Background paper for RUAF-IWMI e-mail conference on "Use of Untreated Urban Wastewater in Agriculture in Low Income Countries".

Title: **The use of untreated wastewater in agriculture: strategies for health risk management**

Author: Wim van der Hoek, International Water Management Institute (IWMI)

The use of urban wastewater in agriculture is an efficient way to conserve water, recycle nutrients and reduce pollution of surface water. It is often the only option that (peri-) urban farmers have. There are important health risks associated with using untreated wastewater and the official policy has therefore been to provide treatment of the wastewater before use. However, in most cases the use is an unplanned practice of poor farmers in developing countries that lack resources to provide wastewater treatment facilities. Authorities then either try to restrict the use of untreated wastewater or they simply turn a blind eye. Both these approaches are not very helpful and innovative solutions are needed to optimise benefits and minimize negative health impacts.

The need for water conservation and pollution control

Many countries in Asia, Africa and Latin America are faced with a dilemma: how to feed their growing populations under conditions of increasing water scarcity. This is a special challenge in arid and semi-arid developing countries where over 90% of all water withdrawn for human uses is for agriculture. In such an environment of increasing water scarcity and competition for water, there is no doubt that other sectors, especially cities will increasingly get priority in water allocations. Although cities withdraw only a small portion of water, the value of use in cities is much higher than in agriculture. The challenge in semi-arid agriculture is therefore to produce more food with less water. Urban and peri-urban agriculture has taken up this challenge by using urban return flows, i.e. wastewater. But wastewater use is usually not an option but a condition that farmers are facing, also in humid countries, as municipal sanitation services cannot keep pace with urban population growth.

In fact, while the growing cities are likely to get the water that they need, whatever the cost, they face worldwide serious problems in disposing of the wastewater. This wastewater contains a variety of pollutants of biological origin and, depending on the level of industrial development, chemical pollutants. Most cities in developing countries do not have the resources to treat wastewater before disposal and they lack the necessary institutions and legislation for pollution control. In such circumstances part or, more often, all of these pollutants find their way into the nearest water body, be it a river, canal, lake, or the ocean. As a result, a number of the rivers, lakes and aquifers in these countries are being severely contaminated. Often farmers depending on irrigation water are not aware of this threat. But even in those cases where farmers would like to use safer water, public support is the exception.

Wastewater use: many advantages

The use of urban wastewater in (peri-) urban agriculture can be seen as a combined strategy for:

- Conservation of water
- Recycling of nutrients
- Disposal of municipal wastewater in a low-cost and sanitary way
- Prevention of pollution of rivers, canals and other surface water in those cases where raw wastewater is used instead of disposed off
- Household income and livelihoods.

For many poor farmers in peri-urban areas, wastewater provides a reliable water supply, because the flow is continuous, unlike rainfall that can be seasonal or erratic and the canal irrigation systems that often do not provide water at the times it is needed by the farmers. The nutrients in the wastewater allow the farmer to use less chemical fertilizer or no fertilizer at all. The easy access to nearby urban markets makes it attractive to farmers to cultivate high value crops, especially vegetables. Wastewater use thereby becomes an important strategy to increase food security and improve livelihoods of poor people, especially in urban and peri-urban agriculture.

Negative impacts of wastewater use

The main disadvantage of using untreated wastewater for irrigation is the presence in the water of bacteria, viruses, and parasites that can pose health risks for the farmers and communities who are in prolonged contact with the wastewater, and also to the consumers of produce irrigated with wastewater. To avoid these health risks standards have been recommended by the World Health Organization (Mara and Cairncross 1989). If the wastewater contains industrial effluent, chemical pollutants such as heavy metals pose an additional problem. However, it is believed that levels of most heavy metals in irrigation water are likely to be toxic to plants at concentrations below that at which they pose a significant risk to human health (Cornish et al. 1999). In low-income developing countries the priority public health risks associated with wastewater use are infections with soil-transmitted helminths such as hookworm and roundworm (Shuval et al. 1986).

These health risks can be greatly reduced by treating the wastewater before use in agriculture. Excellent technologies are available that can produce water of drinking water quality. However, these technologies are prohibitively expensive for many cities in developing countries. A further disadvantage is that conventional treatment methods remove the nutrients in wastewater, thus reducing the economic benefits to the users. There are alternative low-cost treatment facilities such as stabilization ponds, which are used extensively in mid-income countries, especially in the Middle East. However, the reality is that as much as two thirds of the wastewater generated in the world receives no treatment at all and a large number of the wastewater treatment plants dealing with the other one third are not properly operated and maintained (Mari★o and Boland 1999). Thus we do hardly find any safe wastewater, be it 'treated' or not, which complies with WHO standards.

The gap between sound public health policy and the reality of poor farmers

Untreated wastewater remains and will continue to remain a cheap and reliable source of water and nutrients that will be used wherever this is attractive to farmers. The common point of view of researchers, decision-makers, and service providers is that the use of untreated wastewater is unacceptable and that only when the water is appropriately treated, important benefits can be obtained. This approach has resulted in a marginalisation of poor wastewater farmers who are unlikely to benefit from treatment of the wastewater that they use or from alternative water sources any time in the near future. Moreover, this approach implied that there is the alternative of ‘safe = treated wastewater’, which, as discussed above, is in many cases an illusion.

