Journal of Advances in Agricultural Science and Technology
https://www.watchpub/jaast/index.htm

FINANCIAL FEASIBILITY OF PRODUCING A URINE-BASED FERTILISER FOR VEGETABLE FARMING IN ACCRA, GHANA

Mark Kwame Offei[1]* Irene S. Egyir[1], George T-M Kwadzo[1] and Olufunke Cofie[2].
[1]Department of Agricultural Economics and Agribusiness, College of Agriculture and Consumer Sciences, University of Ghana
[2]International Water Management Institute, West Africa Office, Ghana.

Article Info:

Author(s):
Mark Kwame Offei, Irene S. Egyir, George T-M Kwadzo and Olufunke Cofie.

History:
Received: January 29th 2014
Accepted Date: 3-02- 2014

Vol 2 (1), pp, 01-09 February ,2014

Corresponding Author:
Mark Kwame Offei.
Department of Agricultural Economics and Agribusiness, College of Agriculture and Consumer Sciences, University of Ghana.

E-mail: mkoffei@yahoo.co.uk Phone: (+233) 26 9137563

Article Type:
Full Length Research

Abstract

The continual cropping of vegetable lands in the city of Accra necessitates the application of fertiliser in order to improve and sustain production. This paper addresses the question as to whether it is feasible to up-scale and use sanitised human urine as an alternative low-cost fertiliser for vegetable farming in Accra. The study used survey data conducted by IWMI on some urinals located in the Central Business District of the Accra Metropolitan Assembly (AMA) and on a demonstration project of the use of urine to fertilize cabbage together with data obtained by conducting a questionnaire survey of 300 vegetable farmers. The results of the study showed that it is capital intensive to establish the urine collection and reuse system in the city of Accra considering the logistics needed. The cost-benefit analysis (including a sensitivity analysis) showed that the investment can be financially feasible for a profit-oriented entrepreneur and AMA only if the discount rate is 20% and lower with a urine user fee of GH¢ 0.10 per visit and sale of urine to farmers at GH¢0.30 per jerry-can (20 litres) as it gave NPVs, BCRs and IRRs (GH¢ 8,147.79, 1.03 and 22.65%) and (GH¢ 104901.34, 1.49 and 51.45%) with payback periods of 5.44years and 2.91 years respectively. The Partial Budgeting Analysis showed that in one cropping cycle a cabbage farmer in Accra of farm size 0.02 ha with a planting distance of 0.45m × 0.60m would make a savings of GH¢24.59 when he pays for and uses sanitized urine as an alternative to chemical fertiliser (say NPK). Since it is financially feasible to establish and operate a human urine collection and reuse system in the Accra Metropolitan Area, the metro assembly should partner financing institutions such as the Agricultural Development Bank and start with a pilot project, in that way confidence will be instilled in the private business sector to participate later.

Keywords: *financial feasibility, sanitised urine-fertiliser, vegetable farming, Accra.*

Introduction

Vegetable farming in the city of Accra, Ghana is a predominant feature sustaining a small but significant number of households. As a result of urbanization, most farming lands are continually getting smaller and smaller due to land lost to estate developers and construction of drains. The limited land becomes over dependent and plant nutrients depleted leading to low yields. In other for farmers to sustain and improve production, they use poultry manure and chemical fertilisers. Poultry manure is found in peri-urban areas and access to them is a problem since a large volume is required to make any significant impact on the soil. Chemical fertilisers on the other hand are expensive (Danso et al., 2003 and Quansah et al., 2001). Hence, the quantity of fertiliser that farmers are able to afford is inadequate and application is always at the suboptimal level as compared to the recommended dose required to maximize production.

The value of human urine as nutrient is an old phenomenon but its application has been advocated on many platforms in recent times (IWMI, 2006 and Schonning, 2001). It is shown that urine contains the major parts of the daily excretion of nitrogen (N), phosphorus (P) and potassium (K); it can therefore be considered a valuable fertiliser. Also, the plant availability of N urine is the same as chemical urea or ammonium fertiliser (Jonsson et al., 2004). In the city of Accra, Ghana, the availability of urine is not a problem and its source unlimited. According to IWMI (2007), the mean urine generation rate in the Central Business Districts of Accra is 519 litres per day. In terms of nutrients, the volume of nitrogen, phosphorous and potassium that could be obtained per year is 7.95 tonnes, 0.53 tonnes and 2.2 tonnes respectively. This is equivalent to 114%, 11% and 44% of the nitrogen, potassium and phosphorous required for urban agriculture in Accra (Tettey-Lowor, 2007). Yet the product has not been vigorously introduced to farmers.

