

Recycling urban organic wastes in agriculture

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1. Introduction

The paper briefly examines the nature and forms of reuse of urban organic wastes in urban and periurban farming as a local solution to address municipal solid waste problems, as well as urban farmers' needs for nutrients and soil improvers. The main problems and limitations as well as main benefits and opportunities are reviewed. Also the links with other municipal systems such as public health, resource conservation, planning and employment are looked into.

2. The nature of waste recycling

Current situation

The reuse of urban organic wastes in urban and periurban agriculture is an age old activity in many cities in Southern countries. At the same time, it is a modern concept that is gaining increasing recognition as an important strategy for sustainable urban development.

In the cities of developing countries, significant quantities of organic waste are generated by the domestic and agro industrial activities, in the form of solid waste (excreta and pit latrine sludge) and also industrial effluents. A city with one million inhabitants is estimated to produce 5,000 tonnes of waste material per day: These figures show that waste management in urban areas is a serious task.

In fact, the waste management capacities of cities are far insufficient, especially in areas outside of the centre. In average, only 50 % of all waste generated in the city is managed by the public authorities. Cities not only have difficulties to locate, build, run and monitor a sanitary landfill facility but also to maintain the level of functioning of their existing fleet of trucks. Urban solid waste management can consume up to 50% of the operating budget of a Municipality. Therefore, Municipalities seek to reduce the costs on garbage collection and transfer which generates the proliferation of open dumps.

This situation calls for a change and Municipalities are pressurised by their citizens to give priority to sanitation and waste management, since informal open dumps constitute one of the most serious and immediate environmental /health problems faced by local communities.

Municipalities are looking for new ways to share their traditional responsibilities with community-based organisations (CBOs), micro and small enterprises (MSEs), large entrepreneurs and industries⁴. In recent times, these categories of stakeholders have gained a lot of experience and are involved in separation, collection and recycling of urban waste. In many cities, they can employ as many workers as the public sector. One big issue on the agenda remains the non-recognition of the informal sector as an institution. Urban and rural communities in most Southern countries have a long history of resource conservation through waste recycling and the application of composted organic waste in agriculture.

Urban and periurban farmers are in need of organic matter as soil conditioner and fertilizer and as a basic resource for the production of animal feed. Because of the high prices of industrial fertilisers and animal feed, and the difficulties of having regular access to it, organic wastes are a valuable resource for urban producers. Intensive vegetable growers, plant and tree nurseries and pig growers are among the sectors that are using large quantities of urban organic wastes.

Gardeners experience that the application of processed organic waste enhances the level of organic material in the soil, stimulates soil life, improves the water retention capacity and increases the fertility of their soils, which may result in an increase in their yields.

Reduction of the costs on chemical fertilisers, by recycling urban organic wastes, is important since the costs involved in maintaining the soil fertility are estimated at around 20-25% of total production cost.

Recycled materials

The bulk of domestic waste is generated by district markets, followed by the neighbourhood markets and the high-income communities. Depending upon the conditions of temporary storage (with/without container), one large producer is more attractive than decentralised generators such as households. Another interesting material is the "terreau" which is old and sieved waste, diverted from open dumps.

Farmers use a wide range of organic materials depending upon the season and their locations. Materials that are easily accessible for farmers are: household wastes, sludge from pit latrines, leaves, manure from cows, pigs, donkeys and bats, litter from chickens, paper, ashes and water jacinth. Materials that are more difficult to obtain by the farmers on a regular basis are feathers, straw from millet and maize, fish scales, bones and hair, waste from peanuts, tree and shrub clippings, a/o.

Who is recycling

A wide range of individuals handle the recycling of waste in urban agriculture.

Farmers recycle their waste crops. Women are especially active in waste collection and recycling. They are often more dedicated than other actors and see composting and recycling of material as beneficial for the soils and their family.

Young unemployed people are also good candidates to play a role in the collection and recycling of organic wastes. They are hard workers, very motivated and dedicated to their task.

