Wastewater Use for Agriculture in Ghana

1. Introduction

The world has entered the 'urban millenium' as Kofi Annan, the former UN Secretary General, stated. Taking Africa as an example, its population will almost triple by 2050 and this will be primarily in the urban and peri-urban areas. It is projected that by 2015 25 countries in Sub-Saharan Africa will have higher urban than rural populations; this number would increase to 41 countries by 2030 (UN-Habitat, 2001). About 44% of the population in the West African sub-region lives in urban areas (UN Population Division, 2004), compared to only 4% in 1920. The same 44% applies to Ghana, and this number is expected to rise rapidly as some of Ghana's (peri)urban areas have annual growth rates of more than 6 to 9% (Ghana Statistical Service, 2002).

The increasing urban population comes along with increasing demand for sanitation infrastructure. In Ghana, and also in most urban centres in Sub-Saharan Africa, current urban sanitation infrastructure is inadequate and seems not to be keeping pace with population growth rate. In the typical example of Ghana, only 4–5% of the population is linked with – infrequently functional – sewage systems and sewerage treatment plants. Most untreated wastewater ends up in storm-water gutters, streams and other water bodies which are often used as sources for irrigation water (Keraita et al. 2002). In many urban and peri-urban areas wastewater constitutes the only available surface water for irrigation in the dry season, to sustain many livelihoods. Use of the wastewater in Urban and Peri-urban Agriculture (UPA) not only lessens the pressure on water resources but also increases water productivity through reuse of water and nutrients, which may be otherwise a nuisance to the environment.

2. Wastewater status and trends

The total amount of grey and black wastewater produced in urban Ghana is estimated to be approximately 280 million m^3. This quantity of wastewater is mainly from domestic sources since most wastewater from industry is channeled into the ocean. With increasing spread of processing facilities into inland areas future increases in the percentage of wastewater from industrial sources could be expected. It is estimated that urban wastewater generation in Ghana will increase from 530,346 m^3/day in 2000 to 1,452,383 m^3/day in 2020 (36 per cent in 2000 to over 45 per cent in 2020) (Agozo, 2003)

Wastewater treatment in Ghana is very limited with less than 8 per cent of wastewater being treated currently. Majority of available wastewater treatment facilities are used for treating domestic wastewater. The Greater Accra region alone is home to 505 of these facilities most of which are currently under the management of government and public institutions including hospital, schools, security services and ministries. A faecal treatment plant located in Kumasi could treat only 5 per cent (180 – 500 m3/day) of the total faecal sludge produced in the city. A

biological treatment plant located at Korle Lagoon, Accra is able to handle only 8 per cent of Accra's inner city wastewater from domestic and industrial sources. It is estimated that only 10 per cent of Accra's wastewater is collected for some kind of treatment.

In addition to the above existing facilities which are in most case functioning below average capacity or non-serviceable, efforts are underway in the various local government (metropolitan, municipal and district assemblies) authorities to provide facilities for waste (liquid and solid) treatment as a major step towards improving sanitation in urban areas

Some attempts to develop new sanitation facilities have been faced with socioeconomic challenges since they disrupt other existing infrastructure hence most new sewerage treatment plants in Ghana are operating below the design capacity. The related cost factor is tremendous, calculations by Gijzen and Ikramullah (1999) in Bos et al., 2004 showed that new investments in wastewater treatment would require payback periods exceeding by far the infrastructure's economic lifetime. As wastewater treatment does appear a realistic option, banning the use of polluted water by UPA has been tried in Accra and other cities within the Volta basin but has failed since such bans threaten many livelihoods, urban vegetable supply and are contrary to national poverty alleviation strategies. In any case, related institutional and policy frameworks are weak and hardly practicable or enforced in the country.