There are many examples that illustrate the difficult choice between sound public health practice and the livelihoods of poor people. In Nairobi, Kenya, sections of the sewerage network were being rehabilitated with international donor support. What was only realized at a late stage in the planning process was that wastewater farming was the lifeline of about 1000 poor households. The sewer rehabilitation project would cut off all water that was being used for irrigation by households that had no alternative sources of income. Suggestions by the local communities to leave some outlets so that people could continue using the water were rejected by the engineers. In Faisalabad, Pakistan, waste stabilization ponds were constructed and as a result many farmers could not get access to the wastewater anymore. These farmers went to court and re-gained access to the untreated wastewater. In Vadodara, Gujarat, India, there is a 55 km long industrial effluent channel. Despite warning notices and patrolling by the authorities, the water is used for irrigation and farmers stated, “This river is our life”.

One cannot expect that very low-income countries will be able to provide wastewater treatment facilities of appropriate quality to even a small percentage of the population in the foreseeable future. The situation in Pakistan is a case in point. Pakistan has a rapidly growing population, which is expected to increase from 139 million in 1998 to 208 million in 2025. By that time, about 50 percent of the population will live in urban centres. A survey in the Punjab Province of Pakistan showed that in all cities with sewerage system wastewater was used untreated, and no regulations existed for what could be grown with wastewater irrigation (van der Hoek 2001). In the cities surveyed vegetables were the most common crops, because these fetched high prices in the nearby urban markets. The wastewater was valued by the farmers because of its nutrient content and reliability of supply. In some cases the wastewater was auctioned once a year by the municipal council to the highest bidder, often a group of richer farmers who then rented out their fields to poor landless farmers. Under these conditions, the use of untreated wastewater was considered a win-win situation by the municipal council, which was responsible for wastewater disposal and the farmers who got a reliable supply of water with high nutrient content. There were therefore very few incentives to invest scarce resources into wastewater treatment. This was despite the fact that there were important negative health impacts, especially an increased prevalence of hookworm infection among wastewater farmers (Feenstra et al. 2000).

The need for more information

Framework for case studies

The starting point in research activities should be the actual realities of poor people, rather than the ideal state in the future (treatment of all wastewater) as it has been described by policy makers and the research community. The importance of wastewater for agricultural production, food security, poverty alleviation, and pollution control, can only be assessed with detailed case studies. These studies should have an integrated approach and consider water and nutrient use, institutional arrangements, agro economic aspects, and environmental and health impacts. This should lead to a model for benefit – cost analysis. A proper economic analysis would include all benefits and costs, including environmental, health, and social benefits and costs (Hussain et al. 2001, 2002).

Guidelines for safe use of wastewater
More realistic policies and guidelines for the use of urban wastewater are needed. Even today the numerical values of faecal coliforms that are used in water quality standards are based on philosophy and experience rather than science (Cooper 1991). Stringent guidelines lead to unnecessary conservative response to wastewater use by authorities and marginalisation of farmers using wastewater. Instead of protecting public health, they then have the opposite effect. Due to lack of scientific data, discussion of health impacts associated with wastewater use often does not go beyond the level of vague generalizations. Most epidemiological evidence is from a limited number of studies from a very small group of research sites. Furthermore, the focus has been on localised negative health impacts of wastewater irrigation. The potential positive impacts for users that are located downstream from where the wastewater is used or disposed have not been considered. Moreover, we can expect quite different health risks depending on irrigation method and timing. These variations have been ignored in the discussion.

The global importance of wastewater as a resource
The management of urban wastewater is often considered a local issue and is generally not included in integrated water resources management at river basin level or in rural-urban planning. From a water accounting point of view the quantities of wastewater are said to be small compared to the total water requirements for agriculture and untreated wastewater is not seen as a resource but as a problem because it pollutes surface water. However, the extent of wastewater use on a global scale is unknown as wastewater farming is largely an informal, unplanned or even illegal activity. Authorities have tended to condemn or deny the practice of using untreated wastewater for public health reasons. Researchers have focused on health impacts of treated wastewater, ignoring the existence of the much more widespread practice of using untreated wastewater. At the recent World Bank Water Forum (Washington, 8 May 2002) it was estimated that developing country farmers irrigate an estimated 20 million hectares using partially diluted or undiluted wastewater, a practice that sustains the livelihoods of millions of mainly poor people in Asia, Latin America, the Middle East and parts of Africa. In fact, in many countries there are more hectare under informal irrigation with polluted urban stream/drain water than in formal irrigation schemes. However, only the latter are considered in national statistics on “irrigated agriculture” as compiled e.g. annually by FAO.