In an earlier perception study in Accra, Koomson (2010) showed that about 90 percent of farmer respondents were willing to use urine for production whiles more than 55 percent of traders and consumers were willing to buy vegetables produced with sanitised urine. An investor is called for but it becomes very important for the investor to appreciate the profitability of investing in a urine collection and reuse venture. Again, whether the return on investment (ROI) for using urine by farmers will be better than the poultry manure and chemical fertiliser currently being used needs to be settled. This paper shows how the Cost Benefit Analysis (CBA) framework and the Partial Budgeting Analysis technique were used to ascertain the feasibility of the use of sanitised human urine as an alternative low-cost fertiliser in the city of Accra, Ghana.

Methodology

Description of study area

Accra is the capital city of Ghana and covers an area of about 170 km². It is the most urbanized city in Ghana and has an estimated population of about 1.85 million. The population growth rate is estimated at 3.1 % per annum in the city itself but up to 10% in its peri-urban districts. It is located on latitude $5^0$33' North and longitude 0^0 15' West in the southern part of the country. The city is managed by the Accra Metropolitan Assembly. Irrigated vegetable farming takes place on seven (7) main farming sites in Accra: Osu, Korle Bu, Dzorwulu, Roman Ridge, Plant Pool, Cantoments and La.

Cost-Benefit Analysis (CBA) framework

The financial profitability of the urine-based fertiliser production system was assessed by the Cost-Benefit Analysis (CBA) framework. Cost Benefit Analysis takes into account both financial and socio-economic costs and benefits to assess the comparative advantage of different options (explained later for two scenarios) in monetary terms. A detailed identification and valuation of the total costs, total benefits, discount rate and project lifespan are pre-requisites to successful application of the Cost-Benefit Analysis (CBA) framework. A decision on the profitability of this project is arrived at by the estimation of the Net Present Value (NPV), Internal Rate of Return (IRR), the Benefit Cost Ratio (BCR) and the Pay Back Period (PBP), using equations (1), (2),(3) and (4) respectively (Gittinger, 1982 and Berry *et al.*., 1979).

Net Present Value (NPV)

Net present value is computed by finding the difference between the present worth of benefit stream less the present worth of cost stream.

$$NPV = \sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+r)^t} \quad (1)$$

The project is profitable or feasible if the calculated NPV is positive when discounted at the opportunity cost of capital. This would reflect a project where the present value of net benefits exceeds the present value of all fixed and variable costs. The final result is a numerical value in Ghana cedis (GH¢).

Where:

$B - C$= cash flow in n_{th} year of the project, B = Benefit in each year of the project
C = Cost in each year of the project, r = Interest (discount) rate
t = 1, 2…20 (time of the project life in years), n = Number of years in the project, in this case 20 years.

Internal Rate of Return (IRR)

Internal Rate of Return (IRR) is that discount rate which just makes the net present value (NPV) of the cash flow equal zero. It represents the average earning power of the money used in the project over the project life. It is also sometimes called yield of the investment. A project is profitable or feasible for investment when the internal rate of return is higher than the opportunity cost of capital.

$$IRR = \sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+r)^t} = 0 \quad (2)$$

Benefit Cost Ratio (BCR)

It is the ratio of present worth of benefit stream to present worth of cost stream.

$$BCR = \sum_{t=1}^{t=n} \frac{B_t}{(1+r)^t} \Big/ \sum_{t=1}^{t=n} \frac{C_t}{(1+r)^t} \quad (3)$$

The investment is said to be profitable when the BCR is one or greater than 1.