Urban farmers in this harsh situation expressed significant concerns as their livelihoods are at permanent risk. Any solution to reduce health risks without forcing them to change their (market-driven) cropping patterns or water access would be appreciated. However, this practice is known to have adverse public health and environmental effects, especially because untreated wastewater or polluted water has high levels of pathogenic organisms. Previous studies carried out in urban and peri-urban areas in Ghana revealed that most of the surface water bodies used for irrigation are heavily polluted and not appropriate for crop irrigation (Cornish *et al.,* 1999; Mensah *et al*., 2001, Amoah et al., 2005, 2007a, Keraita et al 2008;). Consequently, municipal authorities and government ministries have raised concern regarding the potential health risks to consumers and wastewater irrigators.

Recognizing this limitation, there is increasing advocacy for other measures which could be more appropriate or at least complementary for risk reduction in developing countries. For example, in its revised 2006 wastewater reuse guidelines, WHO adopted a multiple-barrier approach by combining different health protection measures to meet required health-based targets at the consumer level (WHO 2006). This opened the way to target - in line with the Hazard Analysis and Critical Control Points (HACCP) concept - a variety of entry points where health risks occur or can best be mitigated before the food is consumed. In Ghana, a number of research institutions and universities supported by FAO, CPWF, IDRC and WHO have been working with farmers and other stakeholders to explore, develop and test risk reduction measures

where vegetables are irrigated with highly polluted water. The main emphasis was put on safety measures from farm to fork, i.e., those protecting consumers of salad greens.

3. Wastewater use

It was estimated that if only 10% of the 280 million m^3 of wastewater from urban Ghana could be (treated and) used for irrigation, the total area that could be irrigated with wastewater alone could be up to 4,600 ha. At an average dry-season farm size of 0.5 ha, this could provide livelihood support for about 9,200 farmers in the peri-urban areas of Ghana (Agodzo *et al.*, 2003). However, as described earlier, there is inadequate sewage conveyance capacity. In most cities and towns, such as Accra and Kumasi, untreated wastewater flows from drains into streams, which are usually used for irrigation. Thus wastewater is mostly used in a diluted form mixed with surface runoff and/or stream water (Cornish *et al.*, 2001). There are several cases where farmers use wastewater directly from drains and broken sewers without further dilution, especially in the dry season. For simplification, all these water sources are referred to as 'wastewater'.

A common picture in both urban and peri-urban areas of Ghana is the cultivation of cereals such as maize in the rainy seasons and irrigated vegetables in the dry seasons. More than 15 kinds of vegetables are cultivated, all of which are sold. Both exotic and indigenous leafy vegetables are grown with wastewater. Among the exotic ones are lettuce (*Lactuca sativa),* cabbage (*Brassica oleraria),* spring onions (*Allium cepa),* cauliflower (*Brassica oleracea),* green pepper (*Capsicum annuum),* carrots (*Daucus carota*) and radish (*Raphanus sativus*), while indigenous vegetables included okro (*Hibiscus esculentus),* "ayoyo" (*Corcorus olitorius*) and "allefu" (*Amaranthus cruentus*). However, the frequently cultivated ones are lettuce, spring onions, cabbage, and green pepper.

The use of polluted water for vegetable farming is more widespread in the more populated cities where safe water is scare. Safe water is mostly used for domestic purposes. From a general survey among open-space farmers carried out in 2002, it was found that about 84% of nearly 800 farmers farming in and close to Accra and almost all 700 farmers in Tamale (in the north) used polluted water for irrigation, at least during the dry seasons. Generally, farmers place lower priority on the possible nutrient value of the wastewater than on its value as a reliable water source, especially in the dry season.

Typical urban farm sizes range from 0.1–0.2 ha and they increase in size along the urban–rural gradient. As production is market-oriented, farming is input- and output-intensive, particularly in terms of the use of water and other farm inputs as poultry manure, pesticides and fertilisers. In Ghana, most farmers use watering cans to irrigate, while motor pumps are used by a few farmers. Open-space vegetable farming is more than 90% male-dominated especially in urban areas, usually with a large distance between the home and the actual farm plot. The reasons for the dominance of men in vegetable production are the arduous tasks including irrigation with two heavy 15-l watering cans.

