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George Danso

The treadle pump is considered a 'new technology' in Ghana

Micro-Technologies for Urban Agriculture

Agriculture in the city has many faces. It is a dynamic phenomenon and comprises different farming systems, each with specific needs. This issue of the *UA-Magazine* features micro-technologies for urban agriculture. It presents a wide variety of techniques and discusses why and how these technologies were developed, the critical factors for their success and what policy improvements are needed for their further development.

Editorial

Some of the technologies presented have been developed specifically for the urban setting. Hydroponics or the Cuban 'organoponics' for example, will be familiar to many readers. Other practices such as those that make use of waste and wastewater treatment may not be so well known. The small-scale irrigation and composting practices discussed are quite similar to those used in rural settings.

DIFFERENCES IN URBAN AGRICULTURE

Agriculture in the city differs from that undertaken in the rural areas, in location, in economic motive, in type of product, in the use and distribution of harvests, in actors involved and in the types of technologies used.

Urban farming takes place in *locations* inside the cities or in the periurban areas, on the homestead (on-plot) or on land away from the residence (off-plot). It can include production *activities,* but also processing, distribution and sales. Most urban farmers are women from lower income groups who first take up farming to supplement family incomes. Urban *products* include different types of crops, trees or animals. Priority is given to crops such as vegetables, for which there is high demand and good market prices. Although a large proportion of the harvest is used for self-consumption, the surpluses can be traded. As shown in no. 7 of the *UA-Magazine,* the value of these enterprises should not be underestimated. The products can be sold at the farm gate, in the neighbourhood, in shops, farmers markets or even to supermarkets.

A big challenge for urban agriculture is high pressure on the land and insecurity of land tenure. Land and space for agriculture is limited, and when available, it can be contaminated or one has to compete with a multitude of other users. Another constraint is that labour costs are higher in cities, but this may be offset through increased opportunities to sell the output.

René van Veenhuizen
Editor

IWMI-Ghana

TECHNOLOGIES FOR URBAN AGRICULTURE

This issue of *UA-Magazine* discusses 26 experiences from all over the world. The articles emphasize how the technologies have been adapted to urban-specific situations and how continuous research and training are contributing to their widespread use.

In *UA-Magazine* issue no. 5 on Methodologies (December 2001), topic 4 on Technology Development stated that most urban farming systems were characterised by a low level of technology development. The rationale for this include a bias towards rural agriculture within the agricultural research and extension institutions, limited attention given to agriculture by urban authorities and the low participation of urban farmers in technology development.

Some of the articles in this issue indicate an increasing interest in agriculture by urban authorities and that research on suitable techniques has been commissioned see page 12 and 14 for examples from Asia. These and other articles call for more participation of the urban farmers in development and adaptation of technologies. It is important for urban authorities to promote these initiatives through supportive policies on access to land (which will be dealt with in the next issue) and credit (as was discussed in issue no. 9). It is also necessary for urban farmers to build associations and articulate their needs.

ADAPTING TO 'CITY LIMITS'

Urban agriculture, especially in the inner city is limited by the availability of space and often is practised on small pieces of land. Accordingly, several articles focus on growing crops in very small spaces and in areas where land is not fertile. The NGO "Hunger Grow Away" (page 26) has developed an Abundant Harvest Garden (AHG), which is a micro-intensive food production system that can grow the produce needs for a family of four on 1.44m^2. This technique is also applicable for temporal emergency situations like refugee camps. Hydroponics is another technology characterized by the absence of land. Two articles on page 8 and 9 describe the spread of hydroponics in Latin America. In Lima, Peru, the absence of soil of good quality makes hydroponics especially attractive. In Havana, Cuba, (see page 11), intensive production methods have been adapted, like hydroponics, zeoponics (on zeolite), and organoponics (on organic substrata), the latter being popular due to the lack of funds for the application of chemical nutrients. Agricultural land in the city is scarce but many houses have flat concrete roofs, which provide space for growing crops. Initiatives on rooftop gardening in Senegal and Russia are described on pages 16 and 17.

