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Rural-Urban Encounters: Managing the Environment of the Peri-Urban Interface

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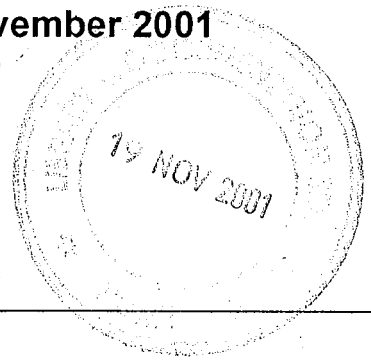

The Development Planning Unit
University College London

Improving Rural-Urban Nutrient Flows Through Urban And Peri-Urban Agriculture

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Workshop C

IMPROVING RURAL-URBAN NUTRIENT FLOWS THROUGH URBAN AND PERI-URBAN AGRICULTURE

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ABSTRACT

Rapid urban growth in several parts of Africa poses challenges to urban food security and municipal waste management. Urban centers can be considered as vast food and nutrient sinks, because unlike in rural areas, urban household waste and market refuse is not returned into food production but rather contributes to urban pollution and health risks. On the other hand, there is an increased nutrient need, for example, in urban and peri-urban production areas specialized on urban food supply.

Increased understanding of rural-urban nutrient flows could reveal the potential for nutrient recycling to agriculture. Concomitantly, recycling can reduce nutrient mining as well as health and environmental problems caused by accumulated organic waste. The paper discusses strategies to study nutrient flows within the rural-urban interface based on an ongoing project conducted in three different agro-ecological zones in Ghana. Flow data show the contribution of rural, peri-urban and urban farming to urban food security. Waste analyses suggest that the organic waste products generated and de facto available could be recommended for crop production. The study also reveals that there is enough waste (solid and liquid) currently dumped as refuse, which could be recycled for agricultural use. A pilot station for co-composting is currently under construction in Kumasi.

Introduction

According to projection made by United Nations, Africa's population will almost triple by 2050 and this will be primarily in the urban and peri-urban areas. In West Africa, it has been estimated that within 20 years, two out of three West Africans will live in urban centres, a development supported by rural-urban and North-South migration. The related increase in urban food demand is giving way to a gigantic one-way flow of food and nutrients into city centres where large parts of nutrients are finally 'wasted' in latrines or landfills or contribute to urban pollution (Fig. 1). This is a special worry in all those developing countries where urbanisation is outpacing the growth of sanitation services.

On the other hand, we observe increasingly intensive farming systems in and around cities often specialized on irrigation of perishable crops or poultry production to meet urban food demands and habits, but also for food export taking advantage of urban infrastructure (airport, agro-industry, harbor etc.). These types of mostly peri-urban agriculture require large amount of inputs, including plant nutrients. This situation calls for an analysis of options for municipal organic waste recycling for the benefit of agricultural and environmental sustainability in the rural-urban continuum (Allison *et al.*, 1998, GTZ/GFA 1999, Drechsel and Kunze, 2001). This analysis may start with a study of rural- urban nutrient flows.