Irrigation Water Requirements and Application Rates

The amount of irrigation water required depends on the effectiveness of rainfall in any given location. For the vegetables grown, the crop water requirements range between 300 and 700 mm

depending on the climatic conditions and the season of the crop at the location. For some farming activities that coincide with the major rainy season, irrigation water requirements are minimal. On the other hand, in the drier months in urban areas located in the dry savannah areas, irrigation water requirements per growing season could be as high as 600 mm. For farmers in the urban centres that depend on water from the drains, there may be insufficient water to meet their crop requirements (Agodzo *et al.,* 2003), especially if crops are grown all year round.

Benefits of Wastewater Irrigation

Cost/benefit analyses have been carried out for urban and peri-urban vegetable farmers in and around Kumasi (Danso *et al*., 2002a; Cornish and Aidoo, 2000). Year-round, open-space urban farmers can achieve annual income levels of US$400–800/ha. These levels are achieved due to the intensive nature of farming made possible partly by the free and reliable supply of water. On average, farm income from all vegetables amounts to about US$1,440/ha but a more conservative estimate considering actual crop mix could be US$500/ha (Cornish *et al.,* 2001).
The value of wastewater irrigation should not only be seen from the perspective of livelihood support, employment, and income generation given that the actual (sometimes small) numbers of open-space farmers might not attract the attention of municipal authorities.

The overall (aggregate) benefit to the city should also be highlighted. An example is the dependence of the city on irrigated urban vegetable production. Due to the lack of refrigerated transport and storage, the supply of perishable vegetables to urban dwellers depends significantly on this kind of agriculture (Nugent, 2000; Smith, 2002). In Accra, for example, about 90% of the vegetables consumed in the city are produced within or close to the city mostly with wastewater (Cofie and Drechsel, 2004). The analysis, that excludes backyard subsistence production, revealed that urban agriculture is a crucial supplier of the most perishable vegetables to the cities' markets. There is high demand for urban produce especially from low-income households and the large number of small (street) eating places (locally known as 'chop-bars') because it is fresh and they have limited possibilities for storage. Thus, most of the chop-bars benefit from wastewater irrigation.

Despite these positive signs the problem of crop contamination raises significant concerns, not only among the health directorates of the same assemblies, but also in the media. This is supported by a municipal bylaw stating, 'No crops shall be watered by the effluent from a drain from any premises or any surface water from a drain which is fed by water from a street drainage'. This bylaw targets those vegetables and fruits likely to be eaten raw (Local Government, 1995). Irrigated urban agriculture therefore remains informal without any cross-sectoral support by authorities. And as farmers at most locations have no alternative to polluted water, they continue to use it.

4. Use of integrated natural wastewater treatment systems

Although less than 8 per cent of wastewater is being treated currently in Ghana, adoption of technologies that are environmentally friendly and self-sustaining in terms of efficiency, cost and treatment performance will maximize the effective use of wastewater in Ghana. To achieve this would entail the adoption of an integrated approach incorporating economic incentives capable of paying for the cost of wastewater treatment as well as selection of technologies that gives the country key advantages considering its peculiar available resources. The use of natural

wastewater treatment systems offers such an opportunity. Natural wastewater treatment systems are artificially created systems capable of utilizing the ecological, biochemical and physical processes involving wetland flora, soils, and their associated macrofauna and microbial assemblages to assist in treating wastewater. It has been suggested that in determining the suitability or the sustainability of a wastewater treatment technology, the following factors need to be considered:

(I) Its robustness while meeting effluent standards
(II) Its generation of wastes such as sludge and by products such as carbon dioxide emissions
(III) Its capacity for various re-use options as well as environmental benefits
(IV) The extent of chemical usage and the degree of environmental nuisance it poses
(V) Its energy source and consumption as well as land and other capital requirements (Brix, 1998; Shutes, 2001)

Natural wastewater treatment systems perform best in tropical climates having highly diverse flora and fauna. Their draw backs are large land space and labour requirement which are usually not severely constrained in developing economies. In Ghana an important requirement of a wastewater treatment technology is its ability to remove pathogens as rural communities tend to use raw water from rivers, streams and drains without any form of treatment. Table 1 summarizes the efficiency of natural wastewater treatment systems in comparison to conventional wastewater treatment systems such as the activated sludge and trickling filter systems. They are robust, low cost and have high purification rates requiring low skilled manpower with potential for economic benefits such as fish farming, thatch harvests for roofing, mats etc (Denny, 1997).