Pay Back Period (PBP)

The Payback period is the length of time required for an investment to pay itself out.

$$PBP = I \Big/ \sum_{t=1}^{n} E_{n=1} \quad (4)$$

Table 1: Fixed cost logistic items for the urine collection system

Item	Quantity	Unit cost (GH¢)	Lifespan (Years)
Construction of platform for the installation of male and female urinal			***
Construction and installation of underground storage tanks at source			***
Construction and installation of storage tanks at destination			***
Urinal cubicles	12	1200	20
Waterless stand alone urinals (for male)	6	35	10
Bidet (waterless urinal for female)	6	135	10
Sink			
Dustbin	12	7	10
Poly kiosk for attendants	2	920	20
Poly tank(Rambo 850)	5	1265	20
Dislodging vehicle (used 6000 litre suction truck)	1	45000	20
Change of the suction truck tires every 5years	6	550	5

Source: Survey results (May 2010) ***See tables at appendix for details

Table 2: Variable cost logistic items for the urine collection system

Item	Quantity	Unit cost (GH¢))	Lifespan (Years)
Mob stick	2	4	1
Mob bucket	2	5	1
Gloves	6	7.5	1
Detergent (allow GH¢ 20.00 per month for detergent)		20	-
Ground rent (30% of total revenue as charged by AMA)	***	***	***
Registration fee (Business Operating Permit)		140	1
Director(salaries increases by 5% of previous every 2 years)	1	1000	**
Supervisors (salaries increases by 5% of previous every 2 years)	1	800	**
Secretary (salaries increases by 5% of previous every 2 years)	1	700	**
Driver for dislodging truck (salaries increases by 5% of previous every 2 years)	1	300	**
Attendants (2) (salaries increases by 5% of previous every 2 years)	2	200	**
Labourer for dislodging vehicle (2) (salaries increases by 5% of previous every 2 years)	2	200	**
Fuel	***	720	1
Change of oil, filters and workmanship	***	1080	1

Source: Survey results (May 2010) **Monthly salaries

Where:

I= initial investment of the project
E = the projected net cash flows per year from the investment.

The Pay Back Period is expressed in number of years and a project with a shorter PBP is normally good for an investor especially when the initial investment cost is higher. In order to ascertain the profitability of the urine collection system, the total costs and total benefits were identified and valued. Table 1 and Table 2 list the logistics that would be required by an entrepreneur in designing the urine collection and reuse system. The unit cost (May 2010 prices) and lifespan are also indicated. The total cost of the urine collection system was then estimated from the equation (5) below

$$TC_{UCS} = TFC_{UCS} + TVC_{UCS} \quad (5)$$

Where:

TC_{UCS} = The total cost of the urine collection system.
TFC_{UCS} = The total fixed cost of the urine collection system
TVC_{UCS} = The total variable cost of the urine collection system

The total fixed cost (TFC_{UCS}) or investment cost is the money required at the beginning of the project to finance or purchase materials, labour and any other costs related to construction and implementation of the urine collection system. Equation (6) was used to estimate the total fixed cost of the urine collection system.

$$TFC_{UCS} = C_{f1} + C_{f2} + \dots + C_{f12} \quad (6)$$

Where: $C_{f1} + C_{f2} + \quad + C_{f12}$ are the fixed cost logistic items shown in table 1.

The total variable cost (TVC_{UCS}) or operational and maintenance cost of the urine collection system is the money that is required to sustain the system once it has began operation. Equation (7) was used to estimate the total variable cost of the urine collection system.

$$TVC_{UCS} = C_{v1} + C_{v2} + \cdots + C_{v14} \quad (7)$$

Where: $C_{v1} + C_{v2} + \cdots + C_{v14}$ are the variable cost logistic items shown in table 2.

The yearly revenue expected to be derived from the urine collection system was estimated from the equations (8) and (9) below.

$$TR_{UCS} = P_V Q_{nv} + P_S Q_S \quad (8)$$

$$TR_{UCS} = P_V \frac{Q_V}{0.26l} + P_S Q_S \quad (9)$$

Where:

TR_{UCS} = the total revenue from the urine collection system
P_v = the price per visit to the urinal
Q_V = the volume of urine generated
Q_{nv} = the number of visits to the urinal with averagely 0.26l of urine per visit
P_S = the price per litre of urine sold
Q_s = the quantity of urine sold in litres

Equation (10) below was then used to estimate the net benefit accrued from the urine collection and reuse system. It was assumed that $Q_V = Q_S$ to cater for spill over and evaporation during transportation, storage and handling.

$$B_{UCS} = TR_{UCS} - TC_{UCS} \quad (10)$$

Where: B_{UCS} = the yearly net benefit from the urine collection system. A cash flow table was then developed for a period of twenty (20) years. The twenty years period was chosen based on the lifespan of the longest lasting logistic such as urinal cubicle and poly kiosk. A discounted cash flow was estimated at an interest rate of 25 % (which was the mean of Ghana Commercial Bank (22.75 %,), Agricultural Development Bank (24.75%) and Barclays Bank (26.9%) lending rates in May 2010.