The agro-ecological setting in the city also gives rise to specific crop and seed requirements. Research in major cities in South East Asia, described on page 12, aims at improving the availability of vegetables during the dry seasons and to reduce vulnerability to pests. In Cagayan de Oro in the Philippines, research was conducted to adapt 'highland' temperate crops, originally not suited for the lowland urban conditions, thus increasing the availability of food within the city, see page 14. Urban growers are reported to prefer temperate crops for which there is more demand and better market prices. On page 22, the experience from Ethiopia illustrates the need to develop cheap, simple technologies that depend on local resources and produce a high-level of outputs in the smallest possible space. On page 24, similar practices in Botswana and Kenya are described. On page 25, permaculture is promoted as a viable option for urban agriculture because of its integrated approach and flexibility.

The lack of clean water may also limit urban agriculture and is a key determining factor in the development and use of technologies. The experience by IWMI in Ghana and Togo, described on page 6, indicates that both site-specific biophysical and socio-economic conditions are critical in the choice of irrigation practices. In South Africa, the Drum & Drip micro-irrigation system was introduced because it allowed for the use of grey water to grow vegetables in areas where the daily consumption of water could not be increased see page 4.

In cities, large amounts of organic wastes are available, and the composting of these materials is an excellent solution for waste disposal, increasing soil substitutes and closing the nutrient loop. The articles on Uruguay, page 40, Ghana, page 30 and Ethiopia, page 13 describe simple, small-scale techniques for making the best use of urban waste. Composting domestic waste for use in urban agriculture is one strategy that can be adopted at the household level. On page 29, the experience from Mexico describes the use of human urine in this process, while on page 32, the article from Tamale, Ghana, illustrates how farmers are requesting that the faecal sludge from the city is applied on their lands during the dry season. These farmers have developed special treatment for the sludge, which is later incorporated into the soil at the start of the farming season. The article on page 34 shows that urban agricultural activities using biogas improves food security, increases income and converts wastes - excreta, wastewater and organic solid wastes – to energy. The residue sludge can be used for soil improvement, feeding fish, finless eels, earthworms, silkworms, and pigs. Biogas can used as fuel for burning lanterns, for cooking in domestic stoves and for generating electricity.

The article from Kolkata, India, on page 36, provides a good example of a closed loop agro-industrial ecology, there the wastes from one process is used as a resource for another. The examples of

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Russia, page 17, the USA and Australia, page 27 and 28, describe initiatives to develop integrated systems of production, consumption and processing.

LABOUR

Contrary to rural farmers, urban farmers most often combine farming with several other economic activities. Time and labour are therefore key concerns. In the article from Vietnam on page 38, farmers and their stakeholders are reported to have identified limited space, labour, and environmental pollution as the key constraints for the developing of their village level food processing enterprise. A combination of land availability and labour for fetching water determines the use of irrigation technologies in Ghana and Togo, as discussed on page 6. The experience from India on page 18, illustrates a gardening technology developed from the need to divide labour across several activities. From another perspective, the Montevideo farmers story suggests that farmers deliberately moved to the city because the inputs they need are more abundant there, see page 40.

THE ROLE OF WOMEN

Urban dynamics and the market economy assign different gender roles and responsibilities to women and men. Many urban women turn to agriculture to ensure food security and to supplement income. On page 20, the experience from Uganda describes mushroom farming as a new trend among urban women farmers. Women have little access and control over land in Uganda and the mushroom cultivation can be done in the home or on the plot, and combined with household work. On page 16, the Senegal experience mentions that women's groups have established rooftop gardening projects in Dakar and Thies.

SUPPORTING URBAN AGRICULTURE

Clearly, the case for and the concerns surrounding agriculture in urban areas is very different from rural agriculture. As discussed in the *UA-Magazine* no. 5, the participation of the farmers and other stakeholders in the selection and continuous development of technologies is critical. Local farmers will provide the inherent (indigenous) knowledge of local conditions that is essential for creative problem solving. The articles from Asia on pages 12, 14 and 38 highlight this.

