Project title (CP 38)

Safeguarding Public Health Concerns, Livelihoods and Productivity in Wastewater Irrigated Urban and Peri-urban Vegetable Farming in Ghana and Burkina Faso

Brief title

Safer (peri)urban vegetable production

Executive summary

This project takes a holistic approach to improve land and water productivity, minimize public heath risks and safeguard livelihoods in irrigated urban and peri-urban agriculture (UPA). It builds on on-going research projects and responds to needs expressed by local authorities and farmers. The contributions of UPA to urban food security, poverty alleviation, women empowerment and balanced diets have been documented but still UPA does not receive appropriate public support. The reason – not only in Ghana – is the common use of polluted water or wastewater for irrigation, which threatens public health. Most irrigation water sources are heavily polluted with untreated urban wastewater and due to high costs involved wastewater treatment is no economic option for local authorities. Health implications relate mostly to pathogens while heavy metal levels are low. Banning polluted water use has failed as this threatens livelihoods of UPA dependants and is not practical as long as alternative water sources are lacking. This has now ended up as a complex situation compounded by biophysical, technical, socio-economic and institutional elements that need an innovative multidisciplinary and integrated approach, hence this project. Such a project will have to go beyond a descriptive situation analysis but to look for solutions.

The project's main goal is to develop integrated and user-oriented strategies to balance land and water productivity and produce safety in UPA to safeguard public health, sustain UPA related livelihoods and urban food supplies. To achieve this, the current land and water use practices will be assessed and pollution and contamination levels and sources (including post-harvest) analysed in order to formulate innovative strategies for health risk reduction. These can take place on-farm (irrigation techniques, pump filters, simple on-site treatment), in markets (vegetable "refreshing") or at the household level. In each case the levels of risk reduction will be quantified. Related awareness-raising will be achieved through active stakeholder involvement in the project and the development of training modules for various stakeholder groups.
Main research methods will include literature review, crop and water analysis, farm surveys using participatory methods, on-farm research and field trials as well as use of GIS tools.

The project will improve productivity in UPA ensuring urban food security and safeguarding livelihoods of many urbanites, especially farmers and produce sellers. In addition, it will enhance produce safety i.e. vegetables which of now are highly contaminated, which will lead to improved health and reduced water related diseases.
The project will involve students and researchers from various institutions leading to capacity building and more collaboration even for future activities. Finally, the developed guidelines will help in decision support for all stakeholders, more especially local authorities, while the tested technologies will be of value for any other wastewater project in developing countries including other CP basins.

Six urban centres in and around the Volta Basin have been chosen for this study. The 3-year project contributes to different basin priorities and to CP theme four. The total budget requested from the CP is **US$ 487,716.** Matching funds of about **US$ 176,000** would be available.

Participating Institutions

1. Name of institution: Kwame Nkrumah University of Science and Technology (KNUST)
   Postal address: University Post Office, KNUST, Kumasi, Ghana.
   Email: dean.sci@knust.edu.gh
   Type of institution: NARES

2. Name of institution: University of Development Studies (UDS)
   Postal address: POB 1882, Tamale, Ghana
   Email: uds@ug.gn.apc.org
   Type of institution: NARES

3. Name of institution: International Water Management Institute (IWMI), West Africa Office
   Postal address: IWMI, PMB CT 112, Cantonments, Accra, Ghana
   Email: iwmi-ghana@cgiar.org
   Type of institution: CGIAR (Future Harvest) Centre

4. Name of institution: Centre Régional pour l'Eau Portable et l'Assainissement à Faible Coût (CREPA)
   Postal address: 03 BP 7112, Ouagadougou 03, Burkina Faso
   Email: crepa@fasonet.bf
   Type of institution: NARES

5. Name of institution: Water Research Institute (WRI)- CSIR
   Postal address: P.O.Box M.32, Accra, Ghana
   Email: wri@ghana.com
   Type of institution: NARES

Project Leader

Name: Dr. Robert C. Abaidoo
Professional Discipline: Microbiology and Environmental Science
Institution: Biological Sciences Dept, KNUST·
Title: Assoc. Professor; also Principal Investigator (PI)

Other Principal investigators - (PIs)

1. Name: Dr. Pay Drechsel
   Professional Discipline: Environmental Sciences
   Institution: IWMI West Africa, Ghana
   Title: Senior Researcher

2. Name: Dr. (Ms) Gordana Kranjac-Berisavljevic'
   Professional Discipline: Agricultural Engineering
   Institution: Agricultural Mechanization and Irrigation Technology Dept, UDS
   Title: Senior Lecturer, Head of Dept.

