Motivating behaviour change for safe wastewater irrigation in urban and peri-urban Ghana

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Abstract

Where wastewater is used without appropriate treatment, additional safety measures such as safer irrigation practices or careful vegetable washing are required to protect farmers and consumers. Implementing such food safety interventions in the informal farming sector is not easy, as they require behaviour change. Even where appropriate and low-cost interventions have been identified, low health risk awareness is a likely adoption barrier. Where this also concerns consumers, market demand for safer crops will be low and social marketing options have to be explored to support the desired behaviour change. Based on experiences from Ghana, where wastewater irrigation is an unplanned reality in and around all cities, the necessary steps and considerations for increasing the adoption probability are outlined under a generic framework which is based on social marketing, incentive systems, awareness creation/education and supporting regulations. Any of these approaches require accompanying research of the target groups and could gain in cost-effectiveness through a more integrated approach linking e.g. handwash and vegetable washing campaigns.

Introduction

To reduce the risk from food irrigated with polluted water, WHO (2006) recommends situation-specific safety interventions which can be combined with conventional wastewater treatment or where treatment is missing still reduce the disease burden. Such post-treatment or non-treatment options include safer irrigation practices, on-farm wastewater treatment, and careful vegetable-washing, which can individually or best in combination (multi-barrier approach) reduce the exposure of consumers to pathogens (Figure 1).

This approach looks at different entry points along the pathogen pathways, from farm to fork, in line with the principles of hazard analysis and critical control points (HACCP) (WHO, 1996, 2002). While the 2006 Guidelines for safe wastewater irrigation offer especially low-income countries more flexibility, their implementation is challenged by low education. In general, three basic requirements for implementation can be distinguished (Favin et al., 2004):

- Provision of access to appropriate infrastructure (such as sanitary facilities in markets or irrigation drip kits for farmers)
- Promotion of hygiene behaviour such safe vegetable washing and irrigation methods
- Strengthening of an enabling environment that facilitates or regulates infrastructure access and/ or behaviour change.

Whereas the provision of treatment plants for safeguarding public health appears straight forward[1], the behavioural change of farmers, traders and consumers still constitutes a pristine research field in the context of 'wastewater irrigation', despite the fact that behaviour change concepts are largely developed and have increasingly been applied in the sanitation and hygiene sector (Bongartz and Chambers, 2009; Martinsen, 2008; Mosler et al., 2012). Drechsel and Seidu (2011) showed that on- and off-farm risk reduction measures can be very cost-effective but also require either on- or off-farm a high adoption rate to avert a sufficiently high percentage of DALY.

We focus in this paper on how behaviour change could be promoted among (i) farmers using highly polluted

[1] Its operation and maintenance can be another story (Murray and Drechsel, 2011)

Key messages:

- Where risk perception is low, behaviour change has to be supported by various strategies.
- Aside education, incentives and social marketing can play a significant role.
- The WHO guidelines on safe wastewater irrigation need to pay attention to behaviour change strategies to support the adoption of alternative risk reduction measures.

