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An assessment of the effect of human faeces and urine on maize production and water productivity

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Abstract

The key challenge facing many catchment authorities in Zimbabwe and elsewhere is the challenge of feeding the growing populations within their catchment boundaries. Modern agricultural practices continue to mine valuable crop nutrients through increased food production to satisfy ever-increasing food demand. In recent diagnostic survey of smallholder agricultural sector in the Manyame catchments of Zimbabwe it was revealed that exhausted soils depleted of their natural mineral and organic constituents by many years of cropping with little fertilization or manuring were the major factors contributing to low yields and poor food security in this sector in Zimbabwe. The objective of the study was to assess the effect of using sanitized human excreta on maize production and water productivity. The study involved six volunteer farmers with four 10 m × 10 m trial plots each with the following treatments the control, commercial fertilizer treatment urine only plot, and the feacal matter and urine plot. Harvest determination was carried by weighing the yield from each of the treatment plots and comparisons done. Water productivity was computed by calculating the amount of water used to produce a tone of maize per ha. The study showed that human excreta improves maize crop production and water productivity in rain-fed agriculture. The study recommends that the ecological sanitation concept and the reuse of human excreta both humanure and (ecofert) urine can be considered as alternative excreta management options in catchment areas.

Keywords: Ecological sanitation; Human excreta; Humanure; Ecofert; Water productivity

1. Introduction

The challenge of feeding tomorrow's world population is largely dependent on improved water productivity and making optimal use of the available land. This could be achieved by improving soil fertility management by using readily available nutrients from ecological sanitation toilets. Rain-fed agriculture plays an important role in this respect because 80% of agricultural land world-wide is under rain-fed agriculture (Rockstrom et al., 2003). It is anticipated that water productivity enhancement in rain-fed agriculture could be achieved by integrating nutrient recycling through human excreta use.

Global crop nutrient sources, especially potassium (K) and phosphorus (P), continue to be depleted as the demand for food to satisfy growing world population increase. It is estimated that the current world phosphorous reserves will only last for 100–150 years (Otterpohl et al., 1996). The known reserves of currently exploitable phosphate rock are estimated at about 40 billion tons. At the peak rate of consumption (150 million tons per year) these reserves will last more than 250 years. In addition there are vast phosphate resources present in the earth crust which, with today's technology, are not yet commercially exploitable. Although nitrogen is the earth's most abundant element (the atmosphere is 78% nitrogen gas) and an essential

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component of all life, plants can only use nitrogen fixed with hydrogen and oxygen in the form of inorganic compounds. The current over-exploitation of nitrogen from the atmosphere in the production of artificial fertilizers is going to upset the nitrogen balance (Gijzen and Mulder, 2001). The global fertilizer consumption has generally risen over the past years (Fig. 1) and if this trend is not reversed soon, will lead to an unsustainable food production situation. It is therefore important that humankind aim at efficiently utilizing the available resources so that they would also be available to future generations. Some schools of thought suggest the use of short, closed cycles in water and waste management. They argue that the logical path/way of disposing human waste is in agriculture as this makes use of valuable nutrients, whilst at the same time avoiding environmental pollution associated with excreta disposal into water bodies.

The cost of commercial fertilizers cannot be afforded by most poor societies and this is also the sector that does not have access to cattle manure, thereby forcing these people to do without these fertilizers. To ensure sustainable food security is achieved through increased food production, it is essential that cheap and readily available nutrient sources are considered. It is for this reason that ecological sanitation, *ecosan*, is now being promoted, offering an alternative to artificial fertilizers, with the added benefit of soil conditioning. In fact, each person is capable of producing enough fertilizer for his food needs (Table 1).

This paper is based on a study on the potential for utilizing human waste (faeces and urine) for the production of maize conducted from November 2003 to May 2004 in the Marondera district of Zimbabwe. The study was based on pilot scale plots aiming at assessing the potential production based on the yield (production per unit area) and effect on water productivity (harvested weight per unit volume of water).

Table 1
Potential for nutrient production from human waste in Zimbabwe

Annual maize needs in Zimbabwe	1,800,000 tonnes
Maize needs per capita/yr for 11,600,000 people in Zimbabwe	155 kg/cap yr
Assuming 1 ha produces 7 t of maize. 1 ha produces maize for	45 people
Therefore, fertilizer requirements at 175 kg/ha per person for N	3.9 kg N/cap yr
Therefore, fertilizer requirements at 30 kg/ha per person for P	0.7 kg N/cap yr
Compare with sewage	
N production at 10 g N/cap d	3.7 kg N/cap yr
P production at 2 g P/cap d	0.7 kg P/cap yr

2. Methodology

2.1. Study area

The study was conducted in the Marondera District Ward 14, in the Chihota Communal Lands (Fig. 2). The district has a population of 155,000 according to the 2002 national census figures (CSO, 2002). The soils are predominantly well-drained sand soils which are generally not suitable for intensive crop production. The water table is shallow at about 3 m. As a result, Mvuramanzi Trust, a local non-governmental organization, has been promoting the use of ecosan toilets of the Urine Diversion type which are constructed above-ground to avoid encountering the water table. The study area falls under natural region 2 and 3 characterized by average to moderate rainfall ranging between 430 mm and 630 mm. The rainfall comes around the middle of October to the end of March, but is highly variable. The cropping season faces high rainfall variability with mid-season dry spells extending to as long as three weeks. In some bad seasons the mid-season dry spell causes complete crop failure.

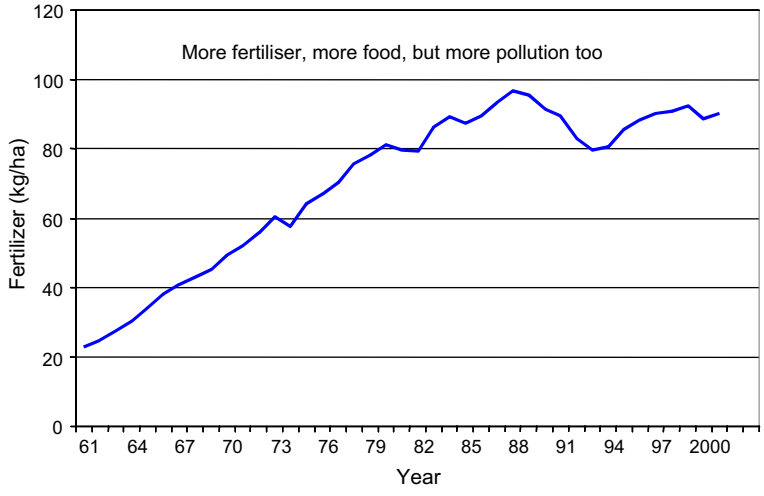

Fig. 1. Global fertilizer use from 1961 (source FAO).