Urban farmers require more specific services than the present day, formal systems can offer. For example, priorities for research on urban farming in the Philippines include improved vegetable varieties (higher nutrition values and longer shelve life); technologies for composting biodegradable city wastes; integrated crop management, intercropping technologies and soil mulch for weed control; and efficient and economic irrigation systems and safe use of waste water. The article on page 30 highlights how the implementation of backyard composting programmes still require substantial training, with local farmers participating in all stages of the planning and implementation process. On page 24, the experience from Botswana shows that agriculture needs to be incorporated into urban planning, and that urban planners need to be educated on its feasibility and benefits.

Urban agriculture is increasingly recognised as a vehicle for the development of productive and sustainable cities. It is heartening to note that several cities have created specific agencies for urban agriculture or are implementing related policies and programmes. For example, the Government of Ethiopia had begun to promote urban agriculture and has included it in the research agenda of the Ethiopian Agricultural Research Organization (EARO), in the teaching agenda of Addis Ababa University, and in the development agenda of GOs, NGOs and CBOs in Ethiopia. In Havana, the agriculture, physical planning, water resources and other provincial offices have worked together in the selection of locations and assembly of organoponic units. They have also developed the necessary irrigation and pest control systems and ensured an adequate management of the substratum. In most cities, however, such initiatives are yet to be developed. It is hoped that this issue of the *UA-Magazine* will encourage stakeholders, including governments, research institutes, NGOs, and farmers, to work together in developing and implementing similar urban agricultural initiatives which will make cities cleaner, safer and more healthier places to live in.

In this issue

The 'Drum and Drip' Micro-irrigation System, Tested in South Africa

Farming is a widespread phenomenon in many poor informal urban settlements found on the periphery of South Africa's cities. Meadows (2000) reported a rate of 35 % families in the Cape Flats near Cape Town, and Maswikaneng et al. (2002) a rate of 54 % in Atteridgeville near Pretoria. At both these places, urban farming was done mainly by women and involved, for the most part, the growing of crops and vegetables in home gardens of less than 10 m^2. The farming of open urban spaces and the use of collective approaches to agriculture in the form of community gardens, had also commenced. Many NGOs and welfare organisations in South Africa recognise the importance of small-scale urban agriculture, but town planners and policy makers tend to ignore it (Martin, Oudwater & Meadows, 2000). The main benefit of urban farming for the poor of South Africa, is better nutrition. In recent times, the importance of a balanced and nutritionally adequate diet has become even more critical due to the impact of HIV/AIDS.

I cannot irrigate with water in which I washed dirty clothes

South Africa is a dry country where vegetable production is difficult, unless irrigation is available. Re-using domestic water may help to address water shortages as long as contact between untreated wastewater and the leafy part of the vegetables is avoided. Suitable methods of applying wastewater to crops include subsurface irrigation and micro-irrigation in the form of drip (Drechsel, Blumenthal & Keraita, 2002), which is known to be efficient, because water is delivered directly to the part of the soil where the bulk of the crop roots are situated (Du Plessis & Van Der Stoep, 2001).

THE DRUM AND DRIP MICRO-IRRIGATION SYSTEM

Gerrie Albertse of Farming Systems Consulting Services in Stellenbosch adapted a low-cost drip irrigation system developed by International Development Enterprises to suit South African smallholder conditions. This adaptation, called the Drum and Drip micro-irrigation system, consists of a 210 litre drum, which is connected via a tap to a set of five polyethylene dripper lines, each with a length of 6 m (see Fig. 1). The drippers are constructed by perforating the polyethylene pipe with a heated nail. A piece of string is threaded through these perforations by means of a bag-needle. Knots on both ends of the string prevent it from slipping out of the pipe. When the perforations get clogged, pulling the string from side to side usually unblocks the openings. Clogging of the drippers is reduced by placing a stone and sand filter at the bottom of the drum. This prevents coarse particles, which may be present in the irrigation water, from entering the pipes and blocking the drippers.

