Recovery and Reuse of Resources: Enhancing urban resilience in low-income countries

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Poor sanitation presents not only risks but also opportunities for urban and periurban agriculture. In many cases farmers accept the risks in anticipation of the benefits, which include low-cost access to waste resources that are rich in nutrients and water. RUAF has a long tradition of carefully examining the interface of agriculture and sanitation. It has analysed case studies, trends and emerging priorities where RUAF partners, like IWMI, and the RUAF network can play a pivotal role.

Urban centres are enormous hubs of consumption of all kind of goods including food. This in turn makes them major waste generation centres. If this waste remains in the urban area, cities will also become vast sinks for the resources that make up the waste. These include water, nutrients and organic matter. This waste is not only the number one environmental and health challenge that growing cities face today. Where waste management is not financed through taxes and fees, as it is in most developed countries, it also represents an economic challenge. In developed countries, not only waste collection but also resource recovery from organic and inorganic waste fractions is common. Households can reduce their waste collection fees by separating for example old glass, used paper, plastic waste and organic kitchen residues into dedicated collection systems. Where there is space, backyard composting of kitchen residues for urban farming is also encouraged. For liquid waste (i.e. grey water from kitchens and bathrooms, and black water from toilets) the common target is to remove it from household premises through sewer systems and resource recovery generally only happens after treatment at community scale.

This system is found today in urban and rural communities in many developed countries. As a result, cities and their environment are less polluted, resources are reused, and, as the overall system is more self-sufficient, the lifespan of landfills is extended.

In developing countries, collection of solid waste and the separation of different solid waste streams are still a major challenge. Most households are poor, while waste management cannot rely on fees and taxes alone. In fact, expenditure on waste management often takes up much of a municipal budget and even then is seldom enough. The possibility of increasing household fees is not only limited by poverty, but also because of low levels of education, and environmental awareness and responsibility. If the fees are raised, households are likely to start dumping their waste in the street or drains. Waste collection coverage rarely exceeds 75% and the remaining waste is a severe public health hazard. Increasing collection coverage is most local authorities’ highest priority, much more so than introducing resource recovery activities, which often remain at pilot scale. Recycling takes place, but is more poverty driven than done for environmental reasons, waste scavenging being an example. However, an increasing number of entrepreneurs are engaged in activities such as commercial plastic recycling and the reuse of faecal sludge.

While urban and periurban food production and especially food safety clearly suffer from poor sanitation, urban farmers do often take advantage of underutilised solid and liquid waste resources. This may be waste from agro-industrial production, such as cotton husks or poultry manure, composted market waste, domestic wastewater or faecal matter. Although the aim will always remain complete waste collection, treatment and controlled reuse, so far only a small percentage of most urban areas (e.g. in sub-Saharan Africa) are connected to sewers. This therefore limits formal reuse, while informally treated and untreated wastewater and excreta continue to be used wherever nutrients or water are in short supply.

When it comes to reuse, we need to consider two waste ‘streams’: the waste that passes through the system on its way towards treatment or disposal; and the waste that bypasses formal systems, leaking out or never getting there in the first place. The captured streams (i.e. those passing...
through the system), have the largest potential for planned resource recovery, such as irrigation using treated wastewater or compost production. The streams that bypass the system are however, in most developing countries, at least as large (Scott et al., 2010, estimate for example that the area under informal wastewater use is ten times larger than that under formal wastewater use) and often support various informal-sector enterprises. Both streams have to be addressed where the ultimate target is planned management and safe reuse.

It is important to note that waste reuse bypassing the formal system not only concerns waste from the un-served population but also from those served by on-site systems, and even those connected to sewerage systems, as many storage and treatment facilities do not function properly. Much sewage in developing countries does not end up in functional treatment plants but in streams or lagoons.

Depending on the service provision level per country, the volumes of the waste streams, collected or uncollected, treated or untreated, can vary significantly. The same is true for the level of reuse in agriculture and aquaculture. The absence of data on the informal reuse sector presents a big challenge. Location, however, is a characteristic common to most reuse cases. Waste products, such as compost, urine or biogas, are usually reused close to their places of generation, as transport costs are a major factor. As a result, urban and periurban areas are hot spots for various resource recovery options, and urban and periurban farmers the main target group. Other target groups are urban departments in charge of landscaping or the private sector engaged in housing (and garden) development.

While resource recovery from waste streams appears to be a classic win-win for public-private goods and services around waste management and agriculture, success stories of planned waste collection, treatment and reuse are rare, and often of small scale, hardly viable and seldom surviving their pilot stage. A typical example is composting: common business and management strategies are rarely applied, largely because the sanitation sector has traditionally been a fully subsidised public service domain (Koné, 2010; Rouse et al. 2008). Many donors are in favour of private sector participation and support a paradigm shift towards cost recovery. This development facilitates a second paradigm shift from treatment for disposal to treatment for reuse, as the latter offers options for cost recovery (Murray and Buckley, 2010).

