Effects Of Waste Water Use On Vegetable Crop Production In Imo State, Nigeria

Emenyonu, Christopher Akujuobi
Department of Agricultural Economics, Federal University of Technology Owerri,
P.M.B. 1526 Owerri Imo State. cemenyonu@yahoo.com, +2348028347174.

Odii; Marshal .A.
Department of Agricultural Economics, Federal University of Technology Owerri,
P.M.B. 1526 Owerri Imo State. macaodii@yahoo.com, +2348037094296.

Ohajianya Donatus .O.
Department of Agricultural Economics, Federal University of Technology Owerri,
P.M.B. 1526 Owerri Imo State. dohajianya@yahoo.com, +2348035438019.

Henri-Ukoha Ada
Department of Agricultural Economics, Federal University of Technology Owerri,
P.M.B. 1526 Owerri Imo State. haukoha@yahoo.com, +2348036682823.

Onyemauwa Sebastian .C.
Department of Agricultural Economics, Federal University of Technology Owerri,
P.M.B. 1526 Owerri Imo State. csonyemauwa@yahoo.com, +2348069284242.

Ben-Chendo, Glory .N.
Department of Agricultural Economics, Federal University of Technology Owerri,
P.M.B. 1526 Owerri Imo State. gnbenchendo@yahoo.co.uk, +2348035841847.

Munonye, Oleander. U.
Department of Agricultural Economics, Federal University of Technology Owerri,
P.M.B. 1526 Owerri Imo State. umunonye@yahoo.com.

Abstract: This study is based on a survey of 36 randomly selected farmers in the three agricultural zones of the state with high concentration of vegetable farming using waste water. Information obtained from the farmers was analyzed using basic statistics and t-values evaluated using the ordinary least squares multiple regression technique. A profit measure was also used to evaluate the profit realized from waste water use and non-waste water use, by applying with and without principle. Results showed that waste water use has a negative effect on vegetable crop production as can be seen from the signs of the parameter estimate representing waste water. It was also observed that people within the age bracket of 46 - 55 years engage most in vegetable farming, and they do this because of the less tedious nature of the job. Some of the vegetable farmers use waste water in addition to fresh water, while others do so in order to take advantage of the nutrients it contains. The study further showed that increased waste water use reduces the farmers output and hence revenue. Given the degree of adverse effects of waste water use in the state, it is therefore imperative that prompt action be taken to curb these effect as well as definite actions towards effective waste water management.

[Emenyonu, Christopher Akujuobi, Odii; Marshal .A., Ohajianya Donatus .O., Henri-Ukoha Ada, Onyemauwa Sebastian .C., Ben-Chendo, Glory .N., Munonye, Oleander. U. Effects Of Waste Water Use On Vegetable Crop Production In Imo State, Nigeria. Researcher. 2010;2(10):47-56]. (ISSN: 1553-9865).

Keywords: Effects, Waste Water Use, Vegetable Production.

1. Introduction

With increasing global population, the gap between the supply and demand for water is widening and is reaching such alarming levels that in some parts of the world it is posing a threat to human existence. Since 1950 the world population has doubled while water consumption has increased six-fold. By 2025, it is expected that 3.4 billion people will be living in countries defined as water-scarce (DFID 2007). Scientists around the globe are working on new ways of conserving water. It is an opportune time to refocus on one of the ways to recycle water-through the use of wastewater for irrigation and other purposes.

Wastewater refers to water whose quality might pose a threat to sustainable agriculture and/or human health, but which can be used safely for irrigation provided certain precautions are taken. It describes water that has been polluted as a result of mixing with Waste or agricultural drainage (Cornish et al 1999).

Pierce and Turner (1990) defined wastewater as water that possesses certain characteristics which have the potential to cause problems when it is used for an intended purpose.

In this work, it is assumed that wastewater may be a combination of some or all of the following:

- Storm water and other runoff.
- Domestic effluent consisting of black water (excreta, urine and associated sludge) and grey water (kitchen and bathroom wastewater).
- Wastewater from farm houses and fish ponds.
- Reserved wastewater from residences.
- Water from commercial establishments and institutions, e.g. hospitals.

