitrogen and phosphorus in sludge is long-lasting, with phosphorus taking several years to be released into the soil for plant use. The use of sludge in agriculture increases the amount of organic matter in the soil, which improves soil structure, water retention, and microbe activity. It also binds harmful substances, such as heavy metals, thus preventing their impact on the soil. Sludge is most advantageous in mineral soils.

Application of human Faeces as soil conditioner

On average, a person produces approximately 100-200 g of faeces per day with a dry matter content of around 20%. The faeces contain a diverse ecosystem of micro-organisms, including bacteria, viruses, protozoa, and fungi, with bacterial numbers ranging up to 10^10/g depending on diet. However, the accuracy of these numbers is not consistent due to the uneven distribution of micro-organisms in faeces and the inability to culture many of them. Enteric pathogens are often found in human faeces and can be spread to others if proper hygiene practices are not followed. To prevent the spread of pathogens, raw or partially composted faeces should be composted with bio-waste and garden waste for at least six months, including summer months, before being spread on the ground. However, little research has been conducted on the nutrient content and hygienic quality of composted toilet waste, and as a result, it is rarely used as a soil conditioner or fertiliser for household vegetables. Utilisation of the nutrients in sludge, urine, and toilet manure still functions poorly in Swedish eco-villages according to research by Hagalund and Olofsson (1997).

Application of human excreta as compost in the agriculture

The use of human excreta has been recognized since ancient times, with some sources indicating its high value. This practice has been supported by recent publications, demonstrating its effectiveness. There are four main methods for treating human excreta. The first method is through the use of flush toilet-based sewage systems, where the excreta is transported to a waste water treatment plant or released without treatment into freshwater or oceans. The second method is by applying raw human excreta directly onto agricultural fields, known as "night soil" in Asia, which may pose a risk of disease transmission. The third method involves slow composting, which is commonly used in commercial composting toilets, and eliminates most disease organisms over a period of months. The fourth method is thermophilic composting, which utilizes thermophilic microorganisms to create an environment that destroys disease organisms, resulting in safe humus for use in food gardens. Composting toilets can be used to implement these methods, and typically consist of three elements: the toilet base, a container (which can be a simple bucket), and cover material, such as plant strings or cellulose. The goal in designing composting toilets is to create an effective process for producing high-quality humus from human excreta.

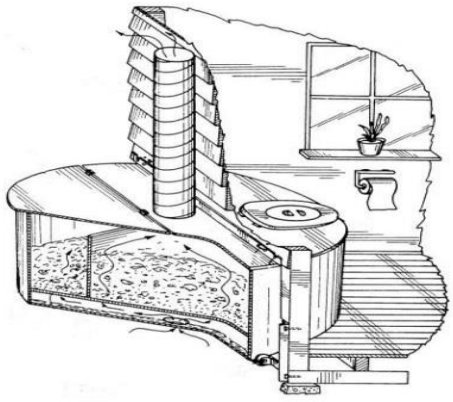

Figure 1: A typical composting toilet accepting kitchen waste and human excreta

By using composting toilets, the human nutrient can remain in the nutrient cycle. The human nutrient cycle is an endless natural cycle, where food for humans must be grown on soil that is enriched by the continuous addition of organic materials recycled by humans. (Figure 2). Since the paper is about the utilization of human excreta in the agriculture, it is important to note, that human urine contains the most of the nutrients out of human waste.

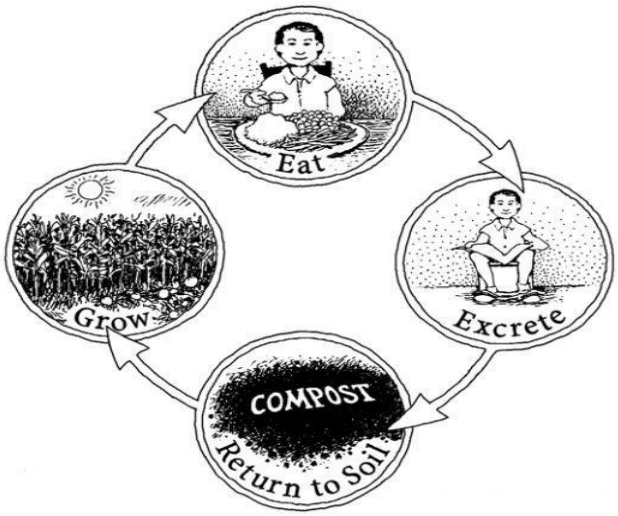

Figure 2: The human nutrient cycle, using human excreta in the agriculture as a natural fertilizer

Importance of Human Waste in Indian Agriculture

Human waste, including feces and urine, is considered a valuable source of nutrients for agricultural crops in India. Farmers in India have been using human waste as a fertilizer for centuries, and it has played a crucial role in sustaining the country's agriculture. Here are some of the key reasons why human waste is so important in Indian agriculture:

- Nutrient-rich: Human waste is a rich source of nutrients like nitrogen, phosphorus, and potassium, which are essential for plant growth. When used as a fertilizer, it can provide these nutrients to crops, which can improve their yield and quality (Karak & Bhattacharyya, 2011).
- Cost-effective: Using human waste as a fertilizer is cost-effective, especially for small-scale farmers who may not be able to afford expensive chemical fertilizers. It also helps reduce the cost of waste management for municipalities, as human waste can be converted into a valuable resource for farmers.
- Sustainable: Using human waste as a fertilizer is a sustainable approach to agriculture, as it helps to close the nutrient cycle and reduce the reliance on chemical fertilizers. It also reduces the amount of waste that needs to be disposed of in landfills, which can help reduce environmental pollution.
- Improves soil health: Human waste contains organic matter, which can help improve soil health and fertility. When used as a fertilizer, it can help to increase the soil's water-holding capacity, reduce erosion, and promote microbial activity.
- Boosts food security: Using human waste as a fertilizer can help increase crop yields and improve the quality of food produced, which can help to boost food security in India. It can also help to reduce the country's dependence on imported fertilizers, which can be expensive and environmentally damaging.
- Despite the benefits of using human waste as a fertilizer, there are also potential health risks associated with its use. It is

important to ensure that the waste is properly treated and processed to reduce the risk of contamination by pathogens and other harmful substances. Proper sanitation facilities and waste management systems are crucial to ensure the safe and effective use of human waste in agriculture.

CONCLUSIONS

The use of human excreta as a valuable source of nutrients in agriculture should be promoted to replace artificial fertilizers. However, there are still unanswered questions that need to be researched before human excreta can be widely used in plant production. Sewage sludge is currently the most important municipal waste used for agricultural purposes in Nordic countries, and its quality needs to be improved to meet the requirements. Strict quality control is necessary to assure consumers that composted products will not cause any problems. Further studies are needed to determine the nutrient content and hygiene of composted faeces and urine. Prejudice and a lack of information are hindering the utilization of toilet waste, so efficient information dissemination is essential to influence public opinion. The development of functional, easy-to-use, and hygienic composting and separating toilets that can compete with flush toilets should also be promoted. Many present models require too much time and trouble from users, which reduces their popularity.

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