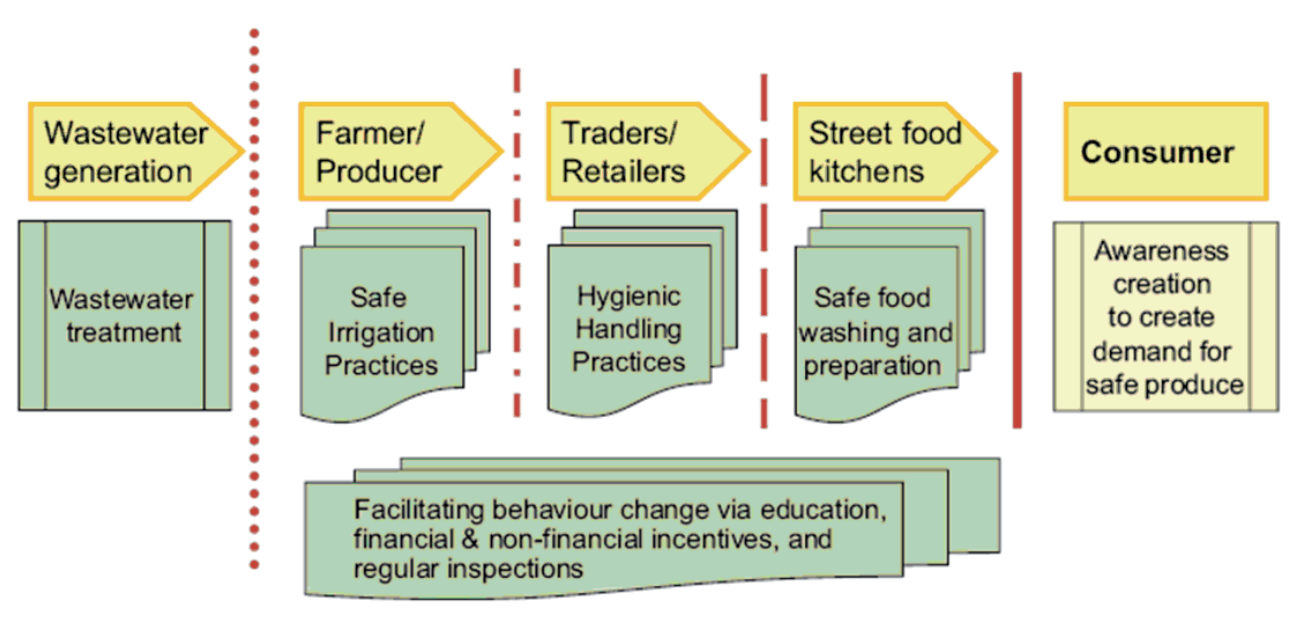

Figure 1: Multi-barrier approach for risk reduction (Source: Amoah et al. 2011)

irrigation water, and (ii) restaurant staff, in particular of street-food restaurants, where more than 90% of the raw-eaten and wastewater-irrigated salad crops are served (Amoah et al., 2007a). The paper draws heavily on Karg and Drechsel (2011) and work by the International Water Management Institute (IWMI) with its partners in Ghana studying on- and off-farm options for health risk reduction (Amoah et al., 2011). Methods used to analyse options for triggering behaviour change include expert interviews, street surveys, focus group discussions, observations, training sessions and a variety of knowledge sharing activities (Amoah et al., 2009; Karg, 2008; Keraita et al., 2008). We describe the lessons learned in their conceptual context to facilitate interpretation beyond the case study.

The context of vegetable irrigation with polluted water in Ghana is described by Obuobie et al. (2006). Farming takes place on open spaces within or close to cities where streams are accessible. Irrigation is manual or facilitated by small pumps, and while farmers might form associations on certain sites, it is important to note that we do not refer to any irrigation scheme with centralized management, but the informal urban farming sector (Drechsel et al., 2006).

Research outside the technical comfort zone

Many projects testing interventions for health risk reduction stop with the verification of their impact; e.g., on the reduction of coliform counts. However, to actually achieve impact, the equally important task is to identify the conditions that can make an intervention work. In the case of wastewater and food safety, this means analysing

- whether safer practices would directly pay off by either improving production or reducing production costs or perceived risks by those supposed to adopt the measures;
- whether safer practices would eventually pay off due to an increased willingness-to-pay by consumers and traders for 'safer crops'; and
- whether there are other triggers and incentives which could change behaviour and how best to instigate and build on them, while avoiding change barriers.

While the first two studies require in general conventional economic analysis (farm cost–benefit analysis, contingent valuation) – though financial incentives do not automatically result in behaviour change -, the third study stretches most more technically oriented projects even further out of their comfort zone. It requires substantial social analysis of the constraints and opportunities of the target group, their perceptions, wants and attitudes (Andreasen, 1995).

The reasons for a person not to change his/her practice can be numerous and of different weight, linked to tradition, family pressure, community norms, time pressure, inconvenience and so on. The primary reason is not always necessarily a lack of awareness of the social or health benefits of adopting the practice promoted. This analysis requires good listening skills and should be based on participatory research principles as described for the case of safer irrigation practices by Keraita et al. (2010a).

Aside from understanding the reasons that might limit behaviour change, it will require a different effort to analyse what might trigger it. Trigger studies must

consider distinct population subgroups and the social and cultural environments in which the people act to make decisions about how to promote and communicate a desired behaviour (Grier and Bryant, 2005).

The planning process, based on findings delivered by applied research, can be outlined in the following steps:

- Assess current food handling behaviours related to the problem(s) of concern and their underlying risk awareness and perceptions.
- Identify feasible options for change which reduce health risks.
- Identify barriers and enabling factors (external and internal triggers) for a related behaviour change and verify them with the target group(s).
- Study appropriate communication channels and (form of) outreach messages.
- Carefully consider which stakeholders and policy-makers will be crucial in developing, promoting and implementing effective change strategies.