3. Forms of reuse of urban organic waste

Garbage farming

Each urban area has its own way of applying waste. Solid waste is applied raw, sieved or after decomposition. The most risky use of urban waste (for the safety of farmers and of vegetable consumers) is the direct application of mixed municipal waste or market garbage into soil, or inadequate composting of the waste. This practice is not sufficient for complete decomposition and stabilisation of the organic material and it is not sufficient for the killing of the pathogens. Often farmers have not properly been informed of the risks associated with application of fresh wastes. Often too, there is an absence of regulating and monitoring practices. Such direct application is routinely practised in some areas in China, India and Africa because farmers need to obtain organic material and nutrients. This practice is very popular in areas where cereal growing is taking place. The price to purchase such material is very attractive and costs ten times less than compost. This practice furthermore generates environmental nuisances with the dissemination of light plastics.

Fresh human waste spread upon fields

This practise is not new and still continues. It is a common practice in many cities that mechanical suction trucks from public or private sectors discharge liquid waste from septic tanks or pit latrine on agricultural areas despite its complications (since the material is liquid) for farmers. Local NGOs, community-based organisations (CBOs) and private emptiers and transformers undertake manual emptying. It seems that there is a lack of knowledge about the risk encountered by farmers when they use this method. Some of them think that they represent the best fertiliser, others think they can kill plants. On a socio-cultural point of view, the human excreta are considered disgusting and therefore the profession of transformer is seen as degrading. At the same time, the emptying activities and the discharge are seen as unavoidable. It is also a profitable business. The risks associated with this practise are huge because the waste is usually not transformed before use (see paragraph on co-composting) and also because actors rarely take protective measures while working. In other words, groundwater and surface water are affected by human pollution and workers can get infected.

Composting

In composting different techniques can be applied (in piles, in pits, with different layers of organic materials, with preliminary sorting and final sieving).

Nowadays, the most active users of compost are the vegetable gardeners and the producers of ornamental crops, tree nurseries, etcetera.

In the past, it was mainly municipalities that operated composting facilities, but often they failed to continue the production of compost. The main reasons for this failure lay in the lack of management capacity, the wrong selection of equipment and the lack of a long-term marketing and promotion strategy and action plans.

At farmers level the use of compost may meet obstacles like the lack of space, lack of labour, fear of ejection from the agricultural area by urban developers at any time, competition with other organic fertiliser that are more easy to obtain on a regular schedule. Nevertheless, all farmers are very interested in compost if the material looks good (without plastic) and with an acceptable price (it should at least be less expensive than chicken manure).

Co-composting

By definition, co-composting means the composting of a selection of different materials. In other words, it is often a mix of human waste with other materials being processed, or transformed. Co-composting is very attractive because the quantity of nutrients involved is high but not too high (as in the case of using human excreta only). There are three different methods to transform the mix:

- The human waste is discharged and disposed on a surface and left to dry, after being mixed with domestic waste (therefore the final product is dry),
- The human waste is left to decompose on an intermediate site and then composted with domestic waste or equivalent material,
- The human waste is directly incorporated into other materials and composted.

The many problems associated with co-composting of human excreta, like the transmission of diseases and pathogens, can be overcome by applying an integrated and sustainable waste management (ISWM) approach which is characterised first by the analysis of the current situation and then by problem solving. WASTE and its partners in Commune IV, Bamako are launching this approach with the design and construction of a final and recycling centre for liquid and solid waste.

Preparation of animal feed

Market refuse and organic waste from food industries (wastes from breweries, expired milk) can be processed in animal feed (especially for pigs) after boiling to kill pathogens.

4. Problems and limitations in reuse of organic wastes

The financial aspects

The production cost of composting can be substantial due to high land prices (for the composting facility), high costs of transportation of raw material and end products, the labour costs for the collection and sorting and the costs of the raw materials from markets and industries due to competition with other users. What is especially costly is the starting up of the activity and the promotion and marketing of the end products. The start up process is lengthy, involves many stakeholders with different interests, ministries and the private sector. It is advisable to process and utilise compost as close to the sources of the waste as possible. The price of compost should not be more than the price of other fertilising inputs such as chicken manure.

