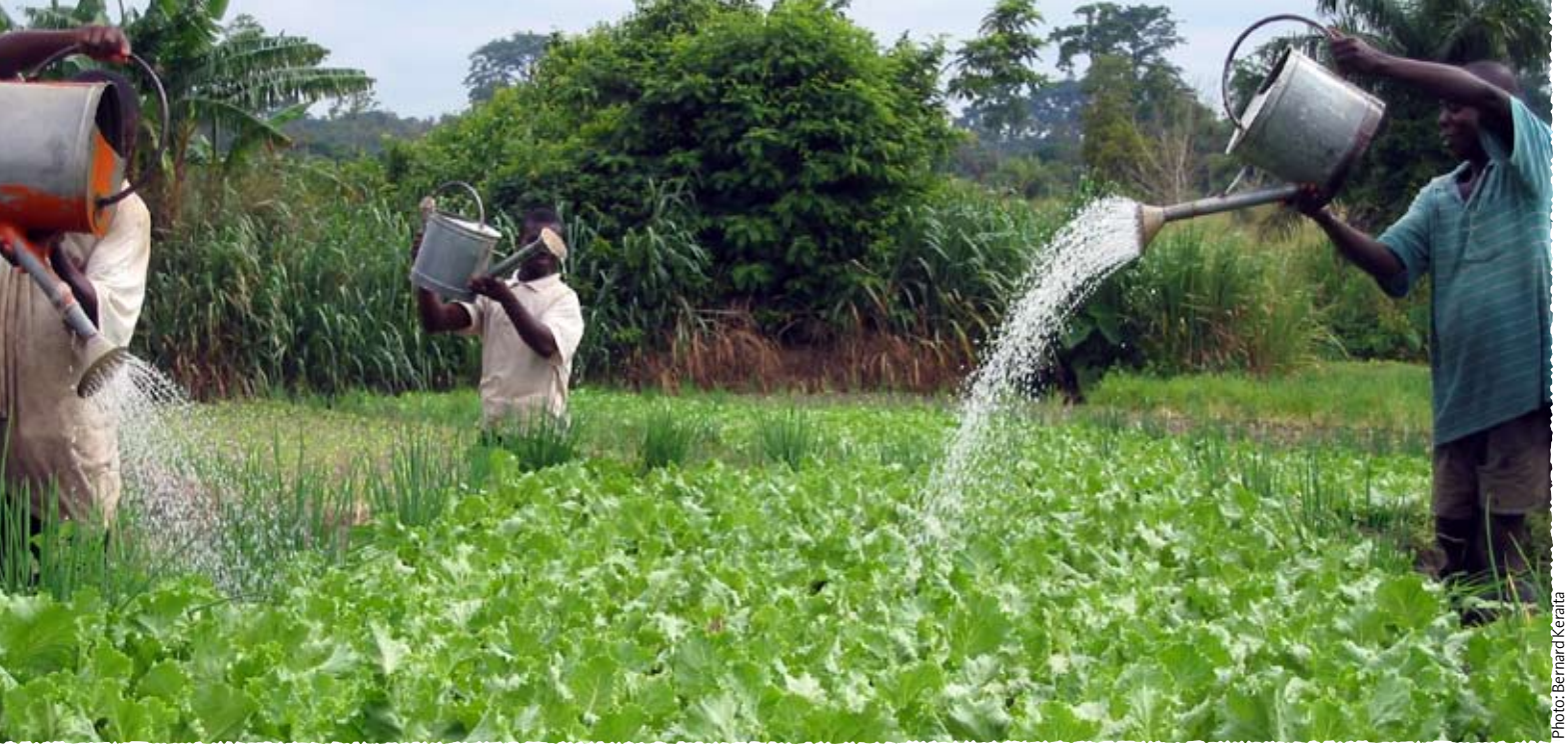

Photo: Bernard Keraita

Experimenting with irrigating from different heights. As it is the soil which needs to be watered, not the plant, watering closer to the ground reduces chances of contamination and damage to leaves.

Safer options for irrigated urban farming

Bernard Keraita, Pay Drechsel and Flemming Konradsen

There is an increasing demand for food in many cities in developing countries due to rising urban populations. While foods like cereals can be transported from rural areas, perishable crops like vegetables lose their market value during transportation as refrigeration is scarce. Most vegetables are therefore grown in and around cities to maintain their freshness and nutrition value. For instance in Accra, Ghana, about 1000 farmers are involved in market-oriented urban vegetable farming and the vegetables produced are eaten by 200 000 Accra residents daily. Urban vegetable farming is now seen as an important means for attaining urban food security, balanced diets, and is the livelihood of many urban dwellers in Ghana.