An initial step for any behaviour change campaign is to understand which perceptions are relevant to the current behaviour and which internal or external factors in the local context might trigger or hinder behaviour change. For interventions to be successful, and this also refers to the promotion of safety interventions, it is important to investigate the target groups' knowledge and perceptions beforehand.

This also applies to other stakeholders such as governmental agencies or community based organizations which might become part of any risk reduction strategy as the wider system within which farmers and vendors operate can have a significant positive or negative influence on farmers' decision-making. A partnership approach should therefore be targeted to get all stakeholders working from a mutually agreed upon agenda. Participatory approaches among scientists and the target group proved to be a prerequisite for effective communication. In the Ghana studies, farmers' perceptions, needs and constraints were incorporated into the formulation of recommended practices. This was supported through farm-based participatory approaches where farmers and scientists worked together in developing risk reduction measures. An important step was the identification of mutually accepted problem indicators, like the smell or colour of the irrigation water (Keraita et al., 2010a).

Factors affecting adoption

Factors supporting or blocking behaviour change are often very context-specific, as internal and external behaviour determinants differ from one cultural and social context to another. Internal factors that influence a current, new or changed behaviour come from within a person, such as awareness of the problem or perceived norms. External factors come from a person's environment including environmental constraints such as lack of time, current policies or access to the essential technology (Favin et al., 2004). For example, risk perception does not only depend on objective facts, but rather is largely a social and individual construct (e.g. fear of spiders). Hygiene behaviour, in turn, can also be approached as a social construct based upon culturally determined ideas rather than as a risk mitigation strategy.

For the implementation of non- or post-treatment options, a supporting internal factor would be awareness about health risks. A supporting external factor would be market demand for safer crops and/or enforced regulations and controls. Unfortunately, both factors did not apply in the Ghana case. Risk awareness was very low, not only among farmers, but also consumers (Box 1), which translated to a low willingness-to-pay for safer food.

While farmers had a very limited knowledge of possible personal or food safety concerns arising from contact and use of highly polluted water for irrigation, media attention and projects addressing the wastewater challenge made them aware of the general concerns. Food vendors, on the other hand, demonstrated basic knowledge, and were generally concerned about food quality. In addition, any wrong doing would affect their direct clients.

Criteria to assess food quality used by farmers, vendors and consumers did not emphasize food safety issues or common hygiene practices (hand washing, cooling, cleaning of utensils, washing of raw vegetables, or efficacy of disinfectants). Instead, the main food-selection criteria related to aesthetic appearance of the food or food stand, appearance of the food vendor, and price and accessibility of food. Questions on the origin of the food were not common. Regarding food safety, interpersonal trust in the vendor was mentioned (Probst, 2008; Rheinländer et al., 2008).

A factor strongly affecting behaviour change concerns implementation 'costs' in terms of capital, land, labour or time requirements to adopt a new practice or change an old one. The safety interventions recommended in Ghana for farmers and street food sellers (Amoah et al., 2007b, Amoah et al., 2011, Keraita et al., 2010b) require either a change in how water is fetched or applied (farmers), or how vegetables are washed (fast food stands). While a few safety practices require only marginal changes, some interventions, like drip irrigation could significantly reduce labour input. On the other hand, the currently available drip kits in Ghana are too far spaced thus reduce cropping density and yields. Capital investments remained generally limited, although more effective vegetable-washing in kitchens would require some investments in, for instance, bleach or chlorine tablets.

