Acceptability of Wastewater Resource and its Impact on crop Production in Tanzania: The Case of Dodoma, Morogoro and Mvomero Wastewater Stabilization Ponds

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ABSTRACT

The study was carried out to assess the views of urban farmers in relation to acceptability of wastewater resource in agriculture and examine its impact for crop production. A total of 200 respondents were involved in this study. The study found that 90% of the 112 households using wastewater and 85% of the 88 households not using the resource indicated effluents from WSPs as main and reliable source of water for irrigation. Wastewater utilization in agriculture was accepted by 97.3% of farmers using wastewater and 64.8% of farmers not using it and the difference was significant (p<0.01). The study found that on average farmers utilizing wastewater produced 4.5 bags of rice per acre more than farmers not utilizing wastewater and the difference was significant (p<0.05). In conclusion, wastewater utilization in agriculture was accepted by both groups of farmers engaging in agriculture in urban and peri-urban areas and that high crop yield was realized by farmers utilizing wastewater in agriculture . Since some respondents indicated that the resource may have health effects to farmers and consumers of the produce, it is recommended that, more research on microbial analysis be carried out to establish evidence of health effects associated with the use of wastewater in agriculture from infectious agents

Keywords: Acceptability; Wastewater; Crop production; Dodoma; Morogoro; Mvomero;

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BACKGROUND

Wastewater is an important source of water for many farmers in arid and semi-arid climates which is used for agriculture and as a source of drinking water for livestock (Rashid-Sally and Jayakod, 2008). More use of wastewater occurs in urban and peri-urban agriculture because this is where the wastewater is generated and available and the demand of food is highest (WHO, 2006a; b). Earlier studies (Ensink and Van der Hoek, 2008; Buechler *et al*., 2006; Mapanda *et al*., 2005; Ensink *et al*., 2004) have shown that wastewater is used for irrigation in countries which experience water scarcity.

Expansion of urban population and increased coverage of domestic water supply and sewerage give rise to greater quantities of municipal wastewater. Available statistics reported by DAWASCO (2010), indicated that the volume of sewage carried in sewers in Dar es Salaam City from July 2009 to June 2010 was 19 717 000 m^3. Volume of sewage treated in seven (7) out of eight (8) wastewater treatment ponds was 20 133 000 m^3/year. The volume of wastewater generated in Dodoma Urban district in 2007 was 4,905,600 m^3/year while in Morogoro Uban district wastewater generated was 7,002,760 m^3/year (URT, 2007).

The use of urban wastewater in agriculture is seen by many as a vital component of integrated water management to overcome regional and global water scarcity (Scott *et al*., 2004). Within the framework of integrated water resources management, wastewater can be viewed as both an effluent and a resource (URT, 2002). In places where wastewater is used for irrigation, society gains value from the crops produced and the improvement in livelihoods. Thus, use of wastewater and other industrial effluents for irrigating agricultural lands is on the rise particularly in peri-urban areas of developing countries (WHO, 2006b; Rattan *et al*., 2005).

Freshwater is a finite and a vulnerable resource which its sustainability is threatened by human induced activities (URT, 2002). Increase in population and concurrent growth of economic activities requiring water as an input such as in hydropower generation, irrigated agriculture, industries, domestic, livestock, fisheries and forestry activities have exerted pressure on this finite resource (URT, 2002). Unreliable rainfall in some areas especially in arid and semi arid areas, multiplicity of competing uses, degradation of sources and water catchments areas have threatened food security, energy production and water use conflicts between sectors of the economy (URT, 2002 ;WHO, 2006a,b).

Urban areas of Tanzania are experiencing rapid expansion coupled with rapid population growth of 2.9% per annum (URT, 2003). This population growth result into more water supply demands for human consumption, irrigation, power generation and industries. On the other hand, more water supply to meet the demands will end up into production of larger volume of wastewater. In 2002, it was estimated that 80% of water supplied in urban areas of Tanzania result into production of wastewater (URT, 2002). Urban farmers have been using wastewater as a source of water for irrigation. This study therefore, aimed at assessing the views of urban farmers in relation to acceptability of the resource in irrigating their crops and examine if there is any differences in land cultivated between the two farmers farming close to WSPs.