The estimated cost benefit analysis parameters were fed into an excel worksheet (Microsoft office package 2007) which was then used to generate the values of the NPVs, BCRs, IRRs and PBPs under two (2) scenarios A and B regarding ownership of the urine collection and reuse system. That is; Scenario A was to be operated by a private profit-oriented entrepreneur and Scenario B was to be operated by Accra Metropolitan Assembly (public ownership).

Sensitivity Analysis

A sensitivity analysis is conducted to systematically test what would happen to the earning capacity of a project, here, the urine collection system if events change from that used in the initial planning of the project. This is done as a means of dealing with uncertainty about future events and values (Gittenger, 1982). The sensitivity analysis is carried out by varying the costs and benefits parameters of the urine collection system and the effect on the outcome of the project's worth is determined. In conducting the sensitivity analysis, the following situations were considered:

1. Increasing urine user charge from GH¢ 0.05 to GH¢ 0.10

The profitability of the urine collection and reuse system is dependent on the total revenue generated from the system, and urinal user charge is a key component of the total revenue equation (equation 8). The operation of a urinal in the Central Business district (CBD) of Accra has Attendants who charge a user fee of GH¢ 0.05 to GH¢ 0.10 depending on the location of the urinal. For the purposes of this feasibility study, it was therefore imperative to keep all benefits at the lower bound and vary them appropriately, hence the increase in the urine user charge from GH¢ 0.05 to GH¢ 0.10.

2. Increasing sale of urine price by 5%

Currently, there is no market price for the sale of urine in Ghana. Therefore, a price of GH¢ 0.30 per 20 litres was assumed on the basis that a 20 litre of urine costs GH¢ 0.29 (US$ 0.20) in Burkina Faso (Ghana's neighbour) (Schuen *et al.*., 2009)). A 50kg NPK (15-15-15) fertiliser costs GH¢58.00 (US$ 40.00) in Burkina Faso and GH¢ 55.10 (US$ 38.00) in Ghana. Hence, by simple proportion, 20 litres urine would cost about GH¢ 0.28 (US$ 0.19) in Ghana. The demand of urine is partly dependent on the own price of urine to farmers. Therefore, for urine to be competitive, its unit price should not be greater than the unit price of the conventional fertiliser currently being used by farmers. A kilogramme of NPK-15-15-15 fertiliser costs GH¢ 1.50 and has a nitrogen content of 0.30kg (N= GH¢0.45). A litre of urine from the CBD of Accra stored for a period of one month has a nitrogen content of 10.30g (Adamtey, 2010). Hence an equivalent of 0.30kg N of urine will cost GH¢ 0.41 which is approximately 8.9% cost reduction in the price of N of urine (0.30kg N of urine = GH¢ 0.41 and 0.30kg N of NPK-15-15-15 = GH¢ 0.45).Therefore, increasing the price of urine beyond 5% will not make it competitive to the chemical fertiliser NPK (15-15-15).

3. Increasing both urine user charge to GH¢ 0.10 and urine sale price by 5%

It was also important to conduct a sensitivity analysis to ascertain what happens when both urine user charge and urine sale price are increased to GH¢ 0.10 and by 5% respectively.

4. Increasing urinal user charge to GH¢ 0.10 and decreasing the discount rate to 20%

The profitability of most investment projects are often reduced by high discount rates. This investment is an ecological sanitation as well as food security project; it is therefore possible for government and non-governmental agencies to receive lower discount rates and grants to ensure the implementation and sustenance of such projects. Therefore, decreasing the discount rate to 20% (lower than 25% base discount rate) as well as a urinal user charge of GH¢ 0.10 became plausible.