3. Name: Dr. John A. Bakang
   Professional Discipline: Agricultural Economist/Rural Sociology
   Institution: Faculty of Agriculture, KNUST
   Title: Senior Lecturer, Head of Dept.

4. Name: Dr. Felix Amerasinghe
   Professional Discipline: Parasitologist, Health Expert
   Institution: IWMI West Africa, Ghana (from Nov. 2004)
   Title: Principal Researcher and IWMI Theme leader

5. Name: Jacob Tumbulto
   Professional Discipline: Civil Engineering/Hydrology
   Institution: WRI-CSIR

Title: Research Scientist

6. Name: Dr. Amah Klutse
Professional Discipline: Engineer
Institution: Centre Régional pour l'Eau Portable et l'Assainissement à Faible Coût
Title: Chargé de la recherche

Consultants

1. Name: Mr. Alan Brewis
Service to be provided: Provision of treadle pumps to test alternative safe ground water supply and to test pump-related water filter options.
Institution: EnterPrise Works (NGO), Ghana
Title: Country Director

2. Name: Dr. Seydou Niang
Service to be provided: Expertise in low-cost on farm treatment and water filtering systems in West Africa; practicality of adoption in Ghana and Burkina Faso
Institution: Laboratoire de Traitement de Eaux Usées (LATEU), University Dakar, Senegal
Title: Chef du Laboratoire

BUDGET requested from CP	US$ 487,716
BUDGET offered as matching funds	US$ 176,000
TOTAL BUDGET	US$ 663,716
DURATION OF PROJECT (in years)	3
COVERAGE of Basins	Volta Basin

PERCENTAGE OF CONTENT ADDRESSING CP THEMES									
Theme 1		Theme 2		Theme 3		**Theme 4**	**100**	Theme 5	

Background and justification

About 800 million people are engaged in urban and peri-urban agriculture (UPA) worldwide and contribute about 30% to the world's food supply (UNDP 1996). This is increasingly becoming a common expression of most urban areas in developing countries and is seen as an important means of attaining balanced diets and urban food security. In several African cities, between 50 and 90% of the vegetable consumed are produced within or close to the city (Cofie *et al.* 2003). The proximity of UPA to consumers ensures freshness of the vegetables and likeliness to have higher nutrient contents than those stored and transported for long periods. This is especially important in Sub-Saharan Africa where refrigerated transport and cool storage are scarce. UPA also offers jobs for the poor, often especially women, and is an effective way to overcome poverty (Cofie *et al.* 2003). In many African countries, 65% of the people involved as UPA farmers or traders are women (WFS, 1996).

In Ghana, UPA is mainly characterized by backyards and commercial small-scale irrigated vegetable farming and is mainly carried out by men while marketing of the produce is predominantly a women domain. It also has significant contributions to livelihoods and food security; for example, around Kumasi, Ghana, more than 12,000 farmers are involved in vegetable farming during the dry seasons (Cornish *et al.* 2001) and urban farmers grow 90% of the main vegetables eaten in the city (Danso et al., 2003). This is done on virtually every open space more close to water sources of almost all major cities and urban centers in the West African subregion (Danso et al., 2003).

About 64% of Ghana's surface falls on the Volta Basin and many urban centers in Ghana draw their water from the basin. In Ghana, domestic and industrial urban water supplies entirely rely on surface water and water use per capita is projected to increase by 15 liters to 91 l/cap/day by 2020 (MoWH 1998). This will increase demands for higher quality water and more wastewater will be generated. Due to inappropriate and inadequate urban sanitation infrastructure, the wastewater ends up in nearby water bodies, which are often used as sources for irrigation water. In many areas of the basin wastewater constitutes the only available surface water for irrigation in the dry season, reducing the pressure on groundwater sources of the basin and sustaining many livelihoods. Pilot studies of KNUST and IWMI showed that especially dry-season irrigation of vegetables could allow farmers to go over the poverty line (Danso et al., 2003). Similar observations have been made in other countries in West Africa including Burkina Faso (UAM, 2002).
Use of the wastewater in UPA will not only lessen the pressure on water resources but will also increase water productivity through reuse of water and nutrients, which may be otherwise a nuisance to the environment. However, this practice could have adverse public health and environmental effects, especially because untreated wastewater or polluted water has high population of pathogenic organisms. There have been some outbreaks of diseases like typhoid in Santiago, Chile and helminth infections in Egypt and Jerusalem that have been associated with crop contamination from wastewater irrigation (Blumenthal *et al*. 2000). The use of wastewater can also affect the farm workers since significant ascaris and hookworm infections have been reported in sewage farmers in India (Blumenthal *et al*. 2000). This is one of the main reasons that make UPA in Ghana, like in many other West African countries, not to receive the appropriate public and institutional support despite its significant contributions to urban food supply, poverty alleviation, women empowerment and improved human nutrition through the provision of balanced diets.
Health concerns are mostly related to water and crop contamination with pathogens from faecal matter while heavy metal levels are in tolerable limits due to the low industrialization of Ghana's and Burkina Faso's cities. Effective wastewater treatment can reduce pathogen levels but in most developing countries it is not an option for the municipal authorities due to the high costs involved (Keraita *et al*. 2002). In Ghana, most urban centres have no means of treating wastewater and the sewerage network serves only 4.5% of the total population (Ghana Statistical Services, 2002). Some attempts to develop new sanitation facilities have been faced with socio-economic 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 (1997) 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 also been tried like 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 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.