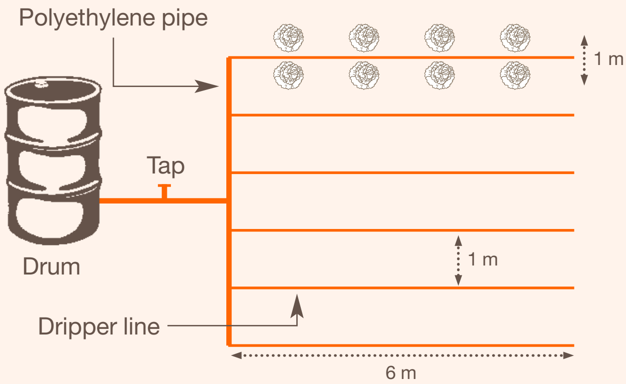

FIGURE 1: The Drum and Drip micro-irrigation system

The Drum & Drip system irrigates an area of 6 m x 6 m = 36 m^2. According to the designer, the system enables production of about 60 kg of fresh vegetables every four months. This requires the application of 600 litres of water per week, which is equal to three full drums. In 2003, the cost of the components needed to construct the Drum & Drip micro-irrigation system was about R150.00 (US$20.00).

Van Averbeke

A garden equipped with the Drum and Drip micro-irrigation system

ON-FARM ASSESSMENT OF THE SYSTEM

The Drum and Drip micro-irrigation system was introduced in Sekuruwe and Ga-Molekane, two settlements north of Mokopane (Potgietersrust) in the Limpopo Province of South Africa. The objective was to lower the high rate (19 %) of chronic malnutrition among the local children (Kleynhans & Albertse, 2000). Research into the diets of the children and their caregivers showed that a lack of fruit and vegetables was the most probable cause for the high rate of child malnutrition. Widespread poverty prevented people from purchasing fruit and vegetables, and a chronic lack of water prevented them from growing their own. The Drum & Drip micro-irrigation system was introduced because it allowed for the use of grey water to grow vegetables. By reusing water

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Overall the intervention had a positive effect

from kitchens or bathrooms for irrigation, the participants do not have to increase their total daily consumption of water. In the two settlements this was a critical issue, access to water was very difficult.

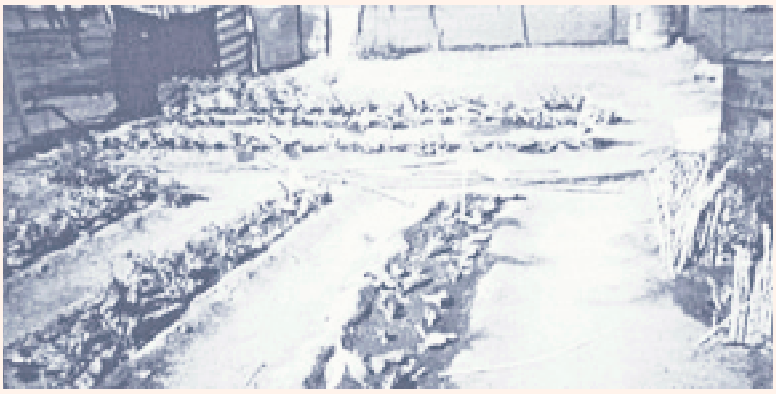
The Drum & Drip system was installed in the home gardens of ten female volunteers. The women were supplied with fertilizers and vegetables seedlings to start their gardens, and obtained basic training in the operation of the system and the growing of vegetables. Their experiences with irrigated vegetable production were monitored over a period of one year.