The main sources of wastewater are domestic and industrial. As a general rule 80-85% of water used is wasted (Spore 2002).

In many countries water is becoming an increasingly scarce resource. Due to increasing population and industrial as well as urban expansion, the production of wastewater and its reuse has grown rapidly. Rough estimates indicate that at least 20 million hectares of land in 50 countries are irrigated with raw or partially treated wastewater (Van der Hoek et al 2001). In addition to being a valuable resource as a source of water, the major objective of wastewater use is the effective utilization of its rich stock of nutrients for agricultural and other purposes.

The use of wastewater in agriculture is gaining tremendous popularity because of the wide range of benefits that accompany it. These benefits include conservation of water, provision of reliable water supply and recycling of nutrients, thereby reducing the need for farmers to invest in chemical fertilizers. On the other hand, wastewater use in crop production is not without some risks. The main risk associated with wastewater irrigation is infection with intestinal helminthes (Mara and CainCross 1989). Also, depending on the source of the wastewater it might contain chemical pollutants and heavy metals that can accumulate in the soil and crops thereby posing a threat to human health.

However, these risks can be greatly reduced by treating the wastewater before using it or by applying some precautions while using it. Given the high cost of freshwater in certain areas of Imo State, farmers are forced to depend on wastewater which is cheaper and more available. But there seems to be a lack of information or awareness of the effects of wastewater irrigation on crop production in these areas. For this reason, Imo State appears to be an appropriate choice for applying a framework for assessing and valuing the effects of wastewater irrigation.

Though generally unacceptable, irrigation using untreated wastewater exists and is practiced in many countries where sanitation and treatment facilities are poorly developed, and besides are not a priority. In other places, this untreated wastewater is the only source of irrigation water-the farmers' livelihood depends on it. This situation is mostly found in areas where there exists no central source of freshwater supply.

A major drive towards wastewater use is the fact that it contains high levels of nutrients, reducing the need for and cost of fertilizers. Consequently, many farmers using wastewater are better able to support themselves and their families and often create extra employment (Spore 2002).

Furthermore, the continuous demand for certain crops especially vegetables has increased the need to cultivate these crops all year round. This in effect leads to the dependence on wastewater during the dry seasons or during periods of drought. Also, due to the light water requirement of some crops, the use of wastewater to augment the freshwater, if any, becomes inevitable. In many areas, the few freshwater supply stations (boreholes) are owned by individuals, and the water is sold to others who cannot afford to set up one. In such a situation, the resource poor farmers are forced to resort to a cheaper alternative - wastewater.

However, unregulated use of wastewater poses some risks to human health and the environment. Because of these risks, the prevailing scientific approach to wastewater irrigation advocates treatment before use. But the reality is that many developing countries lack the resources to build and maintain treatment facilities. And strict regulations in wastewater use -another widely promoted solution are often not enforceable. This is especially true where freshwater is scarce. Farmers therefore consider wastewater a valuable resource; and wastewater irrigation is an individual or community activity, with few or no governance structures (Levine 2000). While some of the effects of waste water use are generally known, a comprehensive valuation of the benefits and costs of these effects has not been attempted in Imo State especially on vegetable crop production.

In view of the foregoing, this study is targeted towards identifying the effects of waste water use in crop production, evaluating its costs and benefits as well as the socio-economic effects of wastewater use on the life of the farmers.

This study is justified based on the hypotheses that wastewater use has no effect on crop production in Imo State and that wastewater irrigation is not profitable. Again, the practice of wrong wastewater for irrigation is widespread, but has hardly been studied because the norm has always been that wastewater should be treated before use. However, increasing water scarcity, lack of money for treatment and clear willingness by farmers to use wastewater have led to an uncontrolled expansion of wastewater use. It is therefore important to better document the practice of irrigation using wastewater in order to find out how it could be improved within the finance possibilities of the resource poor farmers. More so, one-tenth of the world's population eat food produced using wastewater (Luven, 1992).