MATERIALS AND METHODS

Study areas

The study was conducted in three districts of Dodoma, Morogoro and Mvomero. Districts in Tanzania where WSPs owned by the UWSAs or public institution are available. Presence of activities which uses wastewater from the ponds was the major reason for selecting the study areas. The WSPs in Dodoma district are located in Swaswa Street in Makole Ward while WSPs in Morogoro district are located in Mwembesongo Ward. Available WSPs from Mzumbe University were used by farmers from Mvomero district.

Study Methods

The design for this study was cross-sectional which entails collection of in depth data of different groups of respondents at a single point in time (Bailey, 1994). The sample size for this study was 200 households. These were obtained by determining the proportion of households with access to sewerage connection in study areas. It was assumed that the same proportion would have access to the effluent from waste stabilization ponds. The sample size was computed using the formula:

$n = z^2 \times p \times q / e^2$ (Kothari, 1990) ……….………..…..………………..…… (1)

Where;

n= required sample size
z= standard deviation corresponding to 95% confidence level=1.96
e = desired degree of accuracy =0.05
p= proportion of households with access to sewerage connection =15%
q= proportion of households not having access to sewerage connection =85%

Hence, $n= 1.96 x 0.15 x 0.85/0.05^2 = 195$

The sample size computed was minimum and the author decided to add 5 households to make the overall sample size of 200 households.

DATA PROCESSING AND ANALYSIS

Data collected were coded and entered into Statistical Package for Social Sciences (SPSS) for window version 12, cleaned by running frequencies of individual variables and later were analysed. Most of the analysis for this study was based on the descriptive statistics which was done by using SPSS. The Chi-square test for independence was used to explore the relationship between two categorical variables which included farmers using wastewater in agriculture and those who were not using it.

RESULTS AND DISCUSSION

Characteristics of respondents

Of the 200 respondents, 58.5% were males and 41.5% were females. The large proportion of male respondents in this study is attributed to the nature of study that required respondents to be interviewed in their fields and that most activities involving use of wastewater in agriculture were performed by men. Women were also involved in agriculture and related processing and selling activities (Mlozi, 1995). However, in most cases women were left at home performing households' reproductive and non-reproductive roles (Balihuta, 2001). Information with regards to marital status of head of households revealed that, of the 200 households heads, 71.5% of them were married, 14.5% were single and only 2% of them were divorcees (Table 1). With regard to respondents' status, 67.5% were head of households, 25.5% were housewife, 2.5% were daughters and 3.5 were son. Table 1 provides the summary of respondents' characteristics.

Table 1: Respondents' characteristics (N=200)

Sex of respondent	Percent
Male	58.5
Female	41.5
Households' head marital status	
Married	71.5
Single	14.5
Divorced	2.0
Widowed	12.0
Respondents' status	
Household head (Males and Females)	67.5
Housewife	25.5
Daughter	2.5
Son	3.5
Others	1.0

Acceptability of wastewater use in agriculture

Most of farmers in Tanzania depend solely on rainfall for production of food and cash crops (URT, 2001). The rainfall distribution in the country is not uniform and some parts of the country experience drought which affect the production of various food and cash crops, and pasture (URT, 2006). More than half of the country receives on average, less than 800mm of rainfall per year (URT, 2008).

Based on the fact that the rainfall in part of the study area was relatively low and unpredictable in frequency and amount (URT, 2006), investigation on different types of water available in the study area for crop irrigation was done. The results revealed that six sources of water were available in the study area as indicated in Table 2. Findings from Table 2 indicate that piped water, spring water and effluent from commercial building were mentioned by few respondents (less than 5% of all cases) to be the source of waster for irrigation in the study areas. The results also show that wells (30%), rivers (35.5%) and effluent from WSPs (87.5%) were mentioned to be the sources of water for irrigation.