In order to get the reality of the use of untreated wastewater on the agenda of policy and decision makers, a better estimate of the extent of wastewater use is needed. Results of nation-wide assessments should be aggregated to obtain a global estimate. For this, a common *typology* of wastewater use is needed. Such a typology would have to address issues like:

- The relative contribution of domestic sewage and industrial effluent in the urban wastewater
- The extent to which the wastewater is treated
- Direct use of sewage versus dilution of sewage in natural surface water before use
- The use of wastewater in formal irrigation schemes or as informal irrigation by small holders without external support

Options for health risk management

For many low-income countries there is a need for new practical approaches to minimize the negative impacts while maximizing the benefits to the stakeholders, extending from the poor farmers to municipalities to countries. Management options should enable interventions at different entry points across the wastewater use-chain - from pollution source, wastewater management, agricultural practices, crop handling and distribution, to the consumer. Except for wastewater treatment, very little is known about the effectiveness of alternative management strategies in reducing health risks. This electronic conference aims to exchange experiences and generate new ideas, which could complement the following best-known management strategies;

Wastewater treatment
There is no doubt that treatment of wastewater is at least theoretically the best option to protect human health and there is a need for effective and low-cost treatment methods that are appropriate to the local situation. Nutrient removal is often seen as one of the main objectives of wastewater treatment (developed for over-fertilised European and US soils) but this is not in the interest of tropical farmers that need the nutrients on their marginal soils. The most interesting treatment options are those that remove pathogens but retain nutrients in the water. More emphasis is also needed for the possibility of removing pathogens, but not nutrients with inexpensive partial treatment methods, including constructed wetlands and natural pond systems. It is, however, unlikely that these treatment facilities will reach WHO standards, thus also these standards need a revision to become more realistic.

Decentralized wastewater management
Recently a number of alternatives have been proposed to conventional centralized sewerage and treatment systems. In the ecological sanitation approach human excreta are processed on site until they are free from pathogens and the nutrients are then recycled by using them in agriculture (Esrey et al. 1998). Technologies have been developed for separation of faeces (that contains the pathogens) from urine (that contains no pathogens but most of the nutrients), and blackwater (from the toilets) from greywater (household wastewater without blackwater) (Otterpohl et al. 1999). There are other methods for decentralized sanitation and wastewater management that are attractive because of the low capital investment needed. However, little is known of the suitability of decentralized systems in different situations, including the management requirements, and operational costs. A key constraint of all these methods is the limited demand for improved wastewater management and demand for new systems would only be created if there were financial benefits and visible improvements in the local environment and for the household using the system (Parkinson and Tayler 2001).

Crop restrictions
Many countries have legislation that prohibits the cultivation of vegetables with untreated wastewater but that allow for example the growing of fodder and fruit trees. Examples are Mexico and Jordan, countries that make extensive use of wastewater in agriculture. Crop restriction can prevent human health problems but has the disadvantage of reducing economic benefits from the use of wastewater, as it is the high-value crops like vegetables that are popular in urban and peri-urban areas and that are the most susceptible to contamination. In general, the very low-income countries that cannot afford treatment of wastewater are also the ones that have no capacity to enforce legislation.

Human exposure control – prior- and post-harvest
The standard approach within the health system of all kinds of risk practices is to provide health education and encourage behavioural change. However, isolated health education messages such as avoiding direct contact with wastewater are unlikely to have an impact when farmers feel that they have no choice but to accept the conditions under which they work and when protective clothing is not suitable under the local climatic conditions.

Moreover, health education will also have to address post-harvest crop handling as contamination e.g. on markets can be higher than through irrigation. Safe water facilities, on the other hand, are easier to install on markets than on farmers' fields, thus education and protection measures could be expanded to markets and households.

Health impact assessment
The method of health impacts assessment can identify health hazards, assess health risks associated with urban agriculture schemes and propose risk-mitigating measures. An overview is provided by Birley and Lock (1999).

Mass de-worming
Infection with helminths is the most important health risk associated with wastewater use. Especially if the communities of wastewater farmers are localized, and rather homogenous, there are good conditions for effective health protection measures by regular mass treatment of exposed people with anthelmintic drugs. The commonly used drugs against soil-transmitted helminths are safe and effective and regular de-worming campaigns are likely to have an important impact on health status of people exposed to untreated urban wastewater. Of course the repeated treatment with safe, single-dose, affordable anthelmintic drugs is a short-term approach, but one that can provide immediate health benefits.

Irrigation techniques
Certain water application methods can significantly increase or reduce the risk of disease. Health risks from irrigated crops are greatest when spray or sprinkler irrigation is used, and the risk to field workers is greatest when flood irrigation is used (Blumenthal et al. 2000a, 2000b). Drip and trickle irrigation can give the greatest degree of health protection by reducing the exposure of workers to the wastewater. In a study in Pakistan no worm eggs were found in the wash water from vegetables that were grown in wastewater-irrigated fields (van der Hoek et al. forthcoming). This was explained by the bed and furrow practice of cultivating vegetables used by the farmers, in which the aboveground part of the vegetables did not come in direct contact with the wastewater.

Industrial pollution control
The management strategies for prevention and reduction of contamination of domestic sewage by industrial effluent will be discussed under the second topic of the electronic conference.

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