The health aspects

Promoting the recycling of waste in urban cultivation on a large scale in urban areas with high population concentrations raises the issue of public health. Fresh human excreta may contain pathogens which is why the reuse of fresh human excreta in general is not recommended. Household wastes can include hazardous waste (most of the time batteries) leading to contamination with heavy metals. Since backyard and community composting in developing countries uses a high proportion of fruit and vegetable peelings, the compost may include pesticide residues. If compost is produced from more diverse organic materials that risk is substantially reduced. In order to produce the safest compost, the composting process has to be well supervised, especially the sources of the organic wastes. That is more easy for few well selected sources than for a dispersed and large number of sources. Separation of organic wastes at the source and prevention of mixing with waste streams from heavy industry, hospitals and the like is crucial.

Inappropriate use

The quality of compost may vary depending on the type and mix of the organic waste materials used and the method of composting. Farmers are often unaware of the quality of the compost bought due to lack of classification and labelling and/or lack of knowledge.

Farmers should also know that composting may not be sufficient to improve the fertility of the soil if intensive year round cropping is applied and that complementary fertilization with other organic and/or mineral fertilizers may be needed.

Farmers should also know the possible consequences for the health of their family, their customers and the environment of the application of raw uncomposted or badly composted urban organic wastes.

Attitudes of officials

City authorities' negative perception of farming within the metropolitan boundaries is a constraint to the promotion of recycling of organic waste in agriculture. Authorities find it hard to accommodate urban farming in their cities because they view it as a detriment to modern urbanity and a health hazard. One consequence is that urban farmers have little land use security. This may make them reluctant to invest in the soils by applying quality compost and manure in the right quantities since they fear to be evicted from their land at any time.

5. Opportunities and benefits of reuse of urban organic wastes in agriculture

The following benefits of recycling organic waste are widely recognised:

- The amount of urban wastes to be transported to the landfill is decreased which saves money, saves space and decreases the greenhouse gas emission rate at landfill.
- The soil fertility management is improved since compost has beneficial effects on soil structure and soil life, moist retention capacity, soil fertility;
- Application of compost enhances plant resistance against diseases and reduces the need to use pesticides; also erosion control is facilitated.
- Food security and nutrition are enhanced since the yield of products is increased and the quality of the products is improved and the shelf life of vegetables and fruits is prolonged.

1. Review of research on reuse of urban organic wastes in agriculture

There is a rapidly growing volume of literature on the reuse of urban organic wastes in agriculture but the information is fragmented. There are few comprehensive guidelines on this subject. Studies and articles are available from many Southern countries, particularly India, West Africa, and South America. We will briefly review the literature contained in this section of the bibliography. The review will lead to the identification of the missing elements and the identification of future challenges for research and development.

5.1. Social, institutional, financial and legal aspects

The main actors in the waste management system

The list of institutions, presented in the literature, that play a role in waste management and recycling is always long and attention is given to the actual division of work between them. Thorough analysis of such information is often lacking and rarely are the linkages between these institutions and the degree of co-operation and co-ordination studied in more detail. The organisation of the waste management system is often described according to a vertical approach from national to local level and often important stakeholders are omitted on purpose or unintentionally. A lot of attention in the literature is given to actors involved in urban politics, urban planners, public health, urban environmental management, and agricultural policy. Current literature largely ignores the importance of the informal and private sector and their level of contribution. These sectors make a substantial contribution to waste collection, transporting and recycling. Local authorities often do not or only partially give recognition to the important role of these sectors.

The tensions between different ways of thinking and different interests are not always sufficiently analysed and too little attention is given to the local level.

Peoples' Participation

Many authors deal with the participation of poorer sections of the populations (scavengers, poor farmers). However, some case studies clearly show that the type of population engaged in recycling and application of organic waste is much more varied. From this, we can gather that more attention to stakeholder analysis is required.