2. Materials and Methods

The study covered selected local government areas with high concentration of vegetable production and wastewater use. The state is located on Longitude 6°4[1] East and Latitude 4°4[1] and 8°15[1] N with a maximum temperature of 270°C (ISMANR 1996). It covers an area of 5289.49km^2 (FOS 2000). The provisional population figure for the state is 3,393,899 (NPC, 2006). There are 2 distinct seasons, the dry (October - March) and the rainy, April -September). The primary occupation of Imo State inhabitants is agriculture. There are 3 agricultural zones in the state, Orlu, Okigwe and Owerri, with 12, 6 and 9 local government areas respectively. A multi state random sampling technic was adopted. 3 local government areas were selected from each zone, giving a total of 9 LGA's. At the LGA level, 2 communities were taken from each area giving a total of 18 communities. Again, 2 respondents were selected from the list of registered vegetable farmers compiled at the community level by the researcher from each of the communities. This gave a total sample size of 36. Data were collected with a set of structured questionnaire. The questionnaire was administered on a face to face basis to each of the selected farmers. Information obtained from the farmers interalia socioeconomic characteristics, major crops fed with wastewater, benefits and costs to farmers of wastewater use etc. Basic statistical tools like mean, median, and percentages were used in the analysis. Again, the revenue function were estimated using the OLS multiple regression technique, in an effort to evaluate the input-output relationships. A profit function was also fitted to ascertain profits made from vegetable production before and after wastewater using with and without principle following Hussain et al (2001).

In doing them, the following models were used:

Mode 1

$Q = F(X_1, X_2, X_3, X_4, X_5, e)$

Where

- Q = Sum of the values of vegetables produced in ₦ (Okro, fluted pumpkin and amaranthus)
- X_1 = Sum of the values of vegetables seedlings in naira
- X_2 = Area of land in Ha
- X_3 = Quantity of wastewater in litres
- X_4 = Value of labour in ₦
- X_5 = Value of fertilizer in ₦
- e = Error term

Model 1 was fitted before and after wastewater use. Choice of lead equations were based on economic, econometric and statistical criterion following Odii (1996).

Model II

$\prod = TR - TC$

where

- $\prod$ = Profit realized from sale of the vegetable
- TR = Total Revenue earned in ₦
- TC = Total Cost incurred in ₦

This was also fitted before and after waste water use.

3. Results And Discussions

Socio Economic Analysis

Distribution of Respondents According to Age

The table below presents the frequency and percentage distribution of respondents according to age.

Table 1: Distribution of Respondents According to Age

Age (years)	Frequency	Percentage
26-35	3	8.33
36-45	6	16.67
46-55	17	47.22
56 65	10	27.78
Total	36	100

Mean Age: 49.94years. Source computed from field Survey, 2007

Table 1 shows that majority of the respondents fall within the age limit of 46 -55 years and above. This implies that vegetable farmers are mainly people who have passed the middle age. This can be attributed to the fact that vegetable farming is a less tedious job, which requires less manpower.

Distribution of Respondents by Sex

The table below presents the frequency and percentage distribution of respondents according to sex.

Table 2: Distribution of Respondents by Sex

Sex	Frequency	Percentage
Male	2	5.56
Female	34	94.44
Total	36	100

Source computed from field survey, 2007

Table 2 shows that women engage in vegetable farming more than men, as 94% of the respondents are females. This implies that vegetable growing is generally viewed as a job for females because of its simple nature.

Distribution of Respondents by Educational Level

The table below presents the frequency and percentage distribution of respondents by educational level.

Table 3: Distribution of respondents by educational level

Years spent in school	Frequency	Percentage
0	14	38.89
1 -6	10	27.78
7-12	6	16.67
13-18	4	11.11
19-24	2	5.56
Total	36	100

Mean years: Spent in school = 5 years

Source: computed from field survey, 2007

The table above shows that majority of the respondents had no formal education. However, 16% of the respondents passed through secondary school education and 11 % had forms of tertiary education. Further analysis of the group showed that some of them are civil servants, and engage in vegetable cultivation as a secondary occupation. This shows that vegetable farming is a job meant for everyone irrespective of one's status in life.