Box 1: Risk perception

Given the diversity of health hazards which farmers and consumers face, and the complex nature of diarrhoeal infection pathways, underestimating or ignoring the risk might be understandable. Farmers' low risk awareness might also be due to the fact that potentially affected consumers are far down the market chain. There are very few cases where the farm family also consumes the (exotic) vegetables they produce. Exotic vegetables, such as lettuce, which is consumed as raw salad, are not common in the traditional Ghanaian diet. Thus complaints about the food rarely reach the farmers. Also, occupational risk awareness is generally low (Obuobie et al., 2006). Farmers who mentioned enteric diseases did not necessarily relate them to their use of wastewater (Keraita et al., 2010a). Even where some awareness exists, it seldom translates into the adoption of protective measures, such as clothing or rubber boots, because of discomfort, heat and other reasons. In general, exposure to the water is accepted as a professional challenge well balanced by the economic benefit (Gbewonyo, 2007; Obuobie et al., 2006). While farmers projected an 'illusion of risk-control' (cf. Frewer et al., 1996; Knox 2000), an increase in knowledge, awareness and interest in health-risk issues and risk mitigation was noticed where they were exposed to the topic through research projects and media attention (Keraita et al., 2010a). Thus even without personal risk awareness, farmers felt the pressure to respond, to avoid public exposure which could affect their business. In general, however, both farmers and vendors ranked other, mostly business related, challenges and constraints higher than any health challenges (Obuobie et al., 2006; Karg, 2008; Rheinländer et al., 2008).

In short, all recommended practices are distinctively of low cost, which is important but not enough to trigger behaviour change. Most supportive would be a financial benefit in terms of higher revenues.

A common example for financial incentives for food safety can be found in the related sector of organic food production. While in Ghana, risk awareness and a willingness to pay for safe food are largely limited to the upper class (Probst, 2008; Yahaya, 2009), the situation can be different elsewhere. In Vietnam, for example, the emerging middle class is increasingly demanding safe or organic vegetables (Simmons and Scott, 2007, Moustier and Nguyen, 2010). Farmers who are responding could qualify for loans and safety certificates, but often failed to enter specific marketing channels. Those cooperatives which managed to build specific channels, supplying canteens, supermarkets and own stalls reduced or removed intermediate actors in the food supply chain to increase source transparency, consumer contact and profits. Although safer vegetables had higher production costs, and profits were 40-90% higher (Simmons and Scott, 2007; Moustier and Nguyen, 2010). However, the demand for higher quality food is in general limited, and especially the poor who are most at risk of disease transmissions will not be able to benefit from these specialized market chains. To reduce the disease burden from wastewater irrigation beyond minorities, a broad adoption of safety practices covering ideally 75% of the market is required (Drechsel and Seidu, 2011).

Need for social marketing

Even where food safety concerns support an emerging alternative market chain, the majority of farmers will not be able to benefit, thus miss tangible incentives to adopt safety practices. In this situation, social marketing options must be explored to catalyse and support behaviour change at scale.

While commercial marketing ultimately seeks to generate profit for a private interest, social marketing seeks to influence a target audience to voluntarily accept, modify or abandon behaviour for the benefit of individuals, groups or society as a whole. The social marketing approach applies commercial marketing principles and techniques, such as customer orientation, marketing research, etc. and has been tested in the sanitation and public health sectors (Grier and Bryant, 2005; Martinsen, 2008; Siegel and Doner Lotenberg, 2007).

Marketing approaches in general are considered as promising alternatives to traditional (educational) approaches[2] to change behaviours, i.e. instead of being supply driven (providing knowledge and materials), marketing approaches support a demand-driven change, thus are more consumer-oriented. Social marketing focuses on removing barriers and fighting the current alternative to the suggested practice while simultaneously enhancing the activities benefits (McKenzie-Mohr and Smith, 2007).

Whereas the focus of the work in Ghana was on the individual or farming community level of behaviour change, it can only be sustainable if supported by its social and infrastructure environment. In other words, changing habits is always easier at life changing events or when the environment is changing accordingly. This can include informal changes (a new role model or

[2] In the past, many health-promotion campaigns were based on educating people about the threat of disease in order to change their behaviours (Nutbeam and Harris 2004). However, there is little evidence that approaches based on health education have had the anticipated impact, in particular in developing countries (Burgers and Boot 1988, Scott et al. 2007).

image) or formal changes, such as supporting legislation and capacity building. An increasing awareness and knowledge about food safety issues has been observed especially among food vendors (Rheinländer et al., 2008). This shift in knowledge can be attributed to increased food safety education over the last years, especially by local authorities and the private sector (e.g. Nestlé).

These and other external and internal behaviour determinants relevant to the adoption of better food-safety and irrigation practices in the Ghanaian context are summarized in tables 1-3. Following the example from Favin et al. (2004), barriers and enabling factors were sorted according to different categories to help in formulating possible intervention strategies.