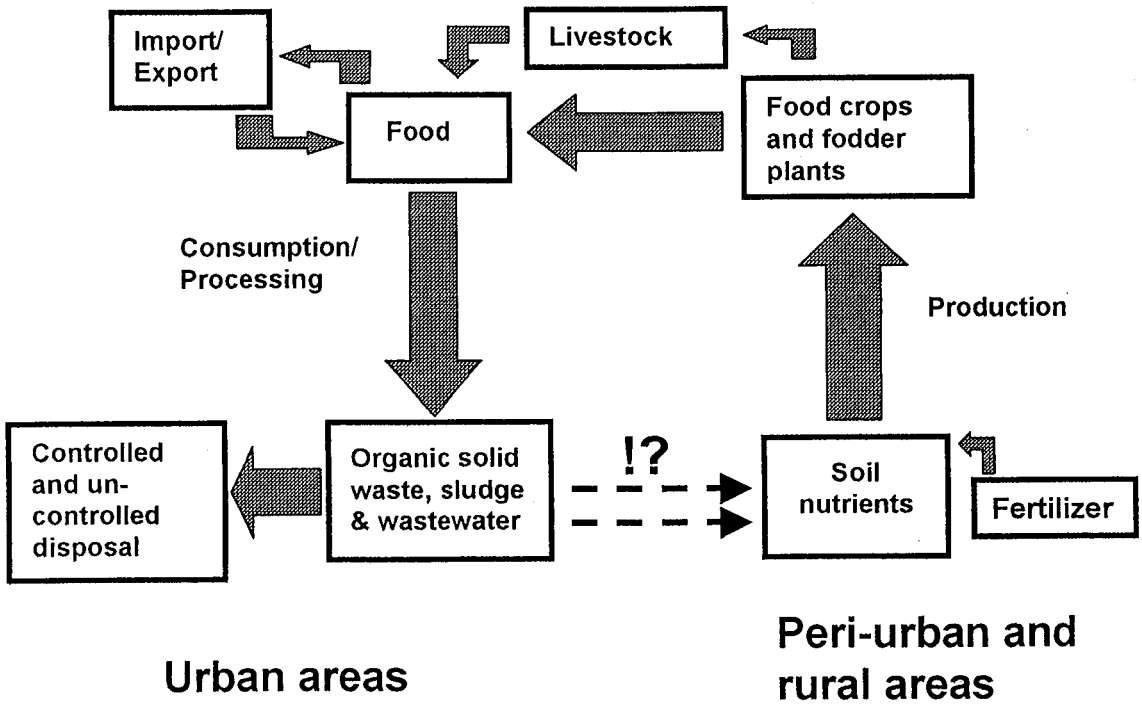

Figure 1: Urban areas as nutrient sinks (Drechsel *et al.*, 1999; modified)

Following an international workshop on (peri)-urban agriculture and nutrient recycling from municipal waste (Drechsel and Kunze, 2001), the Canadian donor IDRC agreed to co-sponsor a corresponding IWMI project in three agro-ecological zones of West Africa addressing zonal variations in organic waste generation, quality and availability. The project is an attempt to develop recycling strategies that should result in closing

the rural-urban nutrient cycle as well as preserving the quality of the urban environment by reducing the (pollution effects of) waste accumulation. It aims at decision support on viable, environmental friendly and location-specific composting technologies that fit into the (peri)urban context and match the requirement and ability to pay of different (peri-) urban farming systems and other potential users.

Approach and first results

Although municipal decision-makers are in need of city-specific recommendations, the methodological approach used is generic and could be described as a holistic 'multidisciplinary situation and stakeholder analysis' or MSSA (Drechsel *et al.*, 2001) which tries to address all segments of the nutrient loop (Fig. 2). In each city context the MSSA involves municipal authorities, especially the waste management departments, farmers, researchers, private sector, project staff, market sellers etc. Moreover, about twelve different university departments of three national and two European universities are involved, which emphasizes the multidisciplinary nature of the study.