The result is a complex situation compounded by biophysical, technical, socio-economic and institutional elements that need a multidisciplinary and integrated approach. The Ghanaian municipalities have recognized the problem, and have sought assistance from the research community. This is supported by Ghana's Tourism Board, which started a campaign for "safer vegetables for healthier cities" as vegetables in urban areas were causing erratic gastrointestinal disorders especially to tourists.
Encouraged by WHO during a recent IWMI workshop in Hyderabad (see also: www.cgiar.org/iwmi/india/hyderabad_declaration.htm) the proposed study is designed to find an appropriate balance between livelihood concerns and safeguarding health. It also aims to directly support further revisions of the WHO wastewater irrigation guidelines in order to address the common situation of UPA in those developing countries where wastewater treatment up to the WHO (1989) norms is not possible. This study will also address risk-reducing elements not covered yet in the WHO guidelines through the consideration of post-harvest contamination and decontamination of wastewater-irrigated crops.

The resulting research question is "How to enhance UPA productivity, safeguard livelihoods of farmers and other beneficiaries in the supply chain without increasing health risks to farmers, sellers and consumers?" Or in other words: Which alternative measures can be recommended to improve productivity, reduce human health risks even in situations where wastewater use is unavoidable and vegetable market demand are too strong for the cultivation of different crops less prone to contamination through wastewater use? And finally, can we also *quantify* the risk reduction through the tested approaches and technologies that have to be simultaneously viable and acceptable in the local smallholder context?

This proposed study builds on previous and ongoing research in Accra, Kumasi and Tamale[1] being carried out by KNUST/IWMI/UDS collaboration. This study has shown significant contributions of urban and peri-urban agriculture as well as the health risks that it poses to consumers and farmers (e.g. Cornish *et al*. 2001, Keraita *et al*. 2002). In this proposed study, three more towns/cities (Ouagadougou in Burkina Faso, Bolgatanga and Bawku, in Ghana's Upper East Region) within the Volta Basin have been added. The proposed work will go beyond descriptive situation analysis and target quantitative and qualitative testing of different innovations to actually reduce the health risk as outlined in a framework by Drechsel *et al*. (2002). The project contributes directly to different Volta Basin goals and expected research outputs of Theme 4 of the Challenge Program (CP). It tries to sustain urban and peri-urban food production, which offers farmers important opportunities for income generation and poverty alleviation. Thus the project contributes directly to the main goal of the CP.

With respect to this background the research hypothesis is that "productivity in UPA systems can be improved and wastewater related health risks for farmers, sellers and consumers reduced at different entry points (on farms, in markets and at consumer level) in a socio-economically acceptable and sustainable way". In addition, the study will give guidelines that will be of decision support for policy makers and contribute to development of WHO guidelines, thus add value to the global discussion of wastewater and agriculture also of benefit in other countries and (CP) basins.

Goal

The main goal is to develop integrated and user-oriented strategies to safeguard public health concerns without compromising livelihoods and land and water productivity in wastewater irrigated urban and peri-urban vegetable farming

Specific objectives

1. To study and evaluate current land and water use practices in urban and peri-urban vegetable farming.
2. To quantify water pollution and compare vegetable (de)contamination along the contamination pathway (farms to markets to households).
3. To identify innovative approaches for health risk reduction on-farm and post-harvest and **quantify** their impacts on contamination levels, land and water productivity, and livelihoods.
4. To develop related guidelines and awareness materials for stakeholders i.e. farmers, sellers, consumers, local authorities, and the WHO.
5. To develop local human capacities in integrated research on irrigation, livelihoods and health through joint NARES-CGIAR student training.