The issue of child labour in waste recycling is often overlooked, despite the fact that children are often involved in the collection of animal waste from farms or of the by-products from industries, the transport of wastes, as well as the distribution and the sale of organic materials.

In the literature, little attention is also paid to gender issues. Women participation is considered marginal and temporary, which is not always the case. Articles on this subject are often more anecdotal than analytical.

Cultural barriers

The literature dealing with the cultural barriers to re-using raw waste or human waste is often

too theoretical and not placed in the local context. More profound analysis of this issue is needed.

Financial aspects

Literature presenting, discussing and analysing costs, expenses, prices and savings on recycling of organic wastes is rare. The literature mainly consists of case studies. There is a need to develop a more systematic approach considering the type of activities, locations and organic materials used.

There is little research done to assess the avoided costs when re-using urban organic wastes in agriculture instead of using chemical fertiliser (less transportation, lower costs of the landfill, less pesticide use, less GHG gas emission).

Some work has been done on the economical comparison between the use of chemical fertilisers, organic fertilisers or a mix of fertilisers reviewing the release of nutrients and other related benefits (increase of organic content, improvement of soil aggregation, porosity and aeration, water infiltration and retention, natural pest control) as well as on farmers' ability to pay for chemical fertilisers.

Few attempts are made to estimate the economy of scale of the recycling unit and the labour productivity for each activity in the waste recycling process.

Legal aspects

The legal aspects are not discussed by many authors and almost never by local experts. It seems that the approach to this aspect is still post colonial and western oriented.

5.2. Technical aspects

Wastes

There is ample knowledge about waste composition, weight, volume, organic fraction, etcetera. Details concerning the variation by season are examined as well.

Composting techniques

There are a great number of studies of good quality on the different steps in the recycling of organic wastes from the design and building of a recycling centre (often a composting or a cocomposting unit) to the implementation phase. Unfortunately, most of the guidelines on composting are based on western experiences and much less so on experiences in Southern countries.

The latter mainly refer to small and medium scale of compost production. There is a great variety of recycling techniques presented according to local context. Authors have described, rather in detail, all-technical aspects related to recycling and transformation but often focusing more on animal waste than on urban waste. Since the local capacity and context are taken into account, the recommended techniques are mainly manpower oriented.

Literature available often uses drawings and figures that are very helpful for the reader.

Source separation and transfer

Much less literature is available on source separation prior to recycling and the reuse of organic waste in agriculture. Very little information and analysis is available on the aspects of source separation in the households and at market areas.

A small section of literature is dedicated to the transfer of waste (from primary to secondary collection) despite the fact that in general, sorting and recycling takes place at transfer sites.

Techniques of reuse

Detailed information is available on the techniques of waste reuse in urban farming including the pros and cons.

Many articles point out the limitations and problems linked with the recycling of raw waste upon fields.

5.3. Health and environmental aspects

Potential health risks associated with the recycling of organic wastes are many. However, little specific information is available. References are scattered and often consist of vague generalisations. There is a need for studies that specify the main health risks associated with the various steps in the recycling and reuse of urban organic wastes, also detailing the conditions under which disease incidents occur and the people most affected, and identifying the most effective preventive and mitigating measures.

The study of the risks associated with the recycling of garbage has not been yet explored as much as the risk associated with the use of human excreta and waste water.

There is little information on the accumulation of pesticides in organic residues and the contamination of organic wastes by biomedical, heavy metals and other toxic substances in the waste stream and along the food chain.

Some papers attempt to formulate rules on “how to” in order to control health risks. Their effectivity depends on the local capacity to monitor and anticipate problems during the transformation processes.

Risk perception and behaviour of groups involved

There are very few surveys and findings available on how the health risks are perceived and tackled by the human groups involved (waste workers, children, farmers, food handlers, livestock and the consumers).

Perception of decision makers

Among city policymakers there appears to be a lack of systematic thinking about the health and environmental risks related with the issue. This often results in unnecessary restrictions on the development of waste recycling in urban agriculture.