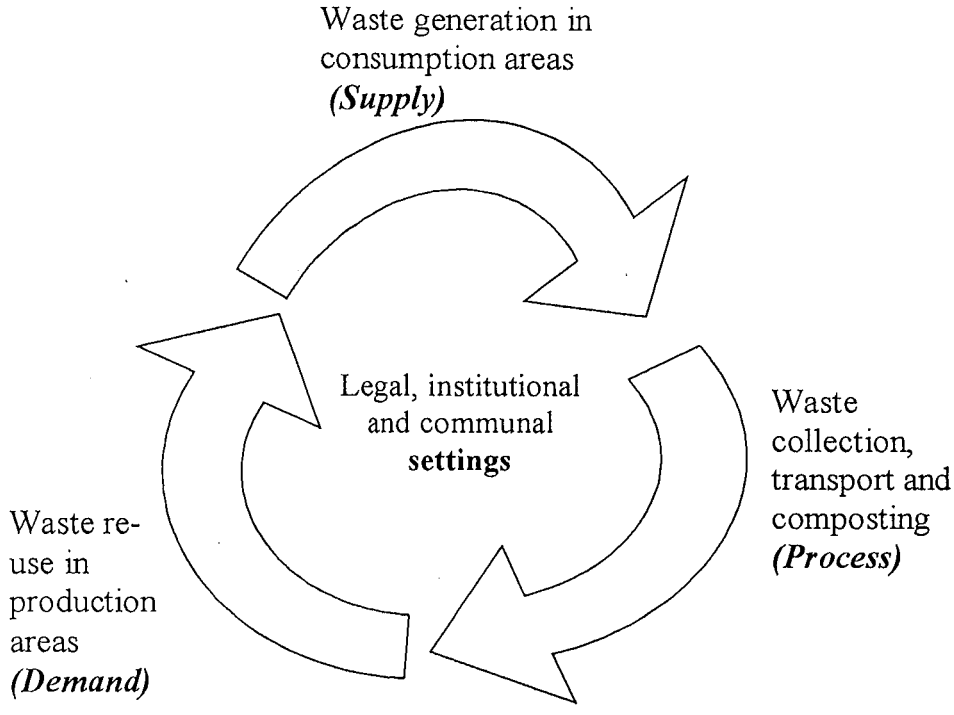

Figure 2: The four segments of the nutrient recycling loop.

1. The rural-urban food flow and related organic waste generation (quality, quantity, availability, etc.)
2. The demand for waste compost (who, where, how much, perception, price)
3. The process of waste collection and composting including the determination of optimal number, capacity, and location of compost stations per city and their economic viability
4. Legal, institutional and communal factors affecting the set-up of compost stations.

For each of these segments, the project tries to answer pertinent questions as summarized in Fig. 3 and described below.