Table 1. External and internal behaviour determinants and possible intervention strategies on-farm in Ghana

Category	Barriers (-)	Enabling factors (+)	Possible response strategy
Input supply	Farmers prefer only slight changes in their current practices or those which required low investments.	Some farmers already apply (unconsciously) risk-reductive irrigation methods in order to reduce work load (like pond creation)	Risk-reduction measures should focus on multiple benefits considering indigenous approaches
Socioeconomic conditions	Farmers are very concerned about their business which is ranked higher than health	Farmers do care about the public perception for the sake of business	Promotion of safe produce can have business advantages
Education	Training on health risks from wastewater irrigation has not been incorporated in education curricula	Farmers are increasingly exposed to the issue, mostly through research projects.	Risk-reductive irrigation methods should be incorporated in agricultural extension programmes
Institutional settings	Harassment from media and authorities resulted in negative public perceptions and subsequent defensive strategies	Authorities are in place and maintain pressure	Positive media support in turn can provide incentives to farmers
Social groupings	Farmers work on several sites in isolation	Innovations are more likely to spread from farmer to farmer than through external facilitation	Existing social networks should be part of communication strategies looking at linked possible incentives (e.g. credit)
Farmer/consumer interaction	No direct interaction, as consumers are far down the market chain	Special market channels can be created for particular outlets, super-markets, canteens, etc.	Closing the loop between consumers and producers (less intermediate traders)
Risk awareness	Health risk awareness is very low, both for the farmers themselves and for consumers	Particular health knowledge is not needed to trigger behaviour change	Relationship between contaminated water and health or related fears should be established.
Scientific knowledge	Very little awareness of invisible risks (micro-organisms) and pathogen pathways	Increasing knowledge, awareness and interest in health-risk issues and risk mitigation through research projects	Invisible risks should be made ‘visible’ best to stimulate disgust.
Practical knowledge	The best practice to fit in the Ghanaian context has not yet been identified	Farmers prefer field demonstration and/or learning by doing	Participatory approaches to identify suitable practice
Intention	Some farmers do not see the need to change their practices and deny the responsibility.	Pressure induced by media and policy make farmers feel to respond	Risk reduction methods coupled with positive incentives can enhance the willingness to change

Table 2. External behaviour determinants and possible intervention strategies in Ghana's informal street restaurant sector

Category	Barriers (-)	Enabling factors (+)	Possible response strategy
Input supply	Effective disinfectants are generally not known, although available. Thus vegetable-washing is not effectively reducing pathogens.	Vegetable-washing to remove dirt is done by over 90% of stakeholders; this is an excellent starting point for effective pathogen removal.	Promote available disinfectants (bleach, chlorine tablets, potassium permanganate) suitable for different classes of restaurants.
Socioeconomic conditions	Vendors are concerned about costs of required inputs or training.	Public and private sector offer free training. Some ingredients (bleach) are very cheap.	Make options known. Engage private sector for promotion and subsidies. Training certificates might increase sales.
Education	In catering schools practical food safety does not get much attention.	Teaching materials are being provided/revised based on current project results.	Establish early link with educational sector to facilitate adoption of results in curricula.
Environmental conditions	Unsafe environment of street restaurants; tap water and toilets might be missing.	Interventions have to consider local possibilities and limitations	Step-wise approach of improvements needed.
Institutional settings	Regulating authorities are under-resourced, which might facilitate corruption.	Authorities are in place.	Institutional capacity building required.
Social groupings	Few members in catering associations due to internal problems. Most associations have weak governance and funding.	Social clubs, church groups and professional associations are common and can be used as possible communication channels. In general, vendors like to join associations and networks.	Associations should be strengthened and memberships promoted. Support loan schemes/ credit for safer behaviour.
Vendor/customer interaction	Customers are more concerned about price, neatness and quantity of the food, rather than food safety.	Customers have much influence on vendors who want to satisfy them. Vendors are willing to learn to please customers.	Customers' awareness about food-safety issues has to be increased.
Neatness as part of cultural norms	Neatness is important but does not necessarily include cleanliness and safe food.	Controllers, vendors and customers are very concerned about neatness which is closely associated with trust and respect.	The term neatness has to be extended to visible and invisible cleanliness; or positively linked to disinfectants.
Cultural norms	Customers do not ask about food origin related to safety which is considered disrespectful.	Food origin can be a 'brand'; e.g. carrots from Togo are preferred to Ghanaian ones.	Safer production sites could get a brand name associated with accepted norms, like 'clean', 'neat', 'tasty'.