Leafy vegetables generally have high water requirements and need to be irrigated on daily basis. Vegetable farming is therefore done near water bodies, where there is a reliable supply of irrigation water. In most cases, these water bodies are heavily polluted with human faecal matter resulting from poor urban sanitation. The use of highly polluted water ("wastewater") in irrigation is known to transmit excreta-related diseases as it has high levels of pathogenic micro-organisms such as bacteria, viruses, parasitic worms and protozoa. This affects farmers and vegetable consumers, especially when vegetables are eaten raw. Vegetables most commonly grown in urban farms in Ghana are lettuce, cabbage, green pepper and spring onions. These are eaten raw as salads which are part of urban fast foods. This has raised serious public health concerns from local authorities, the media and consumers.

In this article, we highlight one component of a broad three-year action research project being implemented in urban vegetable farming sites in Ghana. Assessments are being conducted and management options developed with key stakeholders at all levels of the food chain i.e. production (farm level), marketing (market level) and consumption (households, street food vendors etc). The aim of the specific component of the project described here is to develop appropriate farm-based measures with farmers, for reducing health risks from vegetable contamination while safeguarding productivity and livelihoods. The International Water Management Institute (IWMI) and the University of Copenhagen are leading this component. The project started in January 2005 and will end in December 2007.

Irrigated urban agriculture and the public health dilemma

Firstly the team reviewed the measures in place in Ghana to address the public health concerns. Wastewater treatment (often seen as the ultimate solution for reducing health risks) is a very unrealistic option in the short-term, as only less than 10 percent of urban wastewater produced undergoes some form of treatment. In large cities, local authorities banned the use of polluted water for vegetable farming. However, this practice still persists as no alternatives are given. With increasing water demand and global fresh water resources shrinking, urban farmers increasingly depend on wastewater.

Relevant literature on health protection measures was then reviewed. The World Health Organization (WHO) has been at the forefront in formulating guidelines for wastewater use in agriculture. Recognising that low-income countries cannot treat wastewater effectively, the WHO has proposed some measures to help reducing risks to tolerable limits. Farm-based measures include crop restrictions, improving how irrigation water is applied, and control of human exposure. However, the WHO guidelines can only describe examples from around the globe. Local adaptation trials and field assessment to quantify the effectiveness of the measures in reducing health risks, as well as adoption studies with farmers, are largely missing.

Farmers' perceptions of health risks

We planned to actively involve farmers and relevant government institutions in the project at all stages. Initially, farmers were not motivated to participate as the local media and authorities had condemned this practice and farmers were also sceptical about any related "research". Thus it was difficult getting committed

farmers for the project. This was overcome by clearly spelling out the objectives of the project and explaining the need for their involvement. This was first done through the leadership of their farmers' associations, who in turn organised meetings to explain it to their members.

Feasibility and perception studies were done at the start and during the project, involving about 400 farmers around Ghana's two largest cities, Accra and Kumasi. Various participatory approaches, most of them visual, were used to understand farming practices and farmers' perceptions of health risks and risk management. The findings showed that farmers were aware that the irrigation water used was contaminated. They could identify that water was polluted from its dark color, foul smell and presence of plastics and other solid materials. Farmers indicated that pollution in water bodies has increased over time and is worsening. They attributed most contamination to the failure of local authorities to treat and safely dispose of wastewater generated in the cities.

Farmers clearly associated polluted water with health risks and identified the affected groups as farmers and vegetable consumers. But, they never saw the risks to be significant. Perhaps this was because of their level of knowledge on invisible risks, as also observed in the food catering sector. Or they may have adopted a defensive mechanism to show that their practice was safe, especially after the condemnation from the media and authorities. On the other hand, these farmers live in poor neighborhoods with poor sanitation and no safe drinking water. So, when infections or health problems occurred, they associated this more with their homes than with their farming practices. But as more awareness was created through discussions between farmers and scientists, they became increasingly aware of the health risks they regularly face, and the need to change to safer practices.

