Title	**An assessment of the effect of human faeces (humanure) and urine (ecofert) on maize production and water productivity**
Keywords	Human excreta humanure, ecofert, water productivity
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Short CV for Introduction Purposes (100 words max)	
Photograph attached (jpg)	

1.0 Introduction

The challenge of feeding tomorrow's world population is to a large extent, about improved water productivity within present land use (Rockstrom 2003). This can 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 2003). It is anticipated that water productivity enhancement in rain-fed agriculture can be achieved by integrating nutrient recycling through human excreta use.

This study was an attempt to adapt the use of human excreta to solve the low fertility and poor soil structure problems, improve water productivity and enhance food security in the smallholder sector in the Catchment areas of Zimbabwe using a readily available resource in the community through ecological sanitation practice.

Instead of designating urine and faeces as waste and hiding them in tanks and pits or dispatching them into pipes, ecological sanitation set out to recycle the nutrients in them for use in plant and animal life-cycles. It also has a role to play in poverty reduction, especially in releasing resource for use in food production, and in improving living conditions for those degraded and harmed by a polluted environment (proceeding from Nanning conference 2001).

2.0 Methodology

The study was carried out in Manyame Catchment in the upper part of the catchment specifically Marondera district ward 14 in Chiota communal lands. The study was designed as a two factor experimental design consisting of 10m x 10m randomized blocks with three (3) repetitions to ensure statistical validity. The major factor being assessed was nutrients. The nutrient factor was being assessed on four (4) levels of treatments consisting of the following: plot 1 was the control where maize was planted and allowed to grow without any crop nutrients applied. Plot 2 compounds D was applied as basal fertilizer treatment and ammonium nitrate as top dressing at 4 weeks, both fertilizers were applied at the rate of 6g per crop. Plot 3 was the experimental plot in which urine was applied at the rate of 100 ml per crop as the basal treatment and 100 ml as the top dressing treatment, this was applied at 4weeks old and when the crop was at knee level as usually the practice in the area. Plot 4 was the second experimental plot where feacal matter (humanure) was applied as basal fertilizer at the rate of 80 g per planting station. In the same plot 4 urine (ecofert) was applied at the rate of 100 ml per plant. Plant growth in-terms of leaf area, stem thickness has been monitored at 8 weeks and recorded for each plot.

The table 2.1

Is a representation of the lay out in the experimental fields, the plots were randomly arranged in the sense that no particular treatment had a fixed position in all the fields. In the arrangement we have the control plot (1), the commercial fertilizer plot (2), the ecofert (3), humanure plot (4), Number 1 to 4 had been assigned to these treatment for easy computation

Block A Farmer 1 and 4

Ecofert	**Control**	**Humanure**	**Commercial fertilizers**

Commercial fertilizers	Humanure	Ecofert	Control

Block B Farmer 2&5

Control	Ecofert	Humanure	Commercial fertilizers

Commercial fertilizers	Control	Ecofert	Humanure

Block C Farmer 3 &6

Commercial fertilizers	Humanure	Ecofert	Control

Control	Ecofert	Humanure	Commercial fertilizers

Water use efficiency measurements were done by adding the total amount of rainfall recorded throughout the cropping season and calculating the average rainfall using the following formula
Average Rainfall = Total Precipitation (mm)/ No of rainfall events
In order to get the actual water made available to the crop consideration was given based on the water balance equation:

P = Green + Blue

P = E + T + D + R off + change in storage **equation (2.1)**

3.0 Results and analyses

3. 1 Maize yield

Maize from different 10m x 10m plots was harvested shelled, dried and weighed using an electronic weighing machine. The data was computed and expressed in Kilograms per hectare terms. Below is a graph showing the yield in kg/ha from different treatments

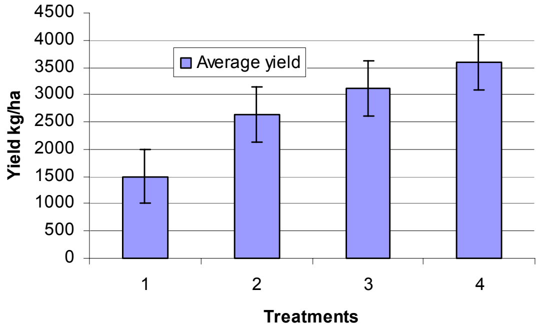


Figure 3.3 Average grain yields/ha harvested from the four treatments

3.4 Water productivity

Figure 3.3 below shows the different water use efficiencies in m^3/ton in the figure/graphs that follow