The women used water from various sources to irrigate their gardens. Grey water only constituted 26 % of the total amount of irrigation water that was applied. The rest came from other sources. Women who had boreholes in their gardens preferred the hard work of hand-pumping water to the use of recycled water. The others irrigated with recycled water, but diluted it with water from a far-away spring or river before use. Invariably the women had serious hygiene concerns about using grey water to irrigate vegetables. *"I cannot take water in which I washed dirty clothes and use it to irrigate vegetables that I will eat"*. Women also complained that recycled water had a negative effect on their soils. *"The soap in the water makes my soil dry and white. When I irrigate now, the water no longer penetrates the soil"*. After about seven months the drippers started to clog more frequently than before. This resulted in uneven water distribution. The clogging was found to be the result of salt accumulation near the perforations, and pulling the string from side to side was no longer effective. *"I have stopped using the irrigation system. It was not irrigating evenly because of blockages. As a result some of my plants were not getting any water.* The electrical conductivity of the different waters available in the area showed that they all presented a high salinity hazard (EC > 130 mSm^{-1}). The high salt content of the water even affected the lifespan of the drum. Rusting of the metal around the tap resulted in leaks, causing people to abandon use of the system. *"The drum is leaking. We do not know how to seal it. That is the reason why we have removed the pipes (dripper lines)"*. This particular problem could probably have been avoided by rustproofing the exposed metal after cutting the opening in the drum to insert the tap.

After about two years of use, the drums started to leak because rust had destroyed the metal where a hole had been drilled to insert the outlet

During the first season, the participants obtained high yields from their gardens, on average about 77 kg of vegetables. The second time, the yield dropped to an average of 45 kg, because of low nutrient supply and damage to crops by livestock. The low rate of nutrient supply used by participants arose from their experience with dryland cropping, in which the application rates they used are considered adequate. Livestock damage resulted from the lack of secure fences around the home gardens. To goats and poultry the lush green vegetables represented an irresistible attraction and without a secure fence, damage to the crops was unavoidable.

This on-farm study showed that the introduction of vegetable production, based on the use of recycled water that was applied by means of a small-scale micro-irrigation system, was not an unqualified success. Users considered recycled water to be unhygienic, and could not be convinced otherwise. The Drum & Drip micro-irrigation system had difficulties in dealing with saline water, resulting in frequent clogging of the drippers and rusting of the drum. The problem of rusting could be prevented by rust-proofing exposed metal parts. The clogging of drippers by salt deposits could be addressed by flushing the system with clean water. Sufficient quantities of clean water could be obtained by harvesting rainwater from roofs. Overall the intervention had a positive effect. Even when participants decided to discontinue their use of the Drum & Drip system they usually continued growing irrigated vegetables, pouring buckets of water in the short-furrows constructed between the rows of crops. In communities where nutrient deficiencies caused by a lack of vegetables are a chronic problem, this is definitely a desirable outcome.



A garden with the drum and drip micro-irrigation removed

Urban and periurban vegetable farmers in Ghana and Togo try to crop as close as possible to the markets of their perishable produce. They accept a large variety of site conditions, including marginal urban soils or sandy beaches, as long as there is a reliable water source within appropriate distance. The water sources can be 0.5 to 1,5 metre wells, 2 to 7 metre hand-dug wells, streams, rivers, or even an urban drain. The water source determines, in part, the water lifting as well as irrigation methods used. The most common irrigation methods are watering cans, buckets, treadle and motor pumps.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The treadle pump is considered a 'new technology' in Ghana

Urban Irrigation Methods and Practices in Ghana and Togo

The use of ***Watering cans*** is the predominant informal irrigation method used in the vegetable farms of Ghana and Togo, with farmers using the cans to carry water from the source to their crops. The method is arduous as the walking distance is usually around 100 metres and one watering can has a volume of about 15 litres. As a result, men who can carry two cans at a time, usually do the watering.

Buckets are used to fetch and carry water from the source to the field, where it can be used immediately or stored in drums to be used later. This practice, commonly observed around Kumasi, mostly involves women and children carrying buckets as 'head loads'. Men usually do the watering using smaller buckets or bowls. The method could have a cultural connotation, in that in most African settings, fetching of water and transport as a 'head load' is traditionally feminine. Farms using buckets are located around 200 metres away from water source, (as opposed to the 100 metre distance when cans are used). Buckets are also used for lifting water from wells and to apply water extracted by a treadle pump.

Though the **treadle pump** (TP) is considered a 'new technology' in Ghana, it has been used in Togo, Benin and other countries, in both urban and rural settings, for a number of years. Farmers often see it as a stepping-stone for acquiring a motorised pump. The TP essentially is a water-lifting device, though in some cases, it can be connected to hosepipes or even sprinklers for irrigation. In most cases two people are needed; one pedalling the TP and the other irrigating.