Partial-Budgeting Analysis model

Partial-Budgeting Analysis was employed to estimate the savings made by farmers when they use urine as an alternative fertiliser. Partial Budgeting is a managerial analysis technique as it looks at the changes in cost and receipts that is, net farm income, likely to result from marginal change in a farming system (Johnson, 1982).It compares the profitability of one alternative, typically what is being done now, with a proposed change or new alternative (Kay *et al.*., 2008). In a Partial Budgeting analysis, four (4) important questions are to be answered on the basis of what would happen if a proposed alternative was implemented, that is:

1. What new costs would arise when Poultry manure + Urine is used as fertiliser?
2. What formal costs would be saved for using Poultry manure + Urine as fertiliser?
3. What formal income would be lost for using Poultry manure + Urine as fertiliser?
4. What new income would arise for using Poultry manure + Urine as fertiliser?

In order to estimate the savings made by farmers for using Poultry manure + Urine instead of poultry manure + chemical fertiliser (NPK 15-15-15) the results of a demonstration project conducted by IWMI on the use of urine for cultivating cabbage were applied. In addition, questionnaires were issued to collect opinions of 300 vegetable farmers. The farmers were purposively sampled based on IWMI's suggestion to use seven (7) main farming sites in Accra to obtain both quantitative and qualitative data on prices of harvested cabbage, cost of NPK fertiliser, poultry manure, common farmer practices and farmer knowledge of and willingness to pay for and use sanitised human urine as an alternative fertiliser. Most of the farming sites had farmer associations; however, accidental sampling was also employed to include some farmers who were not part of the major farmer associations.

Socio-economic characteristics of farmers

The 300 respondents interviewed were made up of 6 %(19) female farmers and 94% (281) males. Very few females were noted to be in urban vegetable farming. About 70% of the respondents were below age 50 years and only 19% of respondents were illiterate, no formal schooling although some can comprehend English and simple arithmetic). About 70% of the respondents indicated that they were married. Out of the 300 farmer respondents, 203 indicated that they are committed to the Islamic religion while 95 indicated they are Christians. About 82% of the respondents indicated that vegetable farming is their full time occupation. Majority of vegetable farmers in Accra do not own the land they operate on. In the survey only 2.3% of the farmers indicated they owned the land. Out of the 7 farmers who indicated they owned the land, 6 came from the "La" farming site. Such is to be expected, because most of the lands in the "La" farming site are owned by the traditional council/family land or individuals who have inherited it from the family.

The mean years of vegetable farming experience is 5.6 and majority (2%) have been in business for over 18 years. Most vegetable farmers in Accra cultivate on beds of average size, 1.8m by 7.6m (13.7m^2). About 18%, of the respondents had 15 beds, the mean number of beds (0.02 ha). Obuobie *et al.*., (2006) reported that plot sizes cultivated by vegetable farmers in Accra ranged between 0.01-0.02 ha and has a mean of 2.0 ha in the peri-urban areas. Fertiliser and pesticide usage are common phenomena of urban vegetable farming in an attempt to sustain production. This study showed that all the respondents used pesticides in cultivation. Also, 98% of the respondents indicated that they used fertiliser whereas 2% indicated that they do not use chemical

Table 3: Financial analysis of the investment into urine-based fertiliser production system - Private ownership

Investment cost	**78,502.60**
Total operating cost	1,062,106.04
Total benefit	885,433.00
NPV (25%)	GH¢ - 89372.15
BCR (25%)	0.59:1
IRR	-

Source: Survey results, 2010

Table 4: Sensitivity analysis of the urine-based fertiliser production system

Cost Benefit Analytical indicators	**Sensitivity Analysis (25%)**
	Increase urine user charge from GH¢ 0.05 to GH¢ 0.10
NPV (GH¢)	(6220.41)
BCR	0.98:1
IRR	22.53%
	Increase sale of urine price by 5%
NPV (25%)	GH¢ -89071.35
BCR (25%)	0.59:1
IRR	-
	Increase both urine user charge to GH¢ 0.10 and urine sale price by 5%
NPV (GH¢)	(5,916.45)
BCR	0.98:1
IRR	22.65%
	Increase urine user charge from GH¢ 0.05 to GH¢ 0.10 and decrease discount rate to 20%
NPV (20%)	GH¢ 8147.79
BCR (20%)	1.03:1
IRR	22.65%
PBP	5.44 years

Source: Survey results, 2010 (see details of discounted cash flow at Appendix 5-8)

fertiliser but poultry waste only. About 65% of the respondents were not aware of the fertilizing potential of human urine, whiles 35% indicated that they were aware. With a brief explanation of the potential benefits of sanitized urine to farmers, about 87% of the respondents indicated that they were willing to use urine as an alternative fertiliser for vegetable farming. Out of the 261 respondents who indicated that they were willing to use urine as an alternative fertiliser, 99.6% showed that they were willing to pay for the use whereas 0.4% indicated that it should be supplied free because it is easier to organise and collect urine from the neighbourhood, therefore it should not be sold.