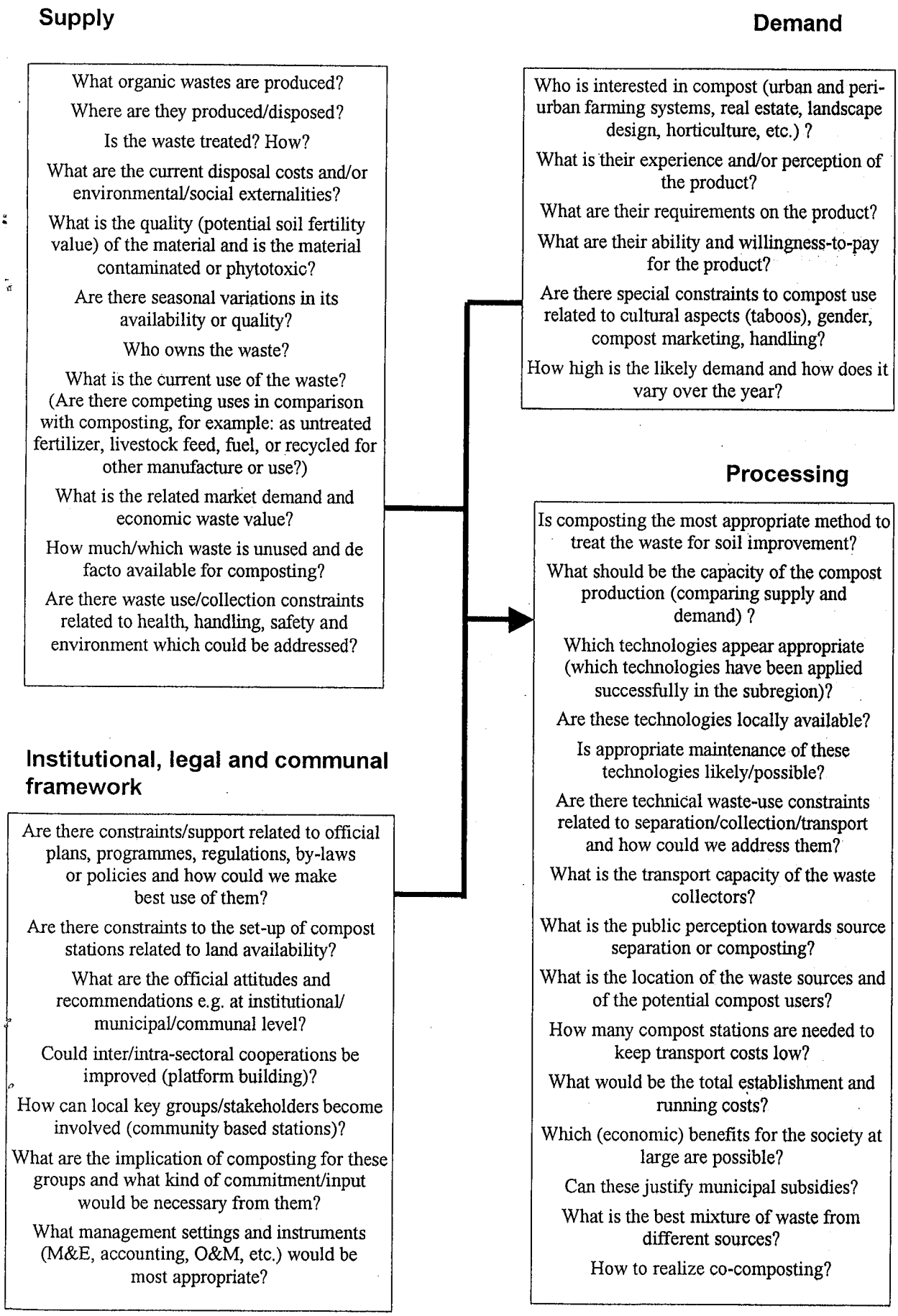

Figure 3: Questions to be answered in the MSSA for an appropriate establishment of municipal compost stations for (peri)urban agriculture and other uses (modified from Harris et al., 2001)

1. The supply of organic waste (food flow study)

Data on waste generation are a major output of the rural-urban food or biomass flow analysis. This is summarized in figure 4 from a preliminary assessment carried out for Kumasi (Belevi *et al.*, 2000). We are here differentiating between peri-urban and urban 'process units' with an outer boundary towards the rural countryside. Typical process units are 'households' or 'agro-industry'. The flow analysis is fed with data e.g. from market surveys, agro-industry, consumption surveys, wood processing etc. and can visualize the various types, amounts, and quality (in figure 3: Nitrogen) of waste produced as well as its fate. This has to be supplemented by information on present and potential waste uses, it's current value and availability for composting. Only major waste sources (markets, households, agro-industry, abattoirs, timber mills, public toilet systems, etc.) are considered, keeping transport costs in mind, although minor sources (e.g. bone meal producers) can become important as compost additives.