Distribution of Respondents According to Years of Wastewater Use

The table below presents the frequency and percentage distribution of the respondents according to years of wastewater use.

Table 4: Distribution of Respondents According to Years of Wastewater Use

Years	Frequency	Percentage
1 - 5	17	47.22
6-10	13	36.11
11 -15	4	11.11
16-20	2	5.56
Total	36	100

Mean years: 4.72years **Source: computed from field survey, 2007**

Table 4 shows that 47% of the respondents have been using wastewater for the past 5 years; 36% for the past 7 years, 11% for the past 15 years and 6% for the past 20 years. Further investigation showed that most of the respondents have been using wastewater since they started cultivating vegetables, and have continued to use it without bothering to find out neither its components nor its effect on the crops.

Distribution of Respondents According to Freshwater Use

The table below presents the frequency and percentage distribution of the respondents according to freshwater use.

The table above shows that majority of the vegetable farmers depend solely on wastewater for their production. Further investigation showed that most of them use wastewater because of the scarcity or unavailability of freshwater. Others use it because of the nutrients contained in it.

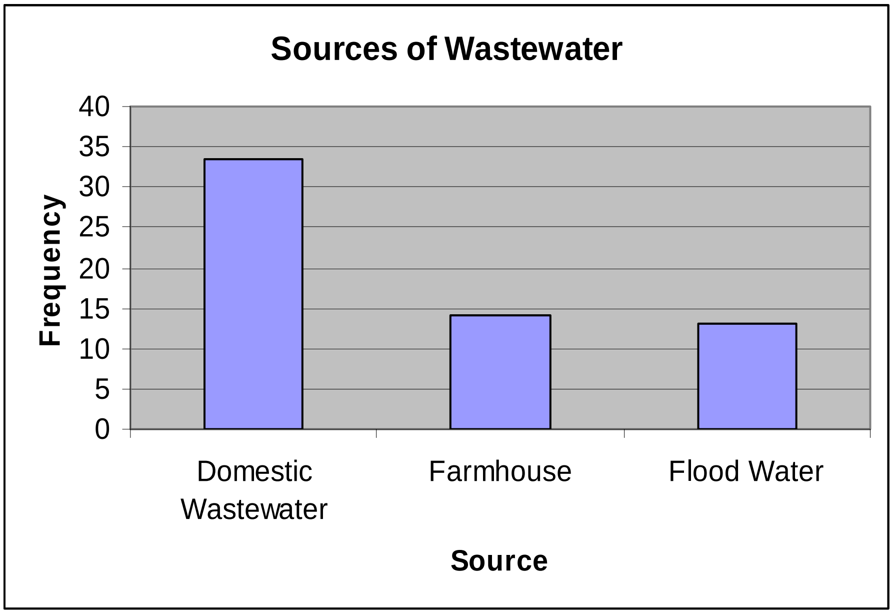
Table 5: Distribution of Respondents According to Freshwater Use

Freshwater use	Frequency	Percentage
Yes		
No	21	58.33
Total	36	100

Source: computed from field survey data, 2007

Distribution of Respondents According to Sources of Wastewater

The figure below presents the frequency and percentage distribution of the respondents according to sources of wastewater.