Table 3. Internal behaviour determinants and possible intervention strategies in Ghana's informal street restaurant sector

Category	Barriers (-)	Enabling factors (+)	Possible response strategy
Risk awareness	Vendors do not perceive any elevated risk and consider current washing practices to be appropriate.	Vendors are to different degrees aware of health risks related to raw vegetables.	Risks should be explained. Invisible risks should be made 'visible'.
Scientific knowledge	Very little awareness of invisible risks (micro-organisms) and pathogen pathways.	High awareness of visible risks like insects and knowledge of the term 'germs'.	Risks should be explained. Invisible risks should be made 'visible'.
Practical knowledge	Few attended formal catering education in schools. Effective vegetable-washing methods are in most cases not known.	Vendors have basic knowledge of food safety through post-school training provided by projects or private sector.	Promotion of effective methods in workshops, through associations and private-sector training.
Emotions and reactions	Promotional materials and campaigns as used in other cultures do not appeal necessarily and might even be misleading if unknown symbols or vocabulary are used.	Perception studies point at positive and negative motivational factors which drive hygiene behaviour.	Strategy should be based on local knowledge and perceptions.
Intention	No barrier	In general, vendors are very willing to learn about clean food preparation and aim unanimously at satisfied customers.	Training workshops can be combined with cooking courses or private-sector product promotions

Key issues of the three tables pointed in the Ghana case at certain possible triggers which should receive particular attention:

- **Making the invisible visible:** An innovative 'germ' indicator, like the Glitterbug™ gel (www.glitterbug.com) can help to visualize invisible hazards (Amoah et al., 2009) and might help to catalyze e.g. disgust (yuck factor), which was a successful trigger in Ghana's hand wash campaign (Curtis, 2002; Scott et al., 2007).
- **Closing the loop between producers and consumers:** Communication channels can be established that provide positive and negative feedback to the farmer. Learning from the Vietnam example, specific marketing channels with limited intermediate traders can support farmer-consumer proximity.
- **Link the new practice to farmers/vendors priorities:** As farmers and street food vendors are very concerned about their business, business incentives or a message built around positive market effects have a much higher potential of triggering behaviour change than messages around health benefits.
- **Build on existing practices:** In many areas, farmers are developing innovations to reduce labour input. For example, farmers have created networks of ponds which reduce transport distances for heavy watering cans and they have blocked wastewater streams for easier water fetching. Both examples can create a cascade of worm egg traps and sedimentation ponds, with an obvious impact on pathogen levels (IWMI, 2008; Cofie et al., 2010). This shows opportunities for building on farmers' own experimentation, while linking health farmers' priorities with public health safeguarding.

From Research to Implementation

The study conducted in Ghana led to the development of a framework for implementing a 3-year national campaign on food safety, with special emphasis on wastewater-irrigated vegetables for which funding is still sought. The framework combines elements or strategies considered as important for changing behaviour in the street-food sector and among farmers (Figure 2). It draws on information in Tables 1, 2 and 3 and the 'Receptivity Model' described by Jeffrey and Seaton (2004), while

emphasizing also the equal importance of different measures to facilitate behaviour change and increase food safety. The framework also considers the benefit of simultaneously using incentives (for behaviour change) and disincentives (for maintaining the old behaviour); e.g., via enforced regulations and fees. The elements of the framework are:

- Awareness creation and education (given the low knowledge level, but being aware that knowledge alone is seldom a trigger);
- Incentives (transforming needs of the target group into opportunities);
- Social marketing (given the low direct commercial incentive for changing behaviour);
- Enforced regulations (to address bad practices and institutionalize good ones).

Depending on location specific opportunities and constraints, the emphasis can change among these four pillars:

- **Awareness creation and education** by themselves might not change behaviour (see above) but remain crucial components of any multi-strategy approach. When considering knowledge as an underlying driver for behavioural change (or lack of knowledge as a barrier to change), it is important to recognize that there are two types of knowledge. The first – practical or logistical knowledge – is essential for adapting new behaviours (e.g. how to prepare the correct chlorine solution for disinfecting vegetables or how to install a drip kit for irrigation). The second type of knowledge, the scientific explanation for the necessity of behaviour change (e.g. how the chlorine works), may not be essential to achieve behaviour change as experienced in the Ghana hand-wash campaign. However, by making the pathogens and their temporally and spatially remote consequences transparent (e.g. pseudo-visible with the Glitterbug™ gel), be it through training or video, the complexity of disease transmission becomes playfully obvious, and awareness might increase as observed in the Ghana case (Amoah et al., 2009).
- **Incentives** are important to move from awareness to application. The most obvious incentive is market demand. But often this is not developed and the benefits of behaviour change are less direct, such as when individual action (safer irrigation practices) serves society (public health) more than the actor. In the Ghana hand-washing case (see above), the benefit was for the person and the family; i.e., a much closer association than for a farmer who is not the consumer of his/her crops. In the case of the farmer, there is a need for extra incentives, such as less labour, increased tenure security, awards, training, credit, subsidized inputs, better market access, and less pressure from authorities and the media. Tenure security was often mentioned in Ghana as urban farms are on public or private land and can easily be closed. An incentive such as better tenure security could facilitate farmers' investments in structures that have positive health impacts, such as wastewater treatment ponds. Similar incentives exist for street food restaurants, which are often more informal than formal.
- **Social marketing** is an important tool where economic arguments do not work. Even if health considerations are not valued highly in the target group, social marketing studies can help identify related benefits that are valued, including indirect business advantages, improved self-esteem, a feeling of comfort or respect for others. Studies must look for 'positive (core) values' that the primary target audience associates or could associate with the innovation (Siegel and Doner Lotenberg, 2007). For example, if using a drip kit for safer irrigation is valued for reasons of feeling 'technologically advanced', then the social marketing messages and communication strategies should reinforce this existing positive association.
- **Regulations** are an important external factor to institutionalize new food-safety recommendations. When enforced, these provide the legal framework for both incentives, such as certificates, and disincentives, such as fees. New rules usually also require capacity building. To integrate improved food-handling practices into institutional structures, inspection forms can be updated, inspectors and extension officers can be trained, and pressure can be applied to farmers and caterers. However, regulations should not be based on imported (theoretical) standards, but rather on locally feasible standards that are viewed as practical and are not prone to corruption. In this way, regulation and institutionalization may contribute to ensuring the long-term sustainability of behaviour change, whereas promotional and educational activities are usually limited to a specific time frame.

Different stakeholders in different locations will be at different stages towards behaviour change (see the four stages in Figure 2). Thus every campaign will set a different emphasis on the balance between awareness creation and education, social marketing, incentive provision, and enforced regulations. An analysis assuming different adoption rates showed the high potential of the here suggested campaign framework in terms of its cost-effectiveness (Drechsel and Seidu, 2011). The cost-effectiveness could be even more favourable if we apply a integrated food safety approach (Box 2).