Motorized pumps are being used in some farming sites, often where farmers are wealthier and the water table is deep. In periurban Kumasi, the fields are often adjacent to the water sources and the pipes, as much as 300 metres in length, are laid across the fields. As the pipes are often in poor condition, leakages and flooding are common occurrences. More than one farmer has to be involved to watch the pump and to hold and carry the pipe or hose.

Electric pumps are used by a few wealthier vegetable farmers in Lome, Togo, but rarely in Ghana. In Lome, motor pumps are also used to fill reservoirs or a connected chain of reservoirs, from where watering cans are used to irrigate (hence reducing the distance for carrying water). The pumps are connected straight to water hoses (single or double hose system), a practice which is hardly observed in urban Ghana.

TECHNOLOGY COSTS

Table 1 provides comparative information on the cost of irrigation technologies. The data was obtained through a rapid assessment done in urban farming sites in Lome, in 2002.

COPING WITH CROP WATER DEMANDS

Vegetables, which are the most commonly grown crops in irrigated agriculture in the study area, have higher and more regular water requirements than more traditional crops like yams, cassava, etc. As extension services for urban farmers are often limited, they have learnt, over time, when and how much water to apply to their crops.

Seventy urban farmers in Kumasi were asked "how do you know the amount of water to apply?" While most urban farmers said they depended on their 'hands-on-experience', most periurban farmers used the soil and status of vegetable leaves as indicators. Generally, most farmers irrigate in the mornings and evenings, saying that at these times "*it is cooler and therefore easier to carry the water-load,*" which corresponds well with the times when evapotranspiration is at its lowest. This watering schedule is also convenient as most farmers work at other jobs during the day.

Not all farmers can afford to buy irrigation equipment like motorized pumps. However, there is often the possibility to hire a pump inexpensively. In Kumasi, for example, most farmers only pay for the fuel of a motor pump available locally. Where farmers are required to pay more than this, the fee is still reasonable, and can be settled after

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selling the harvest or by providing labour for the pump owner. Some farming sites have set up farmers' associations to provide for the exchange labour and irrigation equipment.

When monitoring water efficiency in and around Kumasi, farms in urban areas showed a tendency to over-irrigate by one-third of the water requirement, while farms in periurban areas tended to under-irrigate by the same amount.

Urban farms are, on average, one-seventh the size of periurban ones, and farmers of these smaller areas predominantly use watering cans for irrigation. Periurban farmers mainly use buckets and motor pumps connected to water hoses. The urban farmers achieve a more regular and a more spatially uniform distribution of water, which is greatly facilitated by the use of the watering cans. The periurban farmers have irregular irrigation intervals and poorer water distribution, especially those using hosepipes. As only few periurban farmers own a pump, most farmers need to queue for long periods before they can hire a pump. Subsequently, it is quite common that these farmers apply larger volumes of water, as there is no certainty on when next they will have access to the pump.

DIVERGENCE IN IRRIGATION TECHNOLOGIES

Why are pumps and water hoses used more extensively in Lome, Togo, than in Accra or Kumasi in Ghana? After all, the farmers in Ghana are the first to recognise that their methods are more labour intensive. The answer lies not only in the differences in capital and maintenance costs (listed in Table 1).

A financial comparison showed that the profit margins of open-space vegetable farmers in both countries are similar, although higher amounts are more frequent in Lome, where export crops are also produced (e.g. Basil for Europe). In Lome, even though most farms are located along the ocean on poor beach sands, the Lome city authorities accepts the farmers and allows larger fields than in Accra. These small economics of scale favour investments in labour saving technologies. In addition, water-lifting devices are necessary in Lome, as groundwater is the only acceptable water source along the ocean.

In Accra, on the other hand, farms located along streams and drains, and the transport distance for the watering can is usually short enough to favour labour over capital input. Moreover, watering cans allow more flexibility, one-man-usage, and are less sensitive to bad water quality and solids, which could block any pipe or hose. These are also good enough reasons for farmers to avoid investing in pumps.