Source: Field Survey, 2007

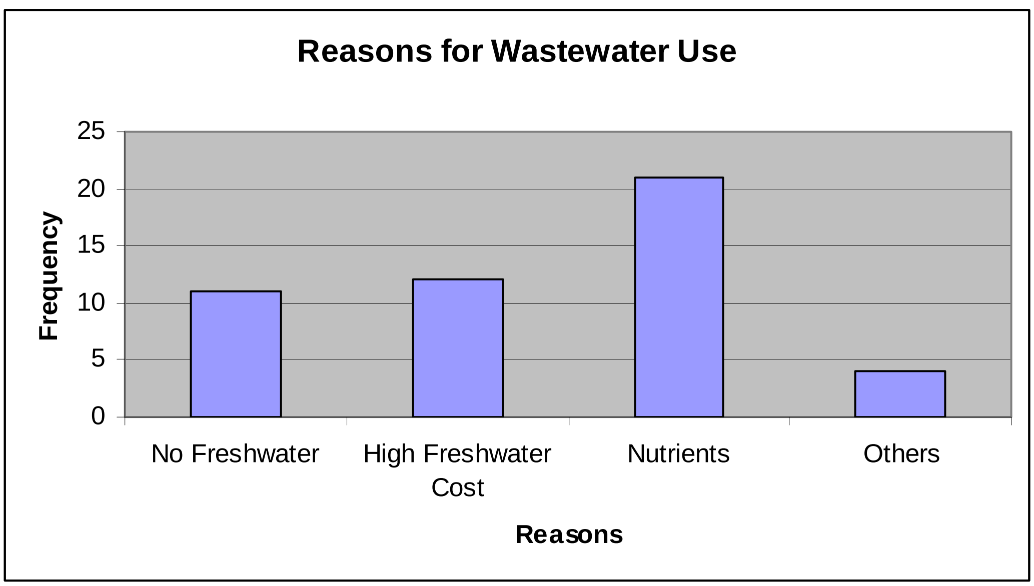
Fig. 1: Distribution of Respondents According To Sources of Wastewater

The figure above shows that almost all the farmers use domestic wastewater as it is the most easily available. Some of the respondents who rear livestocks use farmhouse wastewater and a few others use floodwater.

Distribution of respondents according to reasons for wastewater use

Fig. 2: Distribution of respondents according to reasons for wastewater use.

The figure below presents the frequency and percentage distribution of the respondents according to reasons for wastewater use.



Source: Field Survey, 2007

The figure shows that more than a half of the respondents use wastewater because of the nutrients it contains, while about a third of the respondents use wastewater because of unavailability of or high cost of freshwater. However, further investigations showed that the farmers have never attempted to find out the constituents of the wastewater and how these affect the crops.

Revenue function of the farmers

The tables below presents the revenue function estimates of the farmers during wastewater use and before wastewater use.

Table 6: Revenue function estimates of the farmers during wastewater use

Functional forms	Semi-log	Exponential	Linear	Double log
Intercept	3.3603	3225.062	429.5928	3.6470
R-square	0.784	0.7035	0.7705	0.7330
F-value	21.7777	14.2382	20.1404	16.4704
Vegetable Seedlings (X_1)	0.003 (1.5191)**	3122.784 (1.5896)**	4.7049 (1.6017)**	0.1879 (1.4877)**
Land (X_2)	37.9712 (4.9716)**	5794.589 (2.8718)**	508748.5 (4.3778)**	0.4276 (3.2956)**
Wastewater (X_3)	9.14E -05 (1.624)**	1429.503 (1.447)**	1.5457 (1.805)**	0.0845 (1.330)**
Labour (X_4)	8.84 E -05 (1.5336)**	1833.157 (1.1650)	1.5784 (1.7991)**	0.1088 (1.0753)
Fertilizer (X_5)	5.71 E -07 (0.007)	44.0604 (0.0262)	-0.3135 (-0.2550)	0.0483 (0.4468)

Source: Field Survey, 2007

(**): 10% level of significance; figures in parenthesis are t-rations

X1 - X5: remain as previously defined in methodology

Table 7: Revenue function estimates of the farmers before wastewater use

Functional forms	Semi-log	Exponential	Linear	Double log
Intercept	-11953.83	3.1394	14.0955	2.1378
R-square	0.7323	0.8018	0.7804	0.7800
F-value	16.4147	24.2987	21.3164	25.8183
Vegetable Seedlings (xi)	5048.486 (3.2869)**	0.0010 (4.0645)**	10.3910 (3.5478)**	0.4864 (4.1426)**
Land (X2)	885.6674 (0.5968)	18.7591 (2.3591)**	126222.4 (1.3728)**	0.1649 (1.4543)**
Wastewater (X3)	2955.97 (3.3426)**	0.0003 (2.8882)**	3.8703 (3.8065)**	0.2175 (3.2166)**
Labour (X4)	-15.47221 (-0.0127)	7.67E-05 (0.8952)	0.4175 (0.4214)	0.0495 (0.5339)
Fertilizer (X5)	50.2449 (0.0371)	9.39E-05 (0.8076)	0.7193 (0.5348)	0.0404 (0.3911)

Source: Field Survey, 2007

(**) = Significant @ 10%

Table 6 shows the four functional forms used in estimating the regression model for the farmers' revenue function during wastewater use. The semi-log function gives an R-square value of 0.784 and a significant F-value of 21.777. Vegetable seedlings **(X_1),** land **(X_2),** wastewater **(X_3)** and labour **(X_4)** are statistically significant at 10% level of probability.