Results and Discussions

Cost-benefit analysis (CBA)

Scenario A: Private ownership

This is under the assumption that the urine-based fertiliser production system (all operations, from the point of urine generation through to the point of urine storage and treatment) is under the confines of a private profit-oriented entrepreneur, who invests into the establishment of the system and its sustenance and benefited from the urinal user charges and sale of urine to farmers. It is important to note that currently the Accra Metropolitan Assembly, AMA holds the sole responsibility to operate a urinal in the Metropolis. However, in-line with its privatization policy, private entrepreneurs are invited to operate the urinals on condition that 30% of the earnings (Total revenue) made by the entrepreneurs goes to AMA (AMA, 2006). Table 3 shows the results of the financial analysis of the investment into the urine-based fertiliser production system (Private ownership).

It would cost GH¢78,502.58 to establish the urine collection system and an average annual operating cost of GH¢55,900.32. The average annual benefit is GH¢ 46,601.74. At 25% discount rate the NPV is negative, the BCR is less than one and the IRR is invalid suggesting that there is no real discount rate that would make the

Table 5: Financial analysis of the investment into urine-based fertiliser production system - Public ownership

Investment cost	**GH¢ 78,502.60**
Total operating cost	GH¢ 793,820.04
Total benefit	GH¢ 885,433.00
NPV (25%)	GH¢ - 50699.01
BCR (25%)	0.71:1
IRR	1.37%

Source: Survey results, May, 2010

Table 6: Sensitivity analysis of the urine-based fertiliser production system

Cost Benefit Analytical indicators	Sensitivity Analysis
	Increase urine user charge from GH¢ 0.05 to GH¢ 0.10
NPV (25%)	GH¢ 68089.31
BCR (25%)	1.38:1
IRR	51.45%
	Increase sale of urine price by 5%
NPV (25%)	GH¢ -50269.07
BCR (25%)	0.83:1
IRR	-
	Increase urine user charge from GH¢ 0.05 to GH¢ 0.10 and decrease discount rate to 20%
NPV (20%)	GH¢ 104901.34
BCR (20%)	1.49:1
IRR	51.45%
PBP	2.91 years

Source: Survey results, 2010 (see details of discounted cash flow at Appendix 9-11)

NPV greater or equal to zero. It can be concluded under this scenario that, investment into the urine-based fertiliser production system is not feasible and there would be no payback when the lifespan is 20 years and the discount rate is 25%. The results of the sensitivity analysis suggest that an increase in the urine user charge from GH¢ 0.05 to GH¢ 0.10, does not improve the feasibility situation (Table 4). Only at a lower discount rate does the situation improve.

The investment is feasible when the urine user charge is increased to GH¢ 0.10 and the discount rate is at 20%, then, the NPV of GH¢ 8,147.79 (NPV > 0) is obtained. The BCR of 1.03 is greater than one (BCR: 1.03:1). This means that each GH¢1.00 invested at a discount rate of 20% would yield a return of GH¢1.03. The IRR of 22.65% is greater than the discount rate of 20% which means at a discount rate greater than or equal to 20% but less than or equal to 22.65% the entrepreneur can still breakeven. In this case, the payback period is 5.44 years relatively shorter for the entrepreneur to make a profit within the 20 years investment lifespan. It can therefore be concluded that the investment into the urine-based fertiliser production system by a private profit-oriented entrepreneur is feasible when he invests at a discount rate of 20% or below and should expect to pay back after 6 years of the project life.

Scenario B: Public Ownership

This is under the assumption that; the AMA is the operator of the urine-based fertiliser production system and pays neither ground rent nor annual Business Operating Permit which accounts for 33.8% of total operating cost (that is: saves an average operating cost of GH¢14,120.32 annually). It however makes all other investment and operating costs that the private operator would have made and benefited from the urinal user charges and sale of urine to farmers. In this scenario B, it is shown that it would cost GH¢78,502.58 to establish the urine-based fertiliser production system with an average annual operating cost of GH¢ 41,780.00. The average annual benefit would be GH¢46,601.74.
From table 5 it is shown that at 25% discount rate and base user charges, the NPV is less than zero, BCR is less than one (BCR: 0.71:1) and IRR is 1.37%, far less than the discount rate. It can be concluded under this scenario that, investment into urine-based fertiliser production system would not be feasible and would not yield a payback within the 20 years of the project lifespan.