Table 23: Available sources of water for irrigation

Water source	Frequency	% of cases
Piped	5	2.5
Spring	10	5.0
Wells	60	30.0
River	71	35.5
Waste Stabilization Ponds	175	87.5
Effluent from Commercial Building	9	4.5

Note: Computation of percentage are based on the number of cases, hence the percentage do not add up to 100

Further analysis was carried out to investigate the association between the water sources for irrigation mentioned by more than 10% of all respondents and the two groups of farmers included in the study (Table 3). Findings in Table 3 shows that 27.7% of farmers using wastewater and 33.0% of farmers not using it indicated wells to be the source of water for irrigation. However, the statistical association between the two groups of farmers and wells as a source of water for irrigation was not significant ($p>0.05$). Results in Table 3 also show that 22.3% of farmers using wastewater and 52.3% of farmers not using the resource indicated river to be a source of water for irrigation and the result was significant at $p<0.01$. Findings from Table 3 further show that 90% and 85% of farmers using wastewater and not using it respectively were of the opinion that effluent from WSPs was the source for irrigation and the difference was significant at $p<0.01$. This finding support the argument of Buechler *et al.* (2006) who noted that wastewater was a reliable source for plot irrigation and that it was available year round and not subjected to a rotation schedule as regular irrigation water.

Table 3: Sources of water for irrigation by type of farmers

Water source	% of farmers using wastewater (n=112)	% of farmers not using wastewater (n=88)	P value
Wells	27.7	33.0	0.419
River	22.3	52.3	0.000*
WSPs	90.0	85.0	0.001*

* = significant at $p < 0.01$

Farmers were asked to give their opinion on the acceptability of using wastewater in agriculture. Both farmer groups were involved in providing their opinion as indicated in Table 4. The difference between farmer category and response on acceptability of using wastewater in agriculture was significant ($p<0.01$). This finding suggests that wastewater utilization was acceptable by both farmer groups involved in this study.

Table 4: Acceptability of using wastewater (N=200)

Response	Farmers using wastewater (n=112)	Farmers not using wastewater (n=88)	Test statistic
Yes	97.3	64.8	$\chi 2= 34.73$
No	2.7	29.5	P= 0.000
I don’t know	0	5.7	

Reasons for accepting wastewater use in agriculture

Respondents were asked to give reasons for their responses with regard to acceptability of using wastewater in agriculture. Table 5 summarizes the reasons given by farmers who were interviewed. The result shows that very few farmers (2.7%) irrigating with wastewater understood the health risks associated with the use of wastewater in agriculture. On the other hand, about 15.9% of farmers who were not using wastewater in agriculture had the opinion that wastewater was dirty and that there was a possibility of health risks to farmers and consumers of the products (WHO, 2006b). This suggests that education on health risks which might be caused by the use of wastewater was lacking among majority of farmers using wastewater.

Table 5: Reasons for accepting/ not accepting the use of wastewater (N=200)

Reasons	Farmers			
	Using wastewater		Not using wastewater	
	No.	%	No.	%
Dirty and risks to human health	3	2.7	14	15.9
Not good from religious point of view	0	0	14	15.9
No problem had been observed	45	40.2	24	27.3
High crop yield and source of income	40	35.7	15	17
Not sure if bad or good	3	2.7	18	20.5
Use with precaution	21	18.7	3	3.4
Total	112	100	88	100

Results from Table 5 further show that 40.2% of farmers utilizing wastewater and 27.3% of farmers not utilizing wastewater indicated not to have seen or observed any problems emanating from the use of wastewater in agriculture. The results in Table 5 also show that high crop yield and increased income were mentioned by a high proportion (35.7%) of farmers using wastewater. This result supports the findings by Ensink *et al*. (2004) that farmers irrigating with wastewater usually have high crop yield.

Further data analysis was carried out to compare crop production per acre between the two groups of farmers. There was a significant difference ($p<0.05$) in crop production of paddy per acre for farmers utilizing wastewater (M=8.7, SD=2.6) and farmers not utilizing it (M=4.2, SD=1.5). These results show that farmers utilizing wastewater produced on average 4.5 bags of rice per acre more than farmers not utilizing wastewater.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The study has demonstrated that use of wastewater was acceptable by farmers using wastewater in agriculture and those not using it. The association between respondents' view on the acceptability of using wastewater and farmers' category was highly significant suggesting that wastewater use in agriculture was acceptable by the two farmer groups.

Recommendations

The present study collected information on the acceptability of wastewater use in agriculture. However, the study did not capture information concerning the types and number of different pathogens in wastewater used for irrigation which can be used to quantify risk. It is recommended that, more research on microbial analysis be carried out to establish evidence of health effects associated with the use of wastewater in agriculture from infectious agents.

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