To that end, the semi-log function was chosen as the lead equation for the analysis as it has a satisfactory statistically significant F-value and the highest R-square value. Also, four coefficients of the explanatory variables are statistically significant. Summarily, it gave the best fit as its economic, econometric and statistical parameters were the best of all the functional forms.

Vegetable seedlings **(X_1)** is statistically significant at 10% level of probability. This agrees with the a-priori expectation that if the value of vegetable seedlings is increased it could increase the output level of the farmer.

Land **(X_2)** is statistically significant at 10% level of probability. Its positive value shows that increased land area has a positive effect on the farmers' output value.

This also agrees with the a-priori expectation of the study. The field survey also showed this to be true, as it was observed that farmers with wider land areas had more level of output.

Wastewater **(X_3)** is statistically significant at 10% level of probability. The negative sign denotes an inverse relationship with output value, that is, as the value of wastewater increase, the value of output decrease. A likely explanation for this phenomenon is that the quality of wastewater used might be very poor. Moreover, the field survey showed that none of the farmers applied any form of treatment to wastewater before use.

Labour **(X_4)** is statistically significant at **10%** level of probability. The negative value implies that labour has an inverse relationship with the value of output. This might be because given a fixed area of land, increase in labour will only result in diminishing returns.

Fertilizer **(X_5)** is neither statistically significant at **10%** level nor at **5%** level of probability. This implies that fertilizer had no effect on the output value. This might be as a result of the fact that the farmers depend only on organic fertilizer in addition to wastewater for production.

Table **7** shows the results of parameter estimates before wastewater use.

The double-log function was chosen as the lead equation for the analysis as it has a satisfactory statistically significant F-value and a very high R-square value. Also, three coefficients of the explanatory variables are statistically significant. Summarily it gave the best fit as its economic, econometric and statistical parameters were the best of all the functional forms.

In the double-log function, the F-value is **25.813.** This shows the goodness of fit of the model. The R-square value of **0.78** implies that **78%** of the determinants of the farmer's revenue are explained by the explanatory variables. The remaining **22%** is attributed to error.

Vegetable seedlings (xi), is statistically significant at **10%** level of probability. This agrees with the a-priori expectation that if the value of vegetable seedlings is increased, it could increase the output level and hence revenue of the farmer.

Land (x_2), is statistically significant at 10% level of probability. Its positive value shows that increased land area has a positive value effect on the farmers' output value. This also agrees with the a-priori expectation of the study.

Constraints

The figure below presents the distribution of the respondents according to constraints experienced in their use of wastewater.

Water **(X3),** is statistically significant at 10% level of probability. Its positive value denotes that an increase in the value of water supplied results in increase in the farmers' output value.

Labour **(X4),** and fertilizer **(X5)** is neither statistically significant at 10% nor at 5% level of probability. This implies that labour and water had no effect on the farmers' revenue.

Profit function of the farmers

$\prod$ = TR - TC

Before wastewater use

TR = 171.200 Naira
TC = 68,958 Naira
$\prod$ = (171,200-68,958) Naira/annum
= 102,242 Naira/annum

After wastewater use

TR = 252,300 Naira
TC = 89,043 Naira
$\prod$ = (252,300 - 89,043) Naira
= 163,257 Naira/annum

From the figures above, it can be seen that the profit after wastewater use is greater than the profit before wastewater use. Therefore, we conclude that wastewater use in vegetable crop production is profitable.