Activities and methodology

This study will be done in and around six urban centres in or with an influence of the Volta River Basin. Exchange and sharing of methodology and information with research partners in Senegal and Burkina Faso with proven record in wastewater research for vegetable production and methods for reducing health risks is a key component of the project activities and methodology. In Ghana, study will be done at two levels: Micro (pollution sources, farming sites, markets and households) and Meso (urban and peri-urban areas). Various activities and methodologies will be employed:

0. Stakeholder interviews and workshops

This starting–up activity will be coordinated by KNUST and IWMI and supervised by Drs. Drechsel and Bakang. It will be done with wastewater management agencies, local authorities, and associations representing farmers, sellers, and consumers to (i) introduce the project, (ii) learn about awareness levels and perceptions on water pollution, vegetable contamination and options for health risk reduction, (iii) learning from the achievements and problems of Francophone sister countries with track record of managing

[1] Accra, Ghana's capital city draws much of its water from the Volta River basin, Tamale (3rd largest city) is in the basin and Kumasi (2nd largest city) does not lie in the basin but has been chosen for comparative and strategic purposes. Bawku, Ouagadougou and Bolgatanga are again in the Volta basin.

wastewater use in peri-urban vegetable production to reduce health risks, and (iv) analyses of expectations of stakeholders from the project. Opportunities and constraints for health risk reduction will be identified and ranked using semi-quantitative methods and SWOT analysis. Some of these activities have already started, which will be considered.

1. Monitoring and evaluation of farming and selling practices

This activity will be coordinated by IWMI and supervised by Dr. Drechsel (IWMI) and Dr. Kranjac-Berisavljevic (UDS). It will entail:

1.1 Mapping of major farming sites and water sources used for vegetable irrigation using where possible GIS methods, topographical maps etc.

1.2 Group discussions with farmers in each farming sites to **understand the main farming and marketing practices** during both dry and wet seasons; participatory assessment of farmers' exposure to irrigation water and health implications.

1.3 Assessing and evaluation of land and water productivity in selected farms using productivity performance indicators (economics, agronomic, water use). Done by using simple measurements of water productivity and costing of in- and outputs.

2. Irrigation water and crop quality analysis

Most components in this activity will be coordinated by KNUST and carried out under Dr. Abaidoo (KNUST). Laboratories in IWMI-Accra, KNUST and WRI will be used. Some of these activities have already started by IWMI, and the results will be incorporated. The main components include:

2.1 Water sampling and analysis using standard methods (APHA, 1989). This will be done in close intervals during rainy and dry seasons over one year. Water samples will be taken from irrigation water sources. Analysis will be done for the following physicochemical and microbiological characteristics:

- Total Suspended Solids (TSS), Total Dissolved Solids (TDS),
- Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), pH, Electrical Conductivity, selected heavy metals and plant nutrients.
- Population sizes and composition of Helminth eggs, total and faecal coliforms, faecal streptococci and other pathogenic bacteria.

2.2 Crop quality sampling and analysis using standard methods and procedures. Samples will be collected in two-week intervals in both dry and rainy seasons over one year at farm gate on representative major farming sites. Analysis will be done for the following parameters

- Population sizes and composition of Helminth eggs, total and faecal coliforms, faecal streptococci and other pathogenic bacteria, and heavy metals.

2.3 Contamination pathway

- Studies to understand post-harvest handling of vegetables with special focus on representative market and household procedures.
- Laboratory analysis of levels of post-harvest crop (de)contamination through transport, storage, marketing ('refreshing'), and washing in households/restaurants. Analysis will be done for the above parameters (see 3.2). The students will actually follow the crops from the farms to the markets. This has been tested as feasible approach in pilot studies.
- Comparative assessment if any decontamination or further contamination takes place with respect to pathogens, and heavy metals during typical handling and cleaning processes in markets and households.

3. Risk reduction approaches and assessments

After understanding farm and marketing practices and actual crop contamination as well as stakeholders' problem awareness and perceptions of health risks, **risk reduction strategies** taking into account opportunities and constraints will be identified and tested for their impact on contamination levels. This is a core-component of the study and will be coordinated by KNUST with IWMI backstopping. Dr. Abaidoo

(KNUST), Mr. Tumbulto (WRI), Dr. Drechsel (IWMI) and Dr. Amerasinghe (IWMI) will guide the different components of the work. Possible innovations that have been identified in IWMI's wastewater program and through other partners and networks (CREPA) are highlighted below. These will address different entry points along the contamination pathway (on-farm, markets, households). For a related framework see Drechsel et al. (2002). These innovations will be real-life tested and monitored for stakeholder perception as well as efficiency and impact in view of a viable balance in safeguarding health, livelihoods and land and water productivity. This will lead to an assessment of the **adoption potential** of the innovations (led by Dr. Bakang, KNUST), which will also address local legislations, customs, land tenure, water rights etc. and recommend demonstration trials for feedback from authorities.