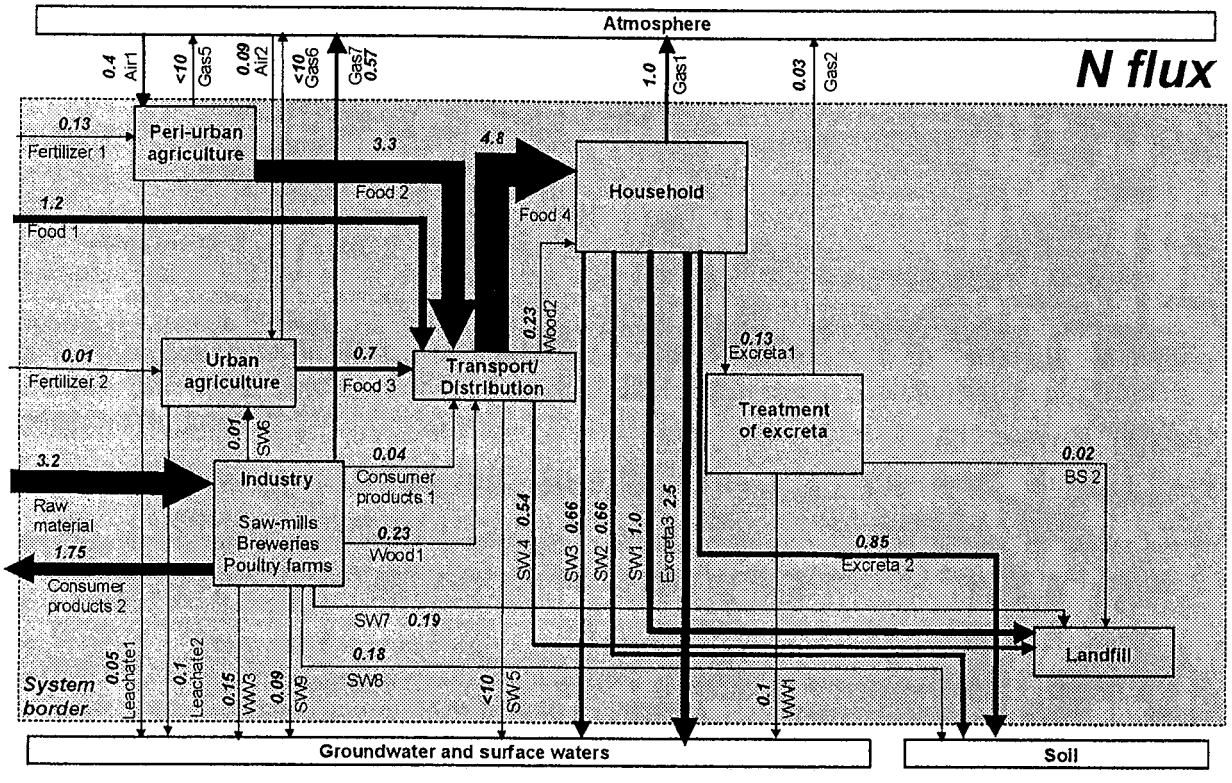

Figure 4: Annual nitrogen fluxes in kg capita^{-1} year^{-1} (Belevi *et al.*, 2001).

While Fig. 4 gives only an overview, the key questions concerning waste for **local planning** are: ***Where*** within the rural-urban zone is ***which*** amount of waste of ***what*** kind of quality ***when*** de facto ***available*** for composting. his information we mostly acquire via:

- ***Questionnaire surveys*** among organic waste producers using randomly selected sources from a stratified total per product. We addressed breweries, wood/food/ fruit processing industries, poultry farms, etc. to quantify the amount, kind and fate of waste generated in different periods of the year.
- ***Secondary data*** on the amount, location and disposal of municipal waste from the waste management departments, NGOs or projects, and if available on its quality.
- ***Laboratory analysis*** of the amount of nutrients in the waste as well as of potential contaminants including heavy metals and E. coli.

Box 1: Example abattoirs.

Five *abattoirs* were identified in Kumasi. These abattoirs process an average of 2115 cattle, 1785 sheep and goats and 110 pigs per week. Apart from pigs, most of the animals slaughtered are from the Northern, Upper East and Western regions of Ghana or outside the country. About 75t of organic waste made up of blood, pre-slaughter dung and stomach content are generated every week. Twenty seven percent of this waste is washed into drains (mostly blood), 57% is dumped (mostly stomach content and dung), and only 16% (bones and blood) is re-used or sold (Fig. 5). The "wasted" residues contain high amounts of N, P, K, Ca and Mg with a low C/N ratio favorable for composting.

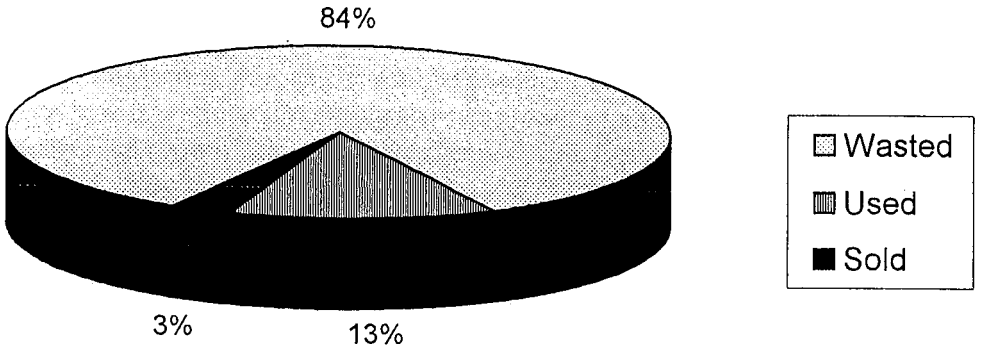

Figure 5: Actual use of abattoir waste in Kumasi (IWMI, unpubl.)

As the food flow analysis is also addressing the origin of the food we can estimate the contribution of urban, peri-urban* and rural agriculture to urban food security. Preliminary results from Kumasi are shown in Table 1.

Table 1: Origin of different food items sold/consumed in Kumasi
(IWMI unpublished; data in %)

Food item (examples)	Metropolitan area	Peri-urban Kumasi	Rural and import*
Cassava	10	40	50
Maize	< 5	5	90
Plantain	< 5	< 10	85
Yam	0	0	100
Cocoyam	< 2	< 10	90
Rice	0	< 5	95
Lettuce	90	10	0
Tomatoes	0	60	40
Garden eggs	0	60	40
Onions	0	0	100
Spring onions	90	<10	0
Poultry/eggs	15	80	< 5
Livestock	5	10	85
Fresh milk**	>95	< 5	0

* Imported are mainly rice, onions and part of the livestock
** University farm (same in Accra)

* The demarcation of the 'peri-urban' area follows the NRI approach (Adam, 2001).