Fig. 3: Distribution of Respondents According to constraints experienced in wastewater use

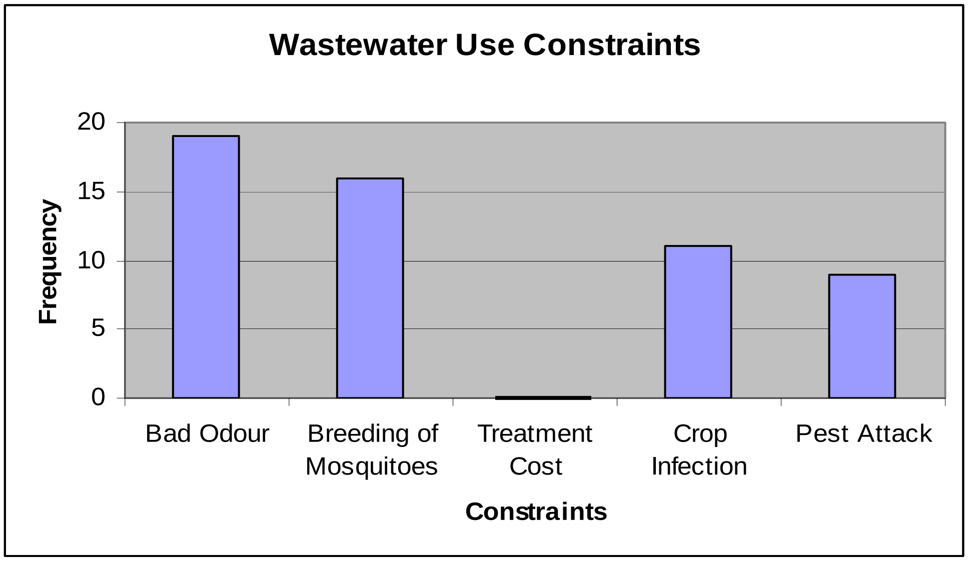


Fig. 3 shows that the respondents experienced a number of constraints in their use of wastewater. These constraints include bad odour from accumulated wastewater, breeding of mosquitoes, infection of crops and pest attack on crops. The most experienced constraints are bad odour from accumulated wastewater and breeding of mosquitoes. This is because as observed in the field survey, the major sources of wastewater for the farmers are domestic wastewater and farmhouse discharge. There were not treatment costs.

4. Recommendations

As examined, the severity of the negative effect of wastewater use in vegetable crop production in Imo State calls for deliberate, calculative and well focused efforts toward the improvement of the practice of wastewater irrigation. It is important to have a system based on sustainable wastewater development framework that is focused on improvement of the wastewater available to farmers, hence, improving the productivity of the farmers.

Having x-rayed the effects of wastewater use on vegetable crop production, the following recommendations are suggested to reduce or entirely check the adverse effect of wastewater irrigation on vegetable crop production in Imo State.

- Education programmes should be developed for farmers who use wastewater and for the general public on the risks associated with wastewater use.
- Guideline on wastewater use should be developed and applied. These guidelines must be developed based on the farmers' socio-economic and environmental context.
- Wastewater treatment facilities should be made available to the farmers who depend on wastewater for production. Innovative indigenous practices can be built upon to help reduce health risks from wastewater agriculture. For example, farmers can store wastewater in ponds to allow suspended solids to settle out before use in irrigation.
- It is important that farmers use safer irrigation methods because irrigation methods can affect the degree of plant contamination. Localized techniques such as trickle or drip irrigation should be encouraged because the wastewater is applied directly to the root zone of the plants.
- Protective materials like shoes and gloves should be worn by farmers and field workers to minimize human exposure to contaminants in wastewater. Also potable water should be provided for proper hygiene.
- If wastewater treatment facilities tend to be unaffordable for the farmers, then efforts should be directed towards providing adequate freshwater for the farmers so that wastewater use and the risks associated with it can be minimized as much as possible.
- The MDGs on clean water should more closely link policies and investment for

improvements in the wastewater supply sector with those of sanitation and waste disposal sectors (Hepang, 2008). Wastewater irrigation should only be used for grass land and non-food crops.