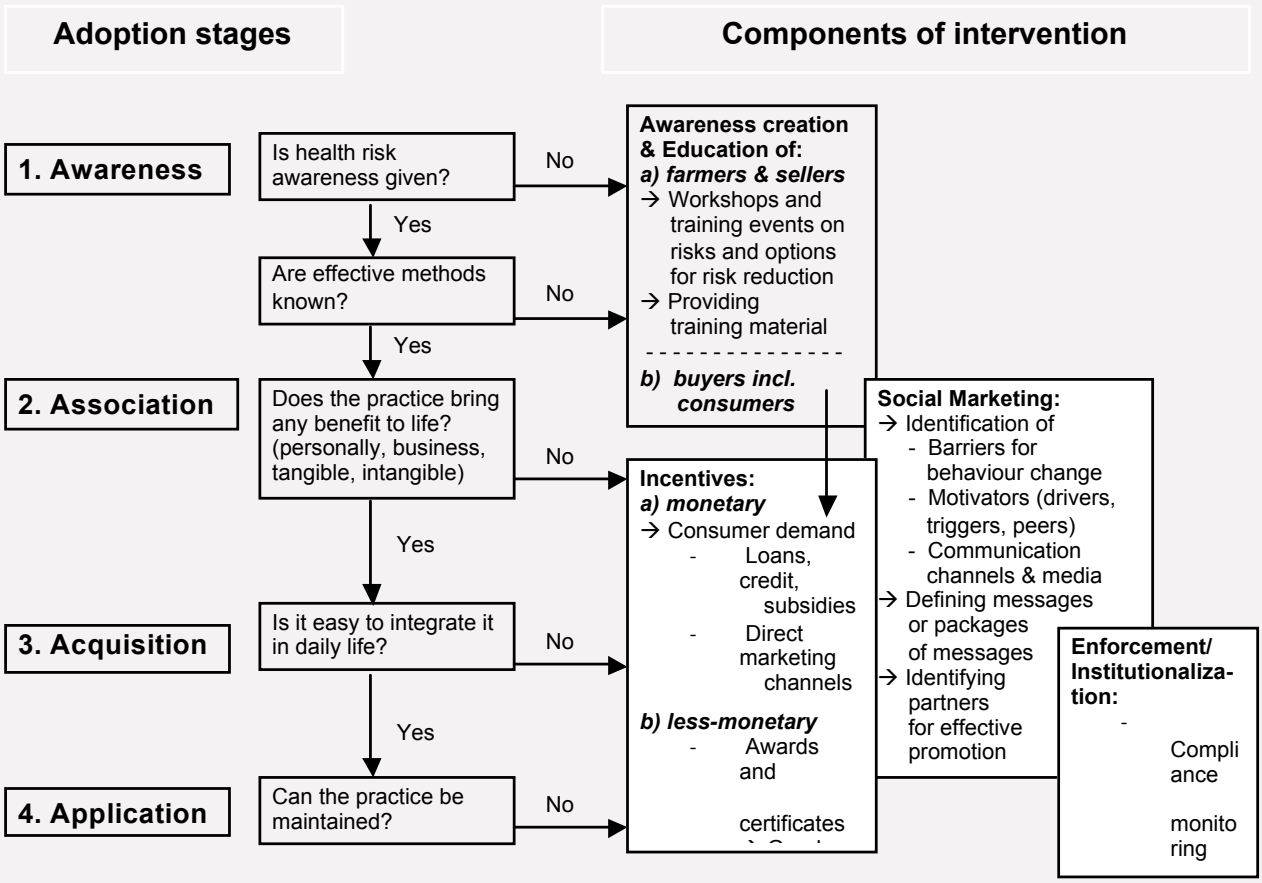

Figure 2: Multi-strategy campaign framework for the adoption of on- and off- farm interventions for the reduction of health risks from wastewater irrigation in urban Ghana (Source: modified from Karg 2008 and Roma and Jeffrey 2008)

Box 2: Looking beyond "WHO 2006"

The introduction of health-based targets in the 2006 edition of the WHO safe wastewater use guidelines moved the attention from the irrigation water to food safety in general. Looking at food-safety, however, authorities might find any wastewater-driven campaign e.g. on safe vegetable washing odd in an environment where food hygiene and food safety are challenged in many more ways than via irrigation. Thus we propose that the WHO adopts in the wastewater sector a more holistic approach beyond their current wastewater use guidelines. Ideally, effective vegetable-washing and other basic (food) safety practices, like hand-washing should be part of an integrated behaviour change approach. Even if not all components of such a 'package' will be adopted, the cost of promoting two to three good practices might be only somewhat higher than the cost of promoting one practice, while multiplying its potential impact and cost-effectiveness.

Conclusions

In areas where public health cannot be safeguarded through adequate wastewater treatment, WHO (2006) recommends additional on- or off-farm based safety measures. While wastewater treatment must rely on institutional capacities and incentives to maintain technical functionality (Murray and Drechsel, 2011), alternative options require individuals and farming communities to change their behaviour. Supporting policies and related education might be milestones in this process, but often do not trigger behaviour change.

This situation calls for a stronger integration of social science research and related strategic partners and stakeholders in the strongholds of engineering and epidemiology to address key adoption barriers, such as:

- In many cases, the recommended practices for increased food safety do not provide direct profit or reduce production costs (they may even be more expensive).
- Educational levels in developing countries are too low to understand public-health risks (especially related to invisible threats) and related responsibility.

- Safety regulations are often too theoretical and do not fit local capacities or context.

In addition to educational and regulatory efforts, social marketing can play a significant role in understanding and facilitating behaviour change, although both approaches are not without challenges (Biran and Hagard, 2003; Cave and Curtis, 1999). To be successful, social marketing requires applied research to understand the needs, aspirations, values, and everyday lives of the target audiences, and their perceptions of factors that might motivate or discourage them from adopting recommended technologies. This research will greatly help in designing a well-targeted food-safety campaign under any policy supporting the WHO (2006) guidelines in the farm and post-harvest sectors. Resulting experiences, like those reported here from Ghana, are needed and should be incorporated in the WHO Guidelines to assist practitioners and authorities in adopting and adapting the WHO Guidelines.

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