Results of the sensitivity analysis show that, if there is an increase in the urine user charge from GH¢ 0.05 to GH¢ 0.10, an NPV of GH¢68,089.30 which is greater

Table 7: Partial budget to estimate the effect of substituting (S+PD+U) for (S+PD+NPK) as fertiliser on a 200m^2 cabbage farm

LOSSES		**GAINS**	
Income lost	GH¢	New income	GH¢
0.197 tonnes mean extra yield of cabbage at GH¢ 0.60/kg	118.20	0.226 tonnes mean extra yield of cabbage at GH¢ 0.60/kg	135.60
New costs		Costs saved	
Fertiliser(S+PD+U):		Fertiliser(S+PD+NPK):	
(61.4kg PD + 117.4L U)	3.70	(61.4kg PD +8.1kg NPK)	10.89
Net gain	24.59		
	GH¢146.49		GH¢146.49

Source: Survey data (May, 2010).

than zero, will be obtained (Table 6). The BCR (1.38) obtained is also greater than one (BCR: 1.38:1), this means that for each GH¢ 1.00 invested at a discount rate of 25% would yield a return of GH¢ 1.38 which is able to recover the total investment and operating costs. Also IRR of 51.45% is greater than the discount rate of 25%. It can be concluded under this scenario that, investment into urine-based fertiliser production system would be feasible with a payback of 2.48years within the 20 years of the project lifespan. The operation of the system is also profitable when AMA charges a urine user fee of GH¢ 0.10 and the discount rate is at 20% with a urine sale price of GH¢ 0.30 per 20litres.

Partial-Budgeting Analysis model

The result of the partial budget of the effect of substituting S+PD+U (Soil + Poultry Dropping + Urine) for S+PD+NPK (Soil + Poultry Dropping + NPK 15-15-15) as a fertiliser on a 200 m^2 cabbage farm showed a net gain of GH¢ 24.59 (Table 7). When cabbage was fertilised with S+PD+U fertiliser (82.9g PD + 158.5cm^{3}U), it increased the mean yield from no fertiliser application of 775.67g to a mean yield of 1080.07g of S+PD+U application (that is, 304.4g extra yield) at a cost of GH¢ 0.84. Cabbage which was fertilised with S+PD+NPK fertiliser (82.9g PD + 10.9g NPK) gave a mean yield of 1041.70g (that is 266.03g extra yield) at a cost of GH¢ 1.46.

Table 7 illustrates that in one cropping season (usually 3 months), a cabbage farmer in Accra of farm size 200 m^2 (0.02ha) with a planting distance of 0.45m × 0.60m would make a savings of GH¢24.59 for using S+PD+U as an alternative fertiliser in lieu of S+PD+NPK. It costs a cabbage farmer GH¢10.89 (S+PD+NPK fertiliser) to gain a mean extra yield of 0.197 tonnes with a revenue of GH¢118.20 when the mean price of cabbage is GH¢0.60 per kilogramme, whilst, it would cost the farmer GH¢3.70 (S+PD+U fertiliser) to gain a mean extra yield of 0.266 tonnes with a revenue of GH¢135.6.The results from IWMI's demonstration project, (Appendix 12), and the partial budget analysis confirms a similar demonstration project done by CREPA for 70 vegetable farmers, on ecological sanitation on some crops in seven West African Countries (Bonzi, 2008).The results of the demonstration showed that crops fertilised with sanitise urine gave higher yields and longer fruiting life than crops fertilised with the chemical fertiliser, urea.