3.1 Alternative water sources: In concrete examples per city, financial and economic feasibility studies will be carried out in view of safer irrigation water sources like (shallow) wells and pipe water and related water lifting devices. NGOs, like EnterPrise Works with an already related approved USAID project on treadle pumps will join in. Gender-specific focus group discussions will be used to record and analyse farmers' views. Technical feasibility and observatory studies (using terrameters, piezometers etc); will be applied to find out the areas that can yield shallow water and getting appropriate locations to avoid on-farm pollution.

3.2 Low-cost on-farm wastewater treatment methods: The wastewater team of University of Dakar (Dr. S. Niang) will contribute a review of possible low-cost on-farm technologies for risk reduction. Field trials using sedimentation ponds, sand filters, filters connected to pumps and other methods will be carried out on farm. Risk reduction will be attested through irrigation water quality changes. Again, any innovation will only be tested after participatory pre-assessments and agreement with the concerned farmer collaborators.

3.3 Change of irrigation practices and cropping patterns: Farm level discussions will lead to alternative ways of water use for different crops, reduction of farmer exposure to polluted water etc. On-farm trials will be done on the devised ways and their acceptance and impacts monitored over four cropping seasons. Changes in cultural habits and labour input will receive special attention.

3.4 Post-harvest handling: CREPA will use its network in West Africa to explore common market and household practices for vegetable washing in the subregion; perceptions of efficiency by households and restaurants. Feasible but safer post-harvest handling strategies (for vegetable refreshing in markets, vegetable washing in kitchens using different media, peeling etc.) will then be tested by KNUST qualitatively and quantitatively for their impact.

As mentioned above, all suggestions will be discussed with stakeholders and their adoption potential analyzed with focus on viability, conflicts with customs, legislations etc. in the context of the different cities and towns.

4. Guidelines development, training and awareness programs

This activity will be coordinated by UDS (Dr. Kranjac-Berisavljevic) and Dr. Bakang (KNUST). Stakeholders' workshops will be held in each of the urban centers.

4.1 Guidelines and awareness materials will be developed for the different local stakeholders i.e. farmers, market women, households, authorities on options and low-cost technologies for health risk reduction.

4.2 A training and awareness program with individual modules for farmer groups, consumer groups, market women, and authorities (with stakeholder specific demonstration workshops, joint farm/market visits, awareness material, etc.) which will target the following three stakeholder groups:

- Women groups and associations and market queen mothers on sanitation measures, hygienic handling and effective cleaning of vegetables (on the market and at home) produced with water of unknown quality.
- Urban farmer groups on health risks related to water pollution and wastewater use, hygienic crop handling and on simple technical options to reduce own and crop contamination. Integration of

these modules in existing e.g. KNUST-led training curricula for farmers/extension staff of the Ghanaian Ministry of Food and Agriculture.

- Authorities on risk reduction through better sanitation and clean water supply especially for urban farmers and in markets.

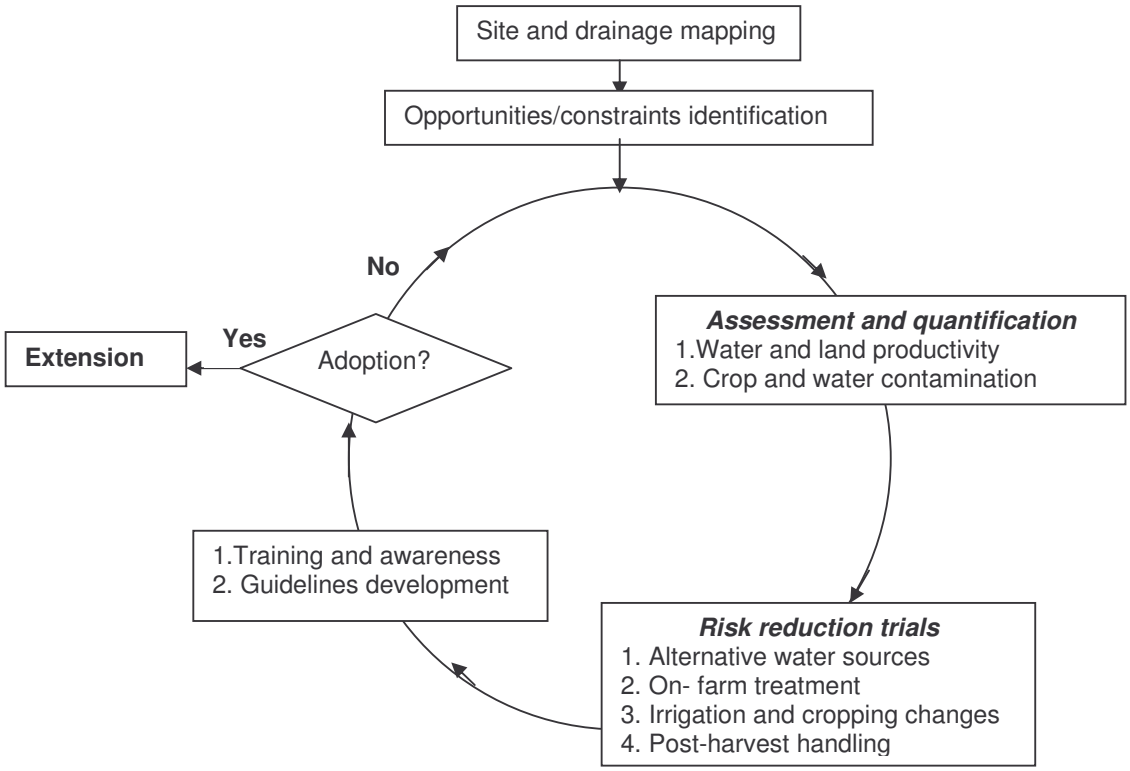
5. Capacity building/ Ph.D. students training