Table 1. Summary of removal efficiencies from selected treatment systems

Treatment technology	Log Removal		
	Bacteria	Helminth eggs	Protozoan cysts
Activated sludge	0-2	0-2	0-1
Trickling filter	0-2	0-2	0-1
Aerated lagoon	1-2	1-3	0-1
Waste Stabilization Ponds	1-6	1-3	1-4
Constructed Wetland	1-4	-	1-3

(Source: Mara and Cairncross, 1989; Quinonez-Diaz *et al*., 2001; Mercedes et al., 2008)

5. Policies and National Strategy

Waste (solid and liquid) treatment is a major strategy being adopted for improving sanitation in urban Ghana. Recently in Accra a composting plant was unveiled for processing solid waste into compost to provide a major link between improved sanitation and urban and peri urban agriculture.

The National Environmental and Sanitation Policy covers all aspects of environmental health, including excreta disposal and solid waste management. It sets out responsibilities for the various stakeholders; including individuals, community organizations and Local Government authorities. Others are Ministries of Environment Science and Technology, Health Education (including educational institutions) and the private sector.

Based on the above, a number of by-laws have been passed and being enforced by local government authorities towards enhancing sanitation and food safety. Directly related to wastewater use is a local government regulation against the use of "effluent from a drain from any premises and or surface water from any drain fed by water from a street drainage … for the purposes of watering or irrigating crops" within the Accra Metropolitan Assembly Area.

Additionally, the National Water Policy provides for the promotion of partnerships between the public and private sectors for the protection and conservation of water resources through the use of cleaner and efficient technologies, effective waste management, and sound land management and agricultural practices and also the prevention of pollution of water sources by waste water.

6. Organizational roles and responsibilities

6.1 **The Environmental Protection Agency** (EPA)

The EPA is the technical arm of the ministry of Environment, Science and Technology and is responsible for ensuring total environmental safety. Thus it enforces compliance with all existing environmental regulations by individuals, and public and private organizations. Specifically, the EPA is responsible for the following;

- advises and makes recommendations to the Minister of Environment on policies the protection of the environment
- developes guidelines for environmental safety
- coordinates activities of such bodies it considers appropriate for the purposes of controlling the generation, treatment, storage, transportation and disposal of waste

6.2 Hydrological Services Department

This is a department of the Ministry of Water Resources and Works and Housing responsible for;

- Monitoring of stream/river flow rates (quantitative)
- Design and maintenance of urban drains (primary treatment)

6.3 Local Government Authorities (Metropolitan, Municipal and District Assemblies (MMDAs)

The local authorities are responsible for;

- passage of by-laws for maintenance of sanitation and environmental health
- collection and disposal of solid and human waste
- development and maintenance of waste treatment and disposal facilities including wastewater treatment plants and landfill sites
- infrastructure development to support socio-economic development including construction of drains

Could be used as a starting point for the development of national policies and strategies for reuse of wastewater

6.4 Ministry of Food and Agriculture

The Ministry of Food and Agriculture provides extension services to farmers including operators of urban and peri-urban agriculture through its metropolitan, municipal and district offices across the country. Services provided include good agriculture practices including irrigation methods towards the achievement of higher productivity, income and food safety. The Ministry over the years has been collaborating with public, private and civil society organizations to build capacity of urban and peri-urban producers including the safe use of wastewater and food safety.

The current Food and Agriculture Sector Policy and its accompanying investment plan recognizes the need to build capacity of operators of UPA towards enhancing food safety and income of operators.

The MoFA will continue to coordinate activities related to ensuring safe use of wastewater for agriculture as it relates to its core duty of ensuring food security and safety.