A recent review (Evans and Drechsel, 2010; Cofie and Murray 2010) commissioned by the Bill & Melinda Gates Foundation looked at a variety of existing reuse cases in low-income countries involving household wastewater, excreta/faecal sludge (FS) and separated urine and faeces. The review specifically looked at technologies that have been proposed or piloted in developing country cities, or are in the process of being up-scaled to manage, treat and use waste products. The aim of the review was to identify potentially replicable reuse technologies with sustainable operating models that ideally can co-finance waste collection and treatment (Table 1).
Summary of promising reuse options

<table>
<thead>
<tr>
<th>Option</th>
<th>Why is it interesting?</th>
<th>Revenue potential</th>
<th>Likely model for implementation</th>
<th>Demand and scalability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw-sludge use in cereal production</td>
<td>Boosting food production with limited risk while generating revenue for septic truck business</td>
<td>Profit for farmers; surplus for sanitation chain</td>
<td>Private sector (farmers, transport)</td>
<td>Limited; seasonal application</td>
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<tr>
<td>Use of treated faecal sludge or wastewater in aquaculture</td>
<td>Can take advantage of existing treatment pond infrastructure</td>
<td>Best bet for profit generation to the advantage of sanitation chain</td>
<td>Private sector; private-public partnerships (PPP)</td>
<td>Variation with region and season possible; depending on available ponds</td>
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<tr>
<td>Co-composting</td>
<td>Promising technologies for waste volume reduction and/or value creation</td>
<td>Operational cost coverage possible</td>
<td>Public sector</td>
<td>Transport cost to farm challenge</td>
</tr>
<tr>
<td>Biogas</td>
<td></td>
<td>Operational cost-recovery</td>
<td>Private sector</td>
<td>Regionally high</td>
</tr>
<tr>
<td>EcoSan (nutrient recovery from separated excreta &amp; urine)</td>
<td>Long-term cost-recovery if household have farm nearby</td>
<td>Private (household); community level under testing</td>
<td>Transport cost to household external farms a challenge</td>
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<tr>
<td>Use of untreated or diluted waste-water using alternative safety measures</td>
<td>Promising on-farm and off-farm safety measure that supports existing farm businesses</td>
<td>Profit for farmers (limited capital costs)</td>
<td>Private sector (farmers only)</td>
<td>Cases report around 10-50% of total wastewater supply used</td>
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<tr>
<td>Use of treated wastewater from treatment plants designed for reuse</td>
<td>Paradigm shift away from treatment for disposal</td>
<td>Considerable capital costs; profit for farmers could give cost-leverage for treatment</td>
<td>PPP with farmers</td>
<td>Location specific 10-100% of treated wastewater</td>
</tr>
<tr>
<td>Nutrient recovery from urine at community level</td>
<td>Low-capital cost models possible without dependence on separating toilets (UDDT)</td>
<td>Profit for farmers; cost recovery for operator if volume reduction possible</td>
<td>Public or PPP</td>
<td>Fertiliser demand not constant and lower than supply, storage and transport volumes are key challenges</td>
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</tbody>
</table>

Outlook

From the review of the various technologies and empirical cases, two main recommendations for future work can be highlighted:

1. A key issue cutting across the review is the lack of data on the economics of waste management and reuse in developing countries. External or public funding does not generally support the development of capacities to analyse and model possible business processes for the various waste streams. Even though many community initiatives and pilot schemes exist, and good tools are available, there are few basic financial analyses of operational aspects or monetary comparisons between different treatment systems, or for different market segments. Very little is known about costs and revenues of smaller or even larger enterprises, the public sector or processes linking the sanitation value chain; and most waste reuse pilots lack any demand and willingness-to-pay analysis. Consequently, such projects rarely survive beyond the end of subsidised operations.

2. Another common challenge constraining the out-scaling of waste reuse is the lack of context-relevant risk information, which could guide appropriate support for SMEs and proposals for adequate regulation and legislation. Without this type of information, reuse takes place in an informal interface between farmers’ needs, cultural concerns and sophisticated standards imported from developed countries. This gives ample space for misconceptions and prejudices, which further constrain the official recognition of urban farming and reuse entrepreneurs, access to credit or support from extension officers, and most of all, jeopardise official support for the implementation of context-specific safety measures for risk reduction.

In addition, future work should also address technical challenges, such as the most appropriate way to dehydrate urine without nutrient loss, which would greatly facilitate its storage and transportation (Pronk and Kone, 2010). This would increase its market value beyond the immediate urban environments, as farming space will be limited within cities. Indeed, for each waste product there are a variety of reuse options and conditions. Each of them requires a different land area and different investments in capital and running costs. Each has different health risks, but also revenues for a standardised number of waste generating households. Cities
One focus is on institutional collaboration across sectors, livelihoods and more resilient rural-urban interactions from agricultural and domestic waste streams for food security reuse of water, nutrients, organic matter and energy recovery.

The overarching objective of this division Programme on Water, Land & Ecosystems (CRP 5) on Resource Recovery & Reuse. A first outcome of the analysis was the establishment of a new research division within the new CGIAR Research Programme on Water, Land & Ecosystems (CRP 5) on Resource Recovery & Reuse. The overarching objective of this division is to increase the scale and viability of the safe and productive reuse of water, nutrients, organic matter and energy from agricultural and domestic waste streams for food security, livelihoods and more resilient rural-urban interactions (Box 1). One focus is on institutional collaboration across administrative boundaries. Another is the analysis of reuse business models for emerging entrepreneurs and public-private partnerships in the agriculture-sanitation interface. The RUAF network, which has partners looking at enterprise development as well as waste valorisation, is in an excellent position to contribute to this task.

The planned activities will build on current research supported by multi-stakeholder platforms, on safe wastewater irrigation, co-composting and organic fertiliser management in urban and periurban agriculture. The work will have a strong link to the emerging sector of waste entrepreneurs to increase the business implications and application potential across scales.

References