The project intends to train students in its research activities. At least two PhD students, about four MSc students, research assistants, and several undergraduate students of both gender will be involved. Most of them will be drawn from the local universities involved in this project (KNUST, UDS). Drs. Abaidoo and Bakang (KNUST) and Dr. Kranjac-Berisavljevic (UDS) will coordinate this activity and share student supervision with their colleagues also from other departments with complementary expertise (Tropical Medicine, Agricultural Engineering, Public Health, Crop Science, and Microbiology). Several prospective students for the project have already been identified.

6. **Planning workshops and reviews**

Workshops involving the PIs, participating institutions, other investigators, support staff, City Authorities, Policy makers, and collaborators from Ghana, Senegal and Burkina Faso, will be held for planning and reviewing of on-going activities. There will be annual review and planning meetings and end of Project reviews. The project leader, Dr. Abaidoo (KNUST), will coordinate these.

A simple flow diagram of these activities is as shown below.



Flow chart of project activities

Roles of project researchers and institutions

KNUST, Kumasi: KNUST is a well-established and leading university in West Africa and trains undergraduate and postgraduate students in different disciplines. The university, specifically the Faculties of Environmental Sciences and Agriculture, will make significant inputs to this project. Both have well-established laboratories for water, soil and plant analysis. This project will be co-ordinated by **Dr. Abaidoo,** a Microbiologist and an Associate Professor at the Department of Biological Sciences. **Dr Bakang,** a sociologist in the Faculty of Agriculture brings in 20 years of experience from practical involvement with the agricultural production systems. His extensive work with farmers, especially in the use of participatory research methods will be invaluable for this project.
Both lecturers will link up with other departments to cover a variety of disciplines and provide supervision for undergraduate and graduate students. The university is centrally located to all project sites and has well-established networks with extension officers of the Ministry of Food and Agriculture.

IWMI, West Africa Office, Ghana: IWMI has offices in Accra and Kumasi and will partially support the two PhD students with research funds and logistics and co-supervise their work under **Drs. Drechsel** and **Amerasinghe.** The local IWMI team has worked on urban agriculture since 1995 (then under IBSRAM) and has recognized expertise in this field as RUAF focal point and through **Dr. Drechsel** who is in the steering committee of the System-wide Initiative on Urban and Peri-urban Agriculture (SIUPA, now Urban Harvest). It is one of the five countries where IWMI's global wastewater projects are being carried out. **Dr. Drechsel**, an Environmental Scientist and Senior Researcher with IWMI will make contributions on natural resources management, urban agriculture and environmental issues and also do the related backstopping. **Dr. Amerasinghe**, a parasitologist and a health expert, will make invaluable contributions in health related issues. He will be assisted by **Dr. Flemming Konradsen** on public health issues. IWMI through other staff will also provide backstopping for socioeconomic issues and GIS use and data interpretation.

UDS, Tamale: UDS is another established university in Ghana and is famous for its development-oriented approaches in teaching students. The university is located in Tamale, a very strategic location for this project, especially for the work in Bawku and Tamale. It will provide more students for research. Dr. **Kranjac-Berisavljevic',** an irrigation specialist and a lecturer at the university, will assist with her expertise in wastewater irrigation and urban agriculture in Northern Ghana and involve and supervise most of the undergraduate students. She will investigate especially links between women empowerment, poverty alleviation and irrigation technology.

WRI: WRI is one of the13 institutions of the Council for Scientific and Industrial Research (CSIR). Its mandate is to conduct research into water and related resources in Ghana. WRI will assist with the exploration of alternative sources of water on UPA sites and has a well-established pesticide laboratory, which meet international standards and will be available for use by this project. **Mr. Tumbulto**, a civil engineer/hydrologist brings in 18 years of experience in active research and will also be involved in on-farm wastewater treatment trials.