6.5 Council for Scientific and Industrial Research - Water Research Institute

The Water Research Institute of the Council for Scientific and Industrial Research (CSIR) is one of the 13 institutes of the CSIR Ghana. The Water Research Institute (WRI) currently employs 64 scientists (mostly trained at the PhD level) and 63 technical staff working in five core departments namely: Fisheries, Environmental Biology and Health, Environmental Chemistry, Surface and Ground Water. The staff and laboratories of the WRI are based in three regions of Ghana namely, Accra (head office), Akosombo, Eastern Region and Tamale, Northern Region. CSIR-WRI is mandated by the Government of Ghana to research into and to advice the Government of Ghana on the sustainable utilization and management of the water resources of Ghana, in support of socio-economic advancement, especially in the agriculture, health, industry, energy, education, environment and tourism sectors. One of its core mandates is to research into the development of technologies for pollution control, pollution prevention and poverty reduction through water use.

CSIR-WRI has key competences in development of health protection technologies for wastewater re-use, health risk assessment of wastewater re-use in tilapia and vegetable crop cultivation and monitoring and assessment of wastewater treatment systems. It has been involved in research on:

I) Improving the pathogen removal efficiency of eco-technologies for wastewater treatment such as stabilization ponds and constructed wetlands.
II) Health risk assessment of wastewater re-use in tilapia and vegetable crop cultivation
III) Wastewater treatment technology assessment and selection based on treatment objectives.

Personnel of the institute had produced verifiable outputs on these technologies in the form of publications in peer-reviewed international journals and Master of Philosophy degrees of supervised postgraduate students from the Universities. The institute is also involved in assisting (wastewater treatment plant performance of) institutions such as municipal assemblies and industries such as Cocoa Processing Company for meeting Environmental Protection Agency (EPA) recommended guidelines on wastewater effluents. The Institute's laboratories analyzes samples commercially and also for scientific research purposes. Parameters include microbial, helminth, nutrients, trace metals, hydrocarbons etc. and therefore capable of characterizing both domestic and industrial wastewater.

6.6 The International Water Management Institute (IWMI)

The International Water Management Institute (IWMI) is one of 15 international research centres supported by the network of 60 governments, private foundations and international and regional organizations collectively known as the Consultative Group on International Agricultural Research (CGIAR). It is an international nonprofit organization with a staff of around 300 and offices in over 10 countries across Asia and Africa and Headquarters in Colombo, Sri Lanka.
IWMI's mission is to improve the management of land and water resources for food, livelihoods and the environment. IWMI targets poor communities in developing countries and through this contributes towards the achievement of the UN Millennium Development Goals (MDGs) of reducing poverty, hunger and maintaining a sustainable environment.

IWMI-West Africa is engaged in numerous action-based research projects related to widespread practice of wastewater and excreta reuse. In Ghana, IWMI has worked expensively in Greater Accra, Kumasi and Tamale addressing health risk management associated with reuse, including a project analysing adoption drivers and cost-effectiveness of different treatment and non-treatment risk-reducing options. Other work, involves evaluating technology options for co-composting organic solid waste and human excreta and integrated use of freshwater, storm as well as wastewater for agriculture.

6.7 Kwame Nkrumah University of Science and Technology (KNUST)

Kwame Nkrumah University of Science and Technology (KNUST) is the second public university established in Ghana and in addition to the other academic programs carries out a number of researches including wastewater use in agriculture. For example, KNUST in collaboration with IWMI and the University of Copenhagen, Denmark, carried out a number of studies aimed at safeguarding Public Health Concerns, Livelihoods and Productivity in Wastewater Irrigated Urban and Peri-urban vegetable Farming. This was a Challenge Program on Water and Food (CPWF) sponsored projects (PM 38 and PN 51) in collaboration with International Water Management Institute (IWMI), Accra, University of Copenhagen and the Royal Veterinary and Agricultural KNUST

6.8 EDEN Tree (private sector operator)

This is a private sector commercial entity involved in the purchase, wholesaling and distribution of fruits and vegetables from UPA operators. The company has over years collaborated with MoFA to educate operators on safe use of irrigation water and handling of produce. The company itself ensures safety of produce through the use of post production safety procedures.