In search of safer irrigation practices

Farmers were first asked to identify safer practices that would reduce risks. This was done in focus group discussions at different farming sites, followed by in-depth interviews with key farmers. With minimal input from researchers, farmers identified the following safer irrigation practices:

- Provision of safer irrigation water like shallow groundwater;
- Protection of water sources from getting polluted;
- Treating of irrigation water before use;
- Use of protective clothing by farmers;
- Better methods for collecting water from irrigation sources;
- Better water application techniques.

Scientists then discussed with farmers other documented health protection measures as stated in the WHO guidelines. Farmers were asked to rate the suitability of these measures in relation to the local context. Table 1 shows the outcome. For example, farmers were not ready to change from planting vegetables to planting other crops as they might lose their competitive edge in urban markets. On the other hand, knowledge sharing and changes in farming practices that need minimal capital investments were perceived as suitable. This corresponded to safer irrigation practices identified by farmers.

Box 1. Field trials on irrigation methods

Setup: Watering cans are usually used for irrigation. This method contaminates vegetables as it applies water directly to the leaves. Applying water to the soil surface could reduce contamination. Trials were conducted to compare furrow irrigation and drip irrigation with watering cans.

Findings I: Laboratory analysis of microbial indicator organisms showed that drip irrigation kits had the highest potential to reduce contamination on vegetables. The kits also saved water and did not damage lettuce leaves as watering cans often did. The main limitations were that the kits would clog up, and fewer lettuces could be planted due to the wide emitter spacing. No significant reduction in vegetable contamination was recorded from furrow irrigation as most vegetables grown were low lying and were in contact with irrigation water in furrows. Farmers also had problems maintaining the furrows. Even with highest contamination rates, watering cans had highest yields and were still most preferred by farmers.

Modifications: Trials on furrow irrigation were stopped since the method had little potential. Drip kits were modified by reducing the emitter spacing and adding lateral lines, which increased cropping densities four-fold. An additional filter was added to reduce clogging. The use of watering cans was also modified. Farmers often use cans with or without caps and raise them to different levels. Caps reduce the speed of water, and lessen the splash of contaminated soil on crop leaves. In the trial, three water lifting levels were tested with and without caps.

Findings II: Production per given area increased without increasing contamination levels for drip kits. However, having many pipes in the plot slightly interfered with other farming practices like weeding. Contamination levels were reduced significantly by watering closer to the soil and using caps on watering cans. This also uses less labour and distributes water evenly. Further modifications are still feasible for more improvements.

Field trials on identified safer practices

Next, an assessment was needed on the effectiveness of the identified practices to reduce risks. Trials were conducted with farmers on their farms. As this needed detailed monitoring and assessments, we restricted ourselves to three farming sites in Kumasi, involving about 70 farmers. Regular feedback was given from farmers and scientists. Some practices were modified and tested further. Assessment was based on laboratory analysis on levels of microbial contamination, perceptions from farmers and socio-economic analysis.

One of the measures proposed was to look for alternative water sources. Findings from geophysical studies showed that in Accra, on the coast, there is groundwater at a depth of 4 m. However, on most sites the water is saline. In inland cities such as Kumasi, groundwater is too deep (more than 15 m) to make it economically feasible to be used by urban vegetable farmers. It became even clearer that farmers had no alternative source but only contaminated water.

Treating irrigation water needs some investment in terms of labour and in some cases also capital. A number of the identified

Table 1. Suitability of specific farm-based health protection measures from WHO guidelines

Not suitable	Suitable	Most suitable
1. Planting non-food crops	1. Using protective clothing	1. Knowledge sharing and awareness creation
2. Planting foods not eaten raw	2. Safer irrigation methods	
3. Full wastewater treatment	3. Stop irrigation before harvesting	
	4. Minimal wastewater treatment	

safer and low-cost practices have been assessed through field trials, including on-farm sedimentation ponds and sand and fabric filters. On-farm sedimentation ponds have shown great potential in removing heavier microorganisms like worm eggs. This could be enhanced by using better designed ponds and training farmers on better water collection practices to reduce suspension of sediments. Farmers could also remove sediments from ponds more regularly. Another practice tested was stopping irrigation a few days before harvest, so that pathogens will die off. Irrigation methods have aimed at minimising contact between vegetable leaves and contaminated irrigation water and soil (see Box 1). These stress the importance of continued dialogue between scientists and farmers in developing best practices. To have a higher cumulative effect, these best practices can be used in combination.