There are also differences in the availability and promotion of pumps and hoses between Francophone Togo and Anglophone Ghana. EnterpriseWorks, for example, started their promotion of treadle pumps in most Francophone countries of West Africa between 1995 and 1999, while corresponding activities in Ghana only started in 2002.

CONCLUSION

This study highlights that when selecting technologies, the consideration of site specific biophysical and socio-economic conditions are critical. While pumps are more viable in Lome, shallow wells and watering cans are considered to be more appropriate in Kumasi's inland valleys. The demand for pumps might, however, rise on upland sites, as well as in Accra, where farms are larger and the water sources are not always located close to farms. Pumps may also be tried where groundwater is available between 1 and 7 meters, or the walking distance between the field and water source is larger than 50 to 100 metres. If the pump is not mobile, the farm site needs more facilities to secure the pump overnight (as farmers may be living at a distance from their fields). Wherever there is better water quality than in drains, low-cost drip irrigation technologies like bucket-kits and drum-kits could be tested. State and local governments are encouraged to give special support to irrigation technologies that bring the added benefits of lowered health risks associated with the use of polluted water.

Small economics of scale favour investments in labour saving technologies

Table 1. Input requirement of different irrigation technologies used in Lome

Irrigation technology	Watering cans	Treadle Pumps	Motor pumps	Electric pumps
Farm Size (m²)	80-250	200-500	1,000-3,000	4,000-12,000
No. of hired labourers	0-1	1-2	4-6	8-12
Initial Cost (CFA 1)	Negligible	70,000-80,000	New: 250,000-400,000 Used: 150,000-200,000 Hiring/month: 4,000-6,000	New: 200,000-300,000
Fuel/electricity (CFA/month)	0	0	12,000-16,000	30,000-80,000
Maintenance (CFA/month)	0	500	500	500
Costs for accessories (CFA/month)	0	80,000	200,000	500,000

Source: Danso *et al.*, unpublished

1 US$ is approx. 650 CFA

Parcel of hydroponics on the roof of a house


Imagen Educativa

Since the mid 80s, the UNDP -soon followed by FAO- began fostering the development and use of Household Hydroponics. This mainly urban agricultural technique is a fast and efficient alternative to address the lack of food and the lack of income of many impoverished households.

Hydroponics in Latin America

In household hydroponics, the key is not to increase the yield per hectare, but to produce small amounts of food in many houses, in spaces unsuitable for conventional agriculture. The project started in Colombia, but reached more than 20 countries. In this development, the support of regional institutions, mayor's offices, non-governmental organizations, professionals, technicians and independent persons was essential. The initial goal of the project was to teach how to grow, prepare and consume legumes in the small housing spaces of poor residents in order to improve the household diet. Afterwards we saw that the high yield obtained generated surpluses that could be sold as a source of additional income.


Imagen Educativa

Pyramid System

However, as the project developed we saw that it has more benefits in almost all the places where the project has been implemented. The main value of the project is that it generated a new attitude among the poor on socio-productive activities that can be developed at home or the neighbourhood, with the involvement of the members of the family group, in an economical, fast and effective way.

More recently, the implementation of the project in the coffee-growing region of Colombia has given rise to many requests for technical assistance from other departments of the country affected by violence, and from other countries around the world (Curacao, Egypt, Mexico and Panama).

The yields obtained using simple hydroponics proved to be higher than those obtained on the traditional soil system. In some cases, yields double, triple and even quadruple when full recommendations are followed and environmental and health conditions are adequately managed. The period between planting and harvesting is cut down (mainly with transplanted species) and planting can be done during every month of the year, because it does not depend on ideal weather conditions. As a result, one can obtain between 7 and 11 harvests per year with the species that have turned out to be more profitable. These are the leafy vegetables (broad-leaf basil, celery, watercress, lettuce, endive, spinach), but also a greater number of harvests can be obtained per year with species that grow slower and have longer productive cycles and that are part of the basic food basket, for example pepper (green chilli), hot pepper, onion, sweet peas, and tomatoes.