7.0 Competences on the safe use of wastewater in irrigation[1]

The report on assessment of knowledge and skill needs is based on responses received from eleven out of fifteen organization served with questionnaire. On the average existing knowledge and skill are mostly basic across the organizations although few of the organizations record good to excellent scores for some of issues assessed. For example IWMI scored between good and excellent for most of the issues whilst Fisheries scored between low and basic for most of the issues/competencies assessed. In case of importance of the issues assessed, the organizations scored most of the issues as being of high and very high importance giving average scores of above 3. There are however marked differences between the scores from various organizations, for example Women In Agriculture Development Directorate scored the importance of elements of Health Risk Assessment to be of between low and very low importance whilst the same were scored by Water Research Institute (WRI) and IWMI to be of high to very high importance.

Assessment of health risk

- Microbial and chemical laboratory analysis – Available capacity is above average in majority of respondent organizations with only five organizations scoring for basic level capacity and below. In exception of WIAD, and Metropolitan Agriculture Development Unit (MADU), all other organizations score the issue as between high and very high importance with an average score of 2.50 (high importance).

- **Epidemiological studies** – Current knowledge level in most organization is basic with only 4 organizations indicating good level of knowledge and available skill.

[1] Assessment of the knowledge, skills and competencies on the safe use of wastewater in irrigation

Majority of organizations however indicate that the issue is of high to very high importance. Only 2 of the organizations think the issue is of low importance.

- **Quantitative microbial risk assessment** - QMRA – current knowledge and skills only 2.09 (basic) with only 4 organizations indicating good level of existing knowledge and skills. Importance of the issue is however high (3.09) across the organizations with only 2 organizations scoring its importance as low.

- **Setting health based targets** – existing knowledge is rated as low to basic (1.91) across the organizations. One organization (WRC) however rated the existing knowledge as excellent. The importance of the subject is rated high across the organizations with 4 organizations rating it as of low importance.

Health protection measures

- **Wastewater treatment** – Eisting Eknowledge and skills are ranked as mostly basic (2.09) with 5 organizations scoring good 3. Importance of the subject is ranked as high by all organisations except one (WIAD – low).

- **Non-treatment options** – Existing knowledge and skills levels are ranked as just above basic (2.43) across the organizations with scoring between good and excellent. In terms of importance, the subject is ranked between high and very high by all organizations with an average score of 2.45.

Monitoring and system assessment

- **Monitoring** – Current knowledge and skills level is ranked averagely as just above basic (2.36) however, 3 organizations scored poor (1) and one scored excellent (4). In terms of importance, the subject was scored as generally high except for two organizations which scored the subject as of low importance

- **System assessment** – Existing knowledge and skills are generally (2.09). IWMI however has an excellent knowledge and skill base as indicated by a score of 4. System Assessment is ranked as of generally high importance with only two organizations considering it as of low importance.

Socio-cultural aspects

- **Cultural and religious beliefs** - Current knowledge and skills are between poor and basic (average - 2.09) across the respondent organizations. Three organisations however have good levels of knowledge. The importance of the subject is between low and high across the organizations with an average score of 2.55.

- **Public acceptance** – Existing knowledge is generally basic with only two organization scoring above the basic level. Importance is generally high across in most of the organizations except two (EPA and WRI)

Crop production aspects

- Components of wastewater harmful to crop production – Knowledge and skills levels are averagely just above basic (2.18) with only one organization scoring excellent (4). In terms of importance, the subject matter is of high importance in all organizations except 3 which consider it as of low importance.

- Agricultural effects of wastewater irrigation – Current knowledge and skills levels are between low and basic except for IWMI and WRI scored excellent and good respectively. The subject is considered as of between low and high importance (average score – 2.73) by majority of the respondent organizations.

- Management strategies for maximize crop production – Existing knowledge and skills level are generally poor to basic (average score – 1.73) across the organizations and considered generally as of between low and high importance

Environmental aspects

- **Components of wastewater harmful to the environment** – Existing knowledge and skills are between basic and good except for two organizations (poor). The importance of the subject is however considered as either high or very high by all organizations with average score of 3.36.