Motivation to adopt safer practices

One limitation that may slow down the adoption of safer practices is the lack of incentives. Currently, there are no marketing channels and institutional frameworks for safer vegetable production in Ghana. While vegetable farming is mostly a domain for men, harvesting and marketing is controlled by women. These gender roles prevent farmers from direct marketing, and "safe" vegetables might end up mixed with unsafe vegetables in markets, making farmers' efforts futile. The net beneficiaries of safe vegetables are the urban dwellers, who perhaps should pay more for safe produce. This may be achieved through streamlining the market channels for safer produce. For example, farmers with safe produce could be linked directly to large consumer establishments like hotels. They can also be allocated selling points in markets and supermarkets for the general public. Other incentives can be institutional support from government agencies like provision of extension services trained in exotic vegetables, loans, awards and land tenure security. Perhaps good media publicity will also encourage farmers to adopt of practices for safer vegetable production.

Risk reduction has to go beyond the farm

A comprehensive health protection programme that extends beyond farms and focuses on post-harvest handling practices needs to be developed. Observations show that some vegetable sellers wash vegetables in irrigation water after harvesting.

Box 2. Changes at Mr. Takyi's farm

Mr. Takyi's farm is located at Karikari farming site in Kumasi, between residential houses. He relies on household effluents, especially during the dry season, which he channels into an earthen pond in his farm, as a source of irrigation water. Mr. Takyi has been involved in the project since its inception. We have conducted several trials on his farm and discussed outcomes of our assessments. As we continue with other trials, we have observed some changes on his farm. The farmer now channels the water from the first large pond through two other ponds before using it for irrigation. This allows for more sedimentation on ponds. The third pond where he collects water from has a blank of wood for stepping on as he collects water, unlike the traditional way where farmers walk into ponds to collect water. The pond is also deeper to allow the water to collect without disturbing the sediment. Even if Mr. Takyi still continues using watering cans, he now consistently uses caps and irrigates from lower heights to lessen splashing of soils to vegetables. The drip kits we left in the farm after the trials have been taken by other farmers who now use them to grow other vegetables like cucumber which need wider spacing. Greater impact is expected after developing comprehensive guidelines and conducting training modules for farmers.

Photo: Bernard Keraita

Discussing the suitability of the different irrigation practices.

Vegetables are transported and sold in markets in very unsanitary conditions. There is little water in markets, and as most vegetables need "freshening water" to look attractive, one bucket is often used for a whole day, causing cross-contamination. Such a programme should also extend to food handling at food selling points. Exotic vegetables like lettuce or cabbage are often eaten raw thus developing better washing methods will be helpful. The new WHO guidelines for safer wastewater use in agriculture support such a multiple approach for comprehensive health protection from wastewater use in urban and peri-urban vegetable farming.

The next step for this project is the knowledge sharing component. First, we are formulating guidelines for best practices developed from field trials. This will be taken up by the extension services division of the Ministry of Agriculture and incorporated in their extension programmes. We are also preparing a training module for farmers on the best practices. There will be an extension of this project through a new WHO-FAO-IDRC project addressing the institutionalisation potential of the new WHO guidelines based on the non-treatment options identified in this project.

■

Bernard Keraita. Field Assessment Program for CGIAR-CPWF (PN 38). IWMI Africa Office, Ghana. Postal Address: c/o KNUST, Kumasi, Ghana. E-mail: b.keraita@cgiar.org

Pay Drechsel. IWMI Theme Leader, Agriculture Water and Cities, IWMI Africa Office, Accra, Ghana. E-mail: p.drechsel@cgiar.org

Flemming Konradsen. Associate Professor, Institute of Public Health, University of Copenhagen. E-mail: f.konradsen@pubhealth.ku.dk

References

- Obuobie, E., B. Keraita, G. Danso, P. Amoah, O. Cofie, L. Raschid-Sally, and P. Drechsel, 2006. **Irrigated urban vegetable production in Ghana: Characteristics, benefits and risks.** IWMI-RUAF-CPWF, IWMI, Accra, Ghana.
- WHO, 2006. **Guidelines for the safe use of wastewater, excreta and greywater. Vol 2: Wastewater use in agriculture.** World Health Organization, Geneva, Switzerland.

Acknowledgements
The authors would like to thank the CGIAR-Challenge Programme for Water and Food (PN 38), CIP-Urban Harvest, and the International Water Management Institute (IWMI) for their financial support.