2. The demand for (waste) compost

The demand assessment involves the characterization of all potential clients under consideration of increasing compost transport costs with increasing distance from the compost stations. This part of the MSSA has to go beyond agricultural production. A major and financially powerful demand, especially in rapidly expanding cities, comes from landscape design (horticulturists, parks and gardens) or real estate developers in general[†].

The demand analysis has to consider socio-cultural aspects, production economics, attitudes/perception of the use of waste compost (with or without nightsoil!), actual demand and its likely development, as well as clients' ability and willingness to pay. It also include the analysis of consumers market for food produced from compost. Key questions are again summarized in Fig. 3. Methods used to answer these include:

- ***Identification*** of the different UPA farming systems, estate developers, garden operators, landscape designers, if possible with and without compost experience.
- This is followed by their ***stratification*** for representative sampling using structured questionnaires (open, closed), focus group discussions etc. to analyse the perception of waste compost (cf. Drechsel *et al.*, 2001b)
- For the willingness to pay (WTP) for compost, ***contingent valuation*** method was used. To give the WTP analysis a reality check, the different UPA farming systems are analysed for their farm finances and de facto ability-to-pay for (further) inputs.

Box 2: Example perception and WTP for waste compost

Results obtained from the demand studies around Kumasi revealed that (Danso, unpubl.):

- Two third of the urban and peri-urban farmers interviewed are used to organic inputs, especially poultry manure as main soil ameliorant. In fact, all urban vegetable growers use it. Only a minority of farmers has been trained in compost production and all are satisfied with the product. However, they complained about the related workload as it can not be compensated through higher market prices.
- All compost users and 80% of non-compost users perceived co-compost (solid waste with human faeces) as 'good' material for soil amelioration and crop growth.
- More than 80% of all farmers interviewed in the urban and peri-urban area have a positive perception of compost and more than 2/3 of those not using compost yet are willing to pay for it.

3. The process of waste collection and composting

This part of the MSSA compares supply and demand to estimate the required/possible capacity of the compost production to decide about an appropriate technical approach and depending on the locations of supply and demand on the number of compost stations under consideration of transport costs. The methods used include:

- The analysis of different scenarios based on different estimates, e.g. with the **software tool on the economic feasibility of compost stations** developed by GTZ/GFA (1999). Scenarios have to address different levels of technical sophistication and the actual and potential (but realistic) transport capacity of the city-specific waste collection system.
- **Visit** to related compost plants within the country and in neighbouring countries have been carried out to observe, study, and exchange information on the technical/operational and economic aspects of composting (cf. Fig 3 'process part' for typical questions
- **Field testing** of different options and combinations of organic waste composting and co-composting with nightsoil to give a safe (assured through laboratory tests) and rich (assured through fertilization trials) product that is acceptable and safe for the farmer and consumer.

[†] In Accra, for example, real estate developers show strong interest in large-scale and regular compost production.

Box 3: Example Pilot station.

From the amount of waste available, its water content (51%) and C/N ratio (37) the potential for municipal waste composting in Kumasi is very high (Belevi *et al.*, 2001). In a French funded subproject, a **pilot station** is currently being established in Kumasi to test different options for safe co-composting of **municipal solid waste and human excreta**. The Waste Management Department of the Kumasi Metropolitan Assembly and EAWAG/SANDEC of Switzerland are partners in this subproject, likely to be unique in Sub-Saharan Africa.

- In case of high compost demand the possibility of organic waste separation at the household level (**'source separation'**) should be explored. More than 70% of the households asked in Kumasi (n= 738) indicated their willingness to separate waste without special incentive (IWMI, unpubl.).