- **Environmental effects through the agricultural chain** – Existing level of knowledge and skill is scored as either basic or good by all organizations except one giving an average score of 2.36. In terms of importance the subject is score as of high to very high importance by all organizations with an average score of 3.27.

- **Management strategies for reducing environmental impacts** – Existing levels of knowledge and skill are poor in 5 organizations, whilst good in four and excellent in one. The importance of the subject is considered as between high and very high in all organizations except one with an average score of 3.36.

Economic and financial considerations

- **Economic feasibility** – Existing levels of knowledge and skills are scored as mostly basic except for 4 organizations which score as good (3) and excellent (1). Importance of the subject was score mostly as of high or very high except for 4 organizations.

- **Financial feasibility** – Current knowledge and skill levels within the respondent organizations were scored mostly between basic except 3 which scored either good (2) or excellent (1) In terms of importance, the subject is considered as of low to very high importance across the organizations giving an average score of 2.82.

- **Market feasibility** – Existing knowledge in majority of the organizations (9) is basic, whilst the importance of the subject matter is considered as mostly high

with an average score of 2.73. Four organizations however consider the importance of the subject to be of low importance.

Policy aspects

- **Institutional roles and responsibilities** – Knowledge on institutional roles responsibilities is either basic or good in the respondent organizations giving an average score of 2.45. The importance of the subject is considered as either high or very high by majority of the respondents (9).

- **Regulations** – Existing knowledge of laws and regulations in the various organizations are considered as between poor and good with an average score of 2.18. On the average the knowledge of laws and regulation is considered as high (3.00) with majority of the respondent organization scoring it as of either high of very high importance.

- **Economic instruments** – Existing knowledge is generally basic with only 3 organizations scoring good level of knowledge of the subject. Majority of the organizations however consider the subject as of high importance.

- **Education and social awareness** – Existing knowledge lis considered to be generally between poor and basic by majority of the respondents but of high to very high importance.

- **Plans and programs** – Only 9 respondents scored for the subject matter. Existing knowledge of which plans and programs were score as between basic and good whilst the importance of plans and programs were scored as high or very high.

The results of the questionnaire indicate that there are existing knowledge and skills gap in most of the respondent organizations. A few of the organizations e.g. IWMI, WRI and EPA have good competency levels in areas that are directly related to their general organizational responsibilities and can therefore be considered as potential candidates to support in-country capacity building programs.

Annex 1.

List of Participants

1.	Paulina S. Addy	Women In Agriculture Development , MoFA
2.	Amarkine Amarteifio	Metropolitan Agriculture Development Unit AMA
3.	Florence Agyei	Environmental Protection Agency,
4.	Philip Amoah	International water management Institute (IWMI)
5.	Jacob Zuttah	Ghana Irrigation Development Authority (GIDA), MoFA
6.	Mike Osei-Atweneboana	Water Research Institute (WRI) CSIR
7.	Rosina Williams	Fisheries Commission
8.	Fuseina Issah	Fisheries Commission
9.	Seth Kudzordu	Hydrological Services Department
10.	Adwoa Painstil	Water Resources Commission
11.	Kodwo Miezah	Zoomlion Ghana Limited
12.	Delali Nutsukpo	Directorate of Crops Services (Focal Person)
13.	Kingsley Amoako	Directorate of Crops Services (Secretary)

Absentees

1. Metropolitan Environmental Health Officer, AMA
2. Managing Director EDEN Tree Ghana Limited

Annex 2.

Agenda for meeting on Safe Use of Wastewater in Agriculture held on 13th December 2011

1. Opening prayer
2. Introductory statement and purpose of meeting Focal person
3. Brief presentation of FAO/UNW capacity building project
4. Presentation and discussion of draft national report
5. Identification discussion and agreement important organizations, roles and responsibilities
6. Presentation and discussion of results of questionnaire
7. Discussion of the way forward and assignment of responsibilities
8. Conclusion and closing