CREPA, Ouagadougou: In charge of sanitation and hygiene and has network of 15 offices in West African Francophone countries. Will provide a larger survey on household and marketing practices related to common vegetable washing methods, i.e. bad and best practices typical in the West African subregion.

University of Dakar: Will provide consultancy services on existing low-cost on-farm water treatment and filtering systems in Francophone and Anglophone West Africa, their management, cost effectiveness and adoption by small-holder farmers.

EnterPrise Works: EnterPrise Works with an already related approved USAID project on treadle pumps will provide assistance with treadle pumps and related filter systems.

Non-research partners: Municipal authorities and their departments for agriculture and health; market associations, through market Queen mothers and Consumer associations, women groups, health concerned NGOs, will participate in project implementation, workshops, and dissemination stage and contribute in the scaling up and scaling out of technologies developed by the project.

Outputs

The following main outputs will be realized:

1. Information base on land and water use practices in irrigated urban and peri-urban vegetable farming established.

2. Database on water pollution and changes in vegetable contamination from farms to markets and households set up.

3. Appropriate health risk reduction strategies identified and tested, and their impact on livelihoods and land and water productivity assessed.

4. Guidelines, awareness materials and training modules developed for stakeholders (farmers, sellers, consumers, authorities, WHO) on risk reducing options and technologies.

5. Human capacity built through collaborative training of local students (PhD, MSc, and undergraduate and laboratory assistants), thesis reports, and joint journal articles and research reports.

Beneficiaries and impact

The main target groups of the project are farmers, traders (i.e. women), and consumers but also those authorities in charge of food safety and public health.
The project will lead to improved awareness on vegetable related health issues in Ghana and Burkina Faso and actively contribute options for the reduction of diseases related to wastewater irrigation. Some of the direct impacts on stakeholders are as enlisted below:

- As most vegetables found in urban markets are produced in the city or its closest vicinity, almost all urban consumers of vegetables will benefit due to safer wastewater and crop management on farm and reduced contamination in markets.

- The general public will benefit through raised public awareness on risks and risk-reducing options related to water pollution and agriculture.

- Policy makers will benefit from practical guidelines to be obtained for their decision support, which can be considered in policy revision and formulation of regulations and bye-laws.

- Urban agriculture and its stakeholders (traders, market sellers) will benefit from a better reputation and can continue (now with public support) to maintain their contribution to urban food supply, creation of employment opportunities and (own) poverty alleviation. This will be of special benefit to all vegetable sellers who are mostly women.

- The WHO wastewater irrigation guidelines will benefit from recommendations based on quantified risk-reduction measures, which tackle health risks beyond the wastewater source and current guidelines.

- The participating research institutions will benefit from their collaboration in a project of applied research of immediate benefit to the public in a developing country and the involvement of various disciplines and scales (farm, market, household) which goes beyond current approaches.

- Two PhD students will benefit as well as well as several M.Sc. and B.Sc. students.

- The awareness material and guidelines for training will be made available to other projects addressing similar situations.

Low quality water in UPA is not only limited to Ghana and Burkina Faso. Similar practices have been reported in most cities in Sub-Saharan Africa. The outlined innovative approaches could be used in similar

situations in the region. In this regard, the project will contribute a detailed case study to IWMI's currently ongoing wastewater research program, which provides parts of the matching funds.

As pertaining the 'pathway to impact', most of the conception and prioritization of alternative options has been done by an ongoing IWMI project. The core of this project will fit in Scales 1 and 2 with some limited activities in scale 3 (adoption and adaptation) which will only be done at micro-level. The assessments of environmental effects are as attached in the Annex 2.

Assumptions and risks

The following assumptions have been made:

1. **Participating institutions and investigators:** It is assumed that there will be full cooperation from participating institutions and investigators. Investigators have been involved fully in this writing the proposal and have committed themselves to carrying out the project. Participating institutions have been informed about the project, given their matching funds and committed them by signing letters. An inaugural meeting will be held before the start of the project and there will be regular meetings.

2. **Stakeholders:** Several groups i.e. farmers, local authorities, vegetable sellers, consumers etc. will be involved in this study. The project assumes good cooperation from all groups. Incidentally, all participating institutions have been working with these groups over some time and this project is based on a project that involved some of these stakeholders. Meetings will be held and those involved in the project will participate.

3. **Funding:** It is expected that required funds will be obtained and always released in time.