4. Analysis of legal, institutional and communal settings

This part of the MSSA targets the legal, institutional and administrative context within which composting and use of compost could be feasible. It involves an assessment of environmental and sanitation by-laws and policies as well as public awareness and the perception of authorities and other interest groups, especially CBOs and NGOs to work with or support organic waste recycling. This includes:

- Study of the legal framework, sanitation policies, medium term plans, project plans and other documents (**literature review** and **interview of key persons**)
- **Questionnaires** for surveying perceptions and anticipated problems of different stakeholders and related **open interviews** with municipal authorities, interest groups (NGOs, CBOs, projects, World Bank programs, etc.) and private investors.
- **Focus group discussions** with community leaders and community members on environmental issues, waste management, and organic waste recycling discussing possible scenarios of community-based compost station (perception, options, by-laws, realization potential, etc.).

Conclusions

Urban and peri-urban agriculture offers the potential for a classic "win-win" situation in which one of the major urban management problems, i.e. waste disposal, can be tackled at the same time as increasing food security through exploitation of the nutrient potential of the "wastes" (solid, liquid, excreta). The study of rural – urban food and nutrient flows is an important part of this analysis. It allows us to estimate the contribution of different regions to urban food security and a comprehensive assessment of the amounts of waste generated along the food chain. These data allow an assessment of the quantities of nutrients currently 'wasted' despite significant demand for appropriate nutrient recycling mechanisms. Anticipated results of the presented project are:

1. Comprehensive decision support for municipal authorities on realistic options for organic waste recycling in their city-context.
2. Paving the way for the production of alternative fertilizer (soil ameliorant) for the use of urban and peri-urban farmers.
3. Capacity building at different levels, among others through the involvement of currently 80 students.
4. Data on rural-urban food flows, consumption patterns, waste generation, compost demand, recycling options etc. from cities in different agro-ecological zones in West Africa allowing data extrapolation to other cities.

References

Adam, M.G. 2001. Definition and boundaries of the peri-urban interface - patterns in the patchwork. In: Drechsel, P. and D. Kunze (eds.) Waste Composting for Urban and Peri-urban Agriculture - Closing the rural-urban nutrient cycle in sub-Saharan Africa. IWMI/FAO/CABI: Wallingford (in press)

Allison, M., Harris, P.J.C., Hofny-Collins, A.H. and Stephens, W. 1998. A review of the use of urban waste in peri-urban interface production systems. The Henry Doubleday Research Association, Coventry, UK. 34p.

Belevi, H., Leitzinger, C., Binder, C., Montangero, A., Strauss, M. and C. Zurbrügg. 2001. Material Flow Analysis. A Planning Tool for Organic Waste Management in Kumasi, Ghana. Healthy Cities Conference, to be held in Accra, Ghana, in 2001 (submitted).

Drechsel, P. and D. Kunze (editors) 2001. Waste Composting for Urban and Peri-urban Agriculture - Closing the rural-urban nutrient cycle in sub-Saharan Africa. IWMI/FAO/CABI: Wallingford.

Drechsel, P. O. Cofie, R. Vázquez and G. Danso. 2001 Technology development for municipal organic waste recycling for urban and peri-urban agriculture - A holistic approach. Paper submitted to RUAF – SIUPA for the UPA methodological workshop, Nairobi, 2001.

Drechsel, P., Quansah, C. and S. Asante-Mensah. 2001b. Tools for the assessment of farmers' perception of organic wastes as nutrient source. In: Drechsel, P. and D. Kunze (eds.) Waste Composting for Urban and Peri-urban Agriculture - Closing the rural-urban nutrient cycle in sub-Saharan Africa. IWMI/FAO/CABI: Wallingford

Drechsel, P., C. Quansah and F. Penning de Vries. 1999. Stimulation of urban and peri-urban agriculture in West Africa - Characteristics, challenges, and need for action. In: O.B. Smith (ed.) *Urban agriculture in West Africa*. IDRC/CTA, Ottawa, Wageningen, page 19-40.

GTZ/GFA 1999. Utilization of organic waste in (peri-)urban centres. Supraregional Sectoral Project. GTZ, Eschborn/Frankfurt. (incl. software programme)

Harris, P.J.C., M. Allison, G. Smith, H.M. Kindness and J. Kelley. 2001. The potential use of waste stream products for soil amelioration in peri-urban interface agricultural production systems. In: Drechsel, P. and D. Kunze (eds.) Waste Composting for Urban and Peri-urban Agriculture - Closing the rural-urban nutrient cycle in sub-Saharan Africa. IBSRAM/FAO/CABI: Wallingford.