5. Conclusion

From the foregoing, it can be concluded that vegetable crop producers are mostly adults, mostly women whose reasons for vegetable cultivation is the simple and less tedious nature of the job. Also, their major reasons for wastewater use are the nutrient content of the wastewater and the inaccessibility of freshwater.

They are mainly married, with families, of the female gender, and have undergone formal education. Most of them take up vegetable farming as a secondary occupation, and depend on wastewater for irrigation. Succinctly, the study has shown that wastewater irrigation is practiced in Imo State and that it reduces the value of output produced by the vegetable farmers, which may be attributed to untreated nature of wastewater used.

Correspondence to *Emenyonu, C.A
Department of Agricultural Economics,
Federal University of Technology, Owerri,
PMB 1526 Owerri, Imo State, Nigeria.
cemenyonu@yahoo.com.

References

1. **Cornish, G.A.; Mensah, E and Ghesquire, P (1999).** An Assessment of surface water quality for irrigation and its implication for human health in perr-urban zone of Kumasi Ghana. Report OD/TN/95, Sept. HR Wallington, UK. Pp. 460
2. **Developments (2007):** A Publication of Department for International Development - DFID Issue 37, pp 5-7. **Doll and Orazem (1984):** *Economic Theory With Applications.* John Wily and Son NYP pp 470.
3. **Ezedinma, C.I. (2000):** Farm Resource Allocation and Profitability of Arable Crops and Enterprise in the Hurnan Forest Inland Valley Ecosystem. A Case Study of Osu Aham in South Eastern Nigeria UNISWA Journal of Agriculture. Vol. 9, 2000, pp 48-55.
4. **Federal Office of Statistics (2000):** Statistical Year Book: A Publication of the Federal Office of Statistics, Nigeria.
5. **Federal Office of Statistics (1999):** Urban Agriculture as a strategy for poverty reduction in Nigeria.
6. **Hepang, Jia (2008):** Wastewater Widely used in Urban Agriculture, Report finds. Pp 1-2, available on line at www.scidev.net/en/navs/wastewater-widelv-used-in-urban-aqriculture-report.html
7. **Hussain I., L. Raschid,** M.A. **Hanjra, F. Marikari, and W. Van der Hoek (2001):** A Framework for Analyzing Socio-economic, Health and Environmental Impacts of Wastewater Use in Agriculture in Developing Countries. Working paper 26, Columbo, Sri Lanka: IWMI. Pp 1-7.
8. **Hussain K. and M**.A. **Hanjra (1996):** National Environmental Quality Standards and Industrial Effluents: A Case Study of Faisalabd, Pakistan. Acta Scientica Vol. 3, No. 1-2.
9. Imo State Ministry of Agriculture and Natural Resources (ISMARVK) (1996).
10. **Levine A. (2003);** confronting the realities of waste water use in Agriculture IWMI Based on Research presented for Urban Water Reuse for Crop Production in the Water short Areas.
11. **Lohani, B**.N. **and** N**.L. Thanh (1978):** Water Pollution Control in Developing Countries. Volume II, *Proceedings of the International Conference held at Bangkok, Thailand.* Pp 70-75.
12. **Luven, K**.U. (1992); Enhancing Use of Science and Technology for Enterprise Development. Publication of Bioscience Engineering, Belgium. Pp. 76.
13. **Mara D.D. and Cain-Cross S. (1989):** Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture - Measure for Public Health Protection. World Health Organization, Geneva.
14. **Odii, M**.A.**C**.A. Modern Farm Management Technique, Alphabet Publishers pp 152-156.
15. **Spore, (2002)**; Waster Water Use in Perr-Urban Agriculture in Kumasi, Ghana, No. 101. 36, www.iwmi.cgiar.org.
16. **Van der Hoek, Wim; Mahmood Ulhassan; Jeroen Ensink; Sabiena Feenslik; Liqa Raschad-Sally' Sarfraz Munic; Rizwan Askin, Nazim Ali; Raheela Hussain and Yutaka Matsumo, (2001);** Urban Waste Water Use A Valuale Resource for Agriculture. A Case Study from Haroonabad, Pakistan. Research Report, 63, IWMI.

9/24/2010