Dissemination strategy

The main dissemination ways to be used are as described below:

In the project area:

- Stakeholders involved in the research process will be having first-hand information from the activities and workshops. Through the developed guidelines on improving productivity, innovative farmers (who were participants in the research process) from each urban centre will be trained further together with extension agents to relay and practically demonstrate the information to their fellow farmers. The developed guidelines will be written in farmer-friendly booklets and in local languages, which will be made available free to the farmers and a demonstration plot will be acquired in each selected farming site. The extension service and NGOs working with UPA vegetable farmers will be involved.

- Training and awareness program with individual modules (with stakeholder specific demonstration workshops, joint farm/market visits, awareness material, poster, videos etc. in local languages) will target farmer groups, consumer groups, market women, and authorities.

- Through the press, local NGOs and collaborating (consumer, women) associations for the general public.

Beyond the project area:

- Through WHO and amended guidelines for wastewater irrigation in agriculture.

- Through IWMI's research database, reports, website and policy briefs and local universities' publications. These means will be used also to reach out others interested in the findings in other countries. IWMI has a wastewater group with related special information channels. Results of this project that have clear recommendations for action to improve policies will be included in IWMI's Water Policy Briefing series, sent 8-10 times yearly to some 5000 development and research decision makers and educators worldwide and will also be published for direct downloads on IWMI's website.

Monitoring and evaluation plan

i. **Research activities monitoring:** Various research activities will be monitored by different PIs according to profession as shown in the activities section. For logistic purposes, three PIs will oversee activities in the different project urban centres: **Dr. Kranjac-Berisavljevic'** for the two northern sector centres of Bawku, Bolgatanga, and Tamale, **Dr. Abaidoo** for the central sector centre of Kumasi and IWMI via **Dr. Drechsel** for the southern sector centre of Accra as well as Ouagadougou (together with CREPA).

ii. **Institutional and human resource development:** The project leader will monitor institutional capacity strengthening and run a gender sensitive analysis. Supervisors from participating learning institutions will monitor students. There will be regular student seminar presentations involving relevant PIs, student supervisors etc. to monitor and evaluate their progress.

iii. **Research and output quality:** Some activities are dependent on outputs of others and lead PIs will ensure that they check the quality of what they give out or receive. Advances in scientific and methodological activities and added value to multi-disciplinary approach will be regularly assessed. Other than student thesis, there will be a mid-term and end-term report. At least four journal papers will be published, one from each major component. Each output (journals, research reports, etc.) will first undergo an internal review committee headed by **Dr. Amerasinghe**.

iv. **External evaluation:** Two external evaluators will be expected to review the project in June 2006. The evaluators should be specialized in the relevant major components i.e. agricultural resource management, health risk reduction and innovation adoption.

v. **IWMI monitoring:** IWMI has a Quality Management System (QMS) in place, which contains an internal quality audit related to project management. It also requires all IWMI project leader to produce quarterly reports to the respective Theme Leaders on technical progress and financial status including time tracker records for regional and international staff. Detailed financial reports are forwarded on monthly basis to IWMI HQ and summary reports per project are sent back to the project leaders to monitor their expenditures. IWMI (Ghana) will ensure an efficient overall monitoring and evaluation; coordinate and also carry out the administrative duties of reporting of financial and management information to CPWF.

Resources needed

The total budget requested from the CP is **US$ 487,716.** Matching funds of about **US$ 176,000** will be made available by the participating NARES and IWMI. Details of budget are attached as annex 6 and include cost for training two PhD students and several graduate and undergraduate students.

Human and material resources needed for this project are listed below.

1. **Investigators:** Seven principal investigators (including a project leader) with different but relevant expertise have been drawn from the participating institutions. They will link up with colleagues from other departments, especially at KNUST and UDS. The project will cater for parts of their working time and traveling expenses. Student researchers and other support staff like laboratory technicians, statisticians, field staff, etc. will also be drawn from participating institutions. The project will cater for the students' working time, research costs, tuition fees etc. in the form of fellowship awards.

2. Investigators will tap into experiences of Francophone sister countries to guide operations, enhance the successful execution of the Project and the transfer potential of the results in the whole subregion.

3. **Laboratories:** Laboratories of KNUST, IWMI-Accra and WRI will be used for crop and water analysis, which will be carried out by lab technicians and research students from participating institutions. Lab consumables and supplies that may not be available will be purchased with project funds.

4. **Specialized staff:** Specialized services such as aerial photography, ground water exploration, IPM advice, etc. will be hired and paid for as local consultants.

5. **Field equipment:** Equipment needed for fieldwork such as sample collection, weighing machines, etc are generally available. Vehicles are also available for field data collection. Specialized (drilling) equipment will be hired locally.

ANNEXES

1. Gantt Chart
2. Environmental effects
3. References
4. Abbreviated CVs of the project manager and all the principal researchers.
5. Letters of commitment
6. Budget