1 is control
2 is commercial fertilizer
3 is ecofert
4 is the humanure + ecofert

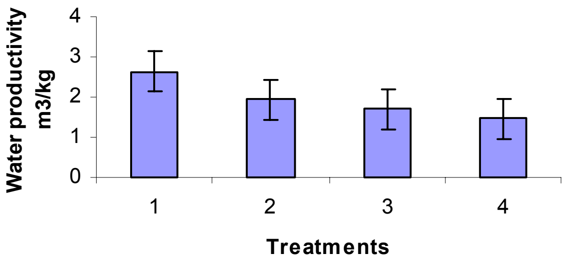
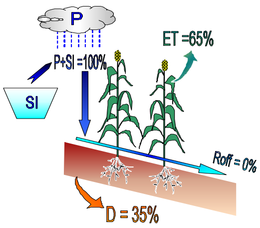


Figure 3.3 Water productivity from different treatment sites

Water use efficiency ranged from 2000 - 2300 m^3/ton for a non fertilized crop in the control plot (1). WUE_{et} for crops fertilized with chemical fertilizers compound D and Ammonium Nitrate (2) and ecofert (3) alone ranged between 1650 m^3 /ton– 1700 m^3/ton. The highest water productivity or efficiencies were to be found on plot (4) the crops fertilized by a combination of humanure and ecofert with WUE_{et} of about 1300 m3/ton from different treatments. The study suggest that humanure plus ecofert has highest water use efficiency followed by ecofert only, followed by commercial fertilizer. Cultivating without any nutrient is an inefficient use of scarce water resources.

The total water supplied to each experimental plot was calculated and an average worked out. Using the data from the water balance Table 4.1above, percentage of water used by the crop as evapo-transpiration (ET) and the one being lost as drainage (D) was calculated. Figure 4.5 below is an attempt to show the water balance in the control experimental plot.

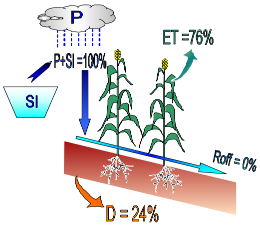
Figure 3.4 Water balance in a control plot



The total water supplied to the humanure plot was calculated and an average worked out. Using the data from the water balance table 4.1 above, percentage of water used by the crop as evapo-transpiration (ET) and the one being lost as drainage (D) was calculated. Figure 4.5 and 4.6 below was an attempt to show the water balance in the control experimental plot.

Figure 3.4 Water balance humanure + ecofert plots.

The above diagrams show the different water partitioning of supplementary irrigation (SI) + rainfall (P) at the experimental field level. Figure A shows water partitioning on a field where the farmer is not applying any form of nutrient amendment. On such the study seems to indicate 65% of the total water supplied is used for productive evapo-transpiration (ET) while 35% is lost as underground drainage (D) and also to contribute to underground water recharge.



The second Figure 3.5 shows a scenario where a farm chooses to embark on a humanure + ecofert maize production strategy. The study reveals that 76% of the total amount of water supplied to a field is taken up by plants as total evapo-transpiration (ET) 11% above the water uptake in field where no nutrients have been used. Consequently a relatively low flow 24% is lost as drainage D. Whilst they is much gain to the farmer in terms of productive (ET) and corresponding grain yield, they is loss to the underground water recharge.

Measurement of harvest from different treatment showed that a combination of humanure and ecofert assures a farmer of a good return from his capital investment because of good yields. Taking the control as our base yields increases of about 250% are achieved by using such a combination and increases of above 200% is achieved by adopting an ecofert only strategy this is still higher than the commercial fertilizer strategy which gives 166% increases in yields. Statistical analysis of the data using (SNK) variance of effect analysis tool showed that they was a major statistical difference in harvest between humanure + ecofert plots compared with the control but they was an insignificant statistical difference between commercial fertilizer, ecofert and humanure + ecofert confirming the hypothesis that human excreta works as good if not better that commercial fertilizers. The analyses also indicated that using humanure + ecofert improves the water productivity in maize production under rain-fed agriculture considerably.

5.0 Conclusions

Taking into cognisance all the research limitations and sample sizes it can safely be concluded that: Humanure + ecofert improve the water productivity by above 10% in rain-fed maize production ensuring more crop per drop of water. Water productivity for a crop where humanure + ecofert is used ranges around 1300 m^3/ton compared to a situation where nothing was used which is about 2300 m^3/ton.

6.0 Recommendations

Governments should revisit legislation and polices that concerns human excreta management and disposal with a view of defining human excreta as a resource and not a waste. Ecological sanitation toilets should be added on to the list of approved sanitation systems and technologies in the country so that it becomes an alternative system for people interested in reusing human excreta as fertilizer and also in areas where it is impossible dig pit to construct Blair latrine

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