Summary and Conclusion

It is a fact that continual cropping of vegetable lands necessitates the application of fertiliser. Resource poor farmers seek alternatives sources of fertiliser. The argument is that any material that can profit direct benefit or aid cost saving will be adopted by farmers. This study sought the opinions of 300 vegetable farmers in the city of Accra, Ghana, on the re-use of urine (human waste) to improve soil fertility. It also ascertained the financial viability of investment in the collection, processing and distribution of sanitised urine by an entrepreneur. The results of the study showed that there is high level (87%) acceptability of urine re-use among vegetable farmers in Accra. The results of financial analysis also showed that at 20 percent discount rate any company, public or private will operate profitably and pay back investment capital by the 6th year. A urine kiosk user fee of GH¢ 0.10 per visit can be charged and sale of urine to farmers should be at least GH¢0.30 per 20 litres. The estimated NPV, BCR and IRR will be favourable. The partial budgeting analysis showed that in one cropping cycle a cabbage farmer in Accra of farm size 0.02 ha with a planting distance of 0.45m × 0.60m would make a savings of GH¢24.59 when he pays for and uses sanitized urine as an alternative to chemical fertiliser (say NPK).

Two policy implications are distilled: First, create awareness among farmers in more sites through the extension services system so that more organic and lower-cost production will be encouraged. Second, start a pilot using the public-private partnership that waves some of the investment costs (cost of borrowing and business operating permit cost) for the private investor in the first decade to serve as incentive. The collection and processing of urine will create an avenue for job creation for the private sector as well as serve as alternative source of fertiliser of farmers in the city. The involvement of local government in the promotion of eco-sanitation and creation of a bioeconomy should trigger un-ending benefits.

Acknowledgement

Sincere gratitude goes to the International Water Management Institute (IWMI) for suggesting the area of research and providing the initial financial support for the process of data collection. We are also grateful to the National Agribusiness Development Programme (NADEP) for providing additional financial support to widen the scope of research to cover more farmers in the Accra Metropolitan Assembly.

References

Adamtey N (2010). Use of human urine in urban and peri-urban agriculture: effect on cabbage growth, yield, nutrient uptake and its characteristics. Report submitted to IWMI, SWITCH and RUAF, p20.

Berry PJ, Hopkins JA, Baker CB (1979). Financial Management in Agriculture by Illinois, the Interstate Printers & Pub., Inc., USA.

Bonzi M (2008). Experiences and opportunities for human excreta fertiliser in improving small scale Agriculture, Stockholm World Water week presentation.

Danso G, Drechsel P, Gyiele L (2003). Urban household perception of urine-excreta and solid waste source separation in urban areas of Ghana. In Ecosan-Closing the loop. Procedure 2nd Int. Symposium on Ecol. Sanitation. April 2003. Luebeck, Germany p. 191-196.

Gittinger JP (1982). Economic Analysis of Agricultural project, Second edition, the John Hopkins University Press; Baltimore, USA.

IWMI (2006). Urban agriculture in Accra, Ghana assessing livelihood potentials and policy mechanisms. A working paper, International Water management Institute (IWMI), Accra.

IWMI (2007). The potential of urine recovery and reuse in densely populated districts within the Accra Metropolitan Area. A working paper, International Water management Inst. (IWMI), Accra.

Johnson TD (1982). The Business of Farming: A Guide to Farm Business Management in the Tropics, the Macmillan Press LTD.

Jonsson H, Stintzing AR, Vinnerås B, Salomon E (2004). Guidelines on the Use of Urine and Faeces in Crop Production. EcoSanRes Programme. Stockholm Environment Inst., Sweden.

Kay DR, Edwards MW, Duffy AP (2008). Farm Management – Sixth Edition, McGraw-Hill Companies Inc. New York

Quansah C, Fening JO, Ampontuah EO, Afreh D, Amin A (2001). Potential of Chromolaena odorata, Panicum maximum and Pueraria phaseoloides as Nutrient Sources and Organic Matter Amendments for Soil Fertility Maintenance in Ghana, in Biol. Agricul. Horticul., 2001, 19(2) 101-113

Schonning C (2001). Urine diversion: hygienic risk and microbiological guidelines for reuse. Department of parasitology, mycology and environmental microbiology, Swedish department for infectious diseases.

Schuen R, Parkinson J, Knapp A (2009). Study for Financial and Economic Analysis of Ecological Sanitation in Sub-Saharan Africa. Nairobi, Kenya, Water and Sanitation Program.

Tettey-Lowor F (2007). Closing The Loop between Sanitation and Agriculture in Accra, Ghana, (Improving yields in urban agriculture by using urine as a fertilizer and drivers and barriers for scaling-up) Msc. Thesis at the University of Wageningen.