Ecological foot print

Some studies have been done on the management of the nutrient balance of cities. However, few of these are actually looking at the material flows in detail, specific for each activity.

5.4 Challenges for further research and development

- Institutional capacity building on strategic and integrated urban planning has to be developed in the following manner: a. the consideration of urban agriculture in the planning process, b. the economics of organic waste management, c. the participation of the stakeholders.
- More research is needed on the institutional requirements of waste management and planning. The specific topics of interest can be: the role of the Municipality and other main stakeholders, especially the growing role of the private sector in recycling of waste, the benefits of partnerships with community actors, the partnership process and the raising of ecological awareness in urban communities. Also the effectiveness of the informal sector activities in recycling, the economic impacts thereof, and the expectations and needs of the people involved should be analysed in more depth.
- There is need for a comprehensive and strategic approach to planning and management of urban wastes. The current approach based on the rational planning paradigm, that excludes important actors and stakeholders in the waste management planning should be changed for more integrative and participatory modes involving citizens and other stakeholders. In order to have greater engagement and quality of information it is very important to involve all important stakeholders in the preparation of waste management studies, plans and projects. Improved access to the literature and pooling of complementary expertise are crucial for dialogue and negotiation between the various stakeholders.
- The time is ripe for a systematic documentation of “best practices” regarding organic waste recycling and for dissemination of this among city administrators. The expected outcome will be that recycling of organic waste becomes a normal feature in their planning activities.
- More research and support is needed for the organisation, monitoring and implementation of composting programmes with participation of the various stakeholders, like waste management, urban agriculture, animal production, transportation, health and veterinary management. Preparation of impact assessments should be made mandatory at project design stage.
- Research into the health and environmental risks associated with recycling and reuse of organic wastes in agriculture needs to be strengthened. It is important to develop an adequate framework for the assessment and monitoring of environmental and health risks together with the direct stakeholders likewise for the development of preventive / mitigating measures. The cooperation between waste management experts, scholars in urban agriculture and public health experts should be strengthened.
- More research and actions are needed in the field of source separation. Priority to be given to the analysis for source separation at markets and households. Together with improving access to recyclable fractions of urban waste, research on how to tackle the management of waste generated by primary health care, private clinics and laboratories is necessary. Also more analysis of the network of distribution and storage of organic wastes need to be given priority, including all available and potential links and locations without excluding any areas at the first assessment. The spatial and land planning implications are also of concern.
- There is a need to create a data base and model on biomass, which looks at the flow of waste generated by activity and location, the fraction recycled, the equivalent in terms of nutrient (carbon, nitrogen and phosphorous) as well as at the flow of goods and consumption patterns.

- There is a need to increase the knowledge about the safe use of compost and application methods, including the monitoring of pathogenic contamination due to the use of non-matured compost.
- Another area for research and development is the use of advanced tools such as GIS for waste management, urban agriculture and city planning.

6. Conclusions

Recycling of organic waste in urban farming is an effective approach to addressing urban waste management problems while providing important resources for agricultural production and making urban agriculture more sustainable.

Promoting the recycling of urban wastes should be combined with dealing with the prevention of associated health risks, especially by supervision of the sources of the organic wastes and the composting process.

Also attention should be given to the creation of more favourable attitudes towards reuse of wastes in agriculture among local authorities and institutions. This can be achieved by educating all actors involved, introducing changes in the urban planning system, diffusion of “best practices”, facilitating public-private dialogue and co-operation among others.

Urban agriculture and organic waste recycling should become an integral part of the management of the urban environment. The centralised approach to solid waste management needs to be revised in order to allow an integrated and participatory approach to solid waste management planning and urban agricultural production.

In order to effectuate a decentralisation in the planning and management of the urban wastes the community level needs to be supported by local authorities regarding the primary collection, the separation and the recycling of organic waste.

Since there is little economic incentive for households to practice thorough separation of household wastes, considerable education and monitoring is necessary to enhance the ecological motivation for separating organic wastes more carefully. The participation of the women is fundamental since they are highly motivated for the preservation of earth and land for the future generations.