In addition the socio-economic benefits are worth noting, as farmers need not take money from their precarious household budget to buy legumes that are essential for adequate human nutrition, especially for children and the elderly. Better nourished mothers and children mean improved performance in learning at all levels, which contributes in a significant way to the development of the population in general.

A hydroponic garden can produce an average of 4.3kg of over 15 species of legumes per m^2. If a household cultivates 10 m^2 in one year (some producers already have production areas that exceed 60 m2), it could produce 431 kg of fresh and clean legumes. If the goal of training 0.2 % of the population of a country (with 6 million inhabitants, for example) is reached, 12,000 households could produce 11,400,000 lb. of legumes that could be eaten by producers and neighbours who eat small amounts of this type of food. The production, sold at an average price of US$ 0.50 per 0.45kg, would represent a production value of US$ 5,700,000. This is an excellent contribution to improve the socio-economic situation of any country.

This technique is contributing to the achievement of the national goals and those of individuals willing to improve the supply of healthy and fresh food, or to start micro businesses that strengthen the economy of the household and the community.


Imagen Educativa

Planting in a sponge

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Hydroponics Technology in Urban Lima – Peru

Simple hydroponics at a school in Peru

Hydroponics is a technology characterized by the absence of soil, allowing the growing of crops of better quality in small urban spaces, requiring less time, less labour, and less inputs. It uses containers, in some cases under direct irrigation with water enriched with nutritive solutions, and in others, with irrigation through substrata that also serves to fix roots, provide adequate humidity and meet the oxygen requirements for specific crops. Results are spectacular, both in terms of yields and low-cost of inputs.

Hydroponics for the poorer segment of the population is based on the following concept: "It allows the production of fresh, healthy and abundant legumes with low water consumption and less physical work, but with a lot of dedication and perseverance, in small spaces at home, in many cases taking advantage of waste elements. This urban agriculture technology gives a productive use to some of the idle time of family members The potential productivity of hydroponic crops when developed in optimal conditions is greater than the productivity generated by traditional garden cultivation systems" (La Huerta Hidroponica Popular", Technical Manual, FAO).

In Lima, Peru, the NGO Imagen Educativa began working in 1993 to promote urban agriculture as a strategy to improve nutrition, family income and environment quality. The focus is on hydroponics as it is the most suitable technology for educational, household and commercial practices. It implies the growth of legumes, ornamental, aromatic and medicinal plants in the peripheral areas of Lima, where it is difficult to farms due to poor soil conditions and lack of water for irrigation.

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THE PROJECT

Seeking to improve the food security of the low-income population living in the peripheral areas of Lima, 3 strategies were used: school and household hydroponic gardens for self-consumption, commercial household hydroponic gardens, and the constitution of a virtual enterprise for the commercialisation of hydroponic produce.

The idea behind the establishment of **hydroponic gardens in primary and secondary schools**, was to include hydroponics in national educational curricular. This would enable the transfer of technology and enable these systems to contribute to the academic programme on biology, physics, chemistry, mathematics and ecology. The produce from the gardens will also improve the nutrition of students, who could be encouraged to replicate the technology at home.

A large variety of crops can be grown on a small parcel

With this objective, more than 200 teachers were trained in the hydroponics technology and in the development of projects for school hydroponic gardens. The trainees established hydroponics gardens in 42 schools in several districts of Metropolitan Lima. The crops included legumes, aromatic and medicinal herbs and, to a lesser extent, fodder to feed Guinea pigs. The produce is freely distributed among the students who work in the gardens and in rare cases it is sold to parents. The dissemination and promotion of this experience has led the government to include it as an option in the school curricular.

The implementation of **household hydroponic gardens** for self-consumption was another strategy used to improve household food security. This project was carried out in Marcavilca and Armatambo, two marginal human settlements in the district of Chorrillos, Lima-Peru. These marginal settlements are characterized by the lack of farmland, public or household gardens and by a large concentration of substandard, unfinished houses, built using recycled materials, over 40 to 50 years. The project sought to transfer hydroponics technologies to farm food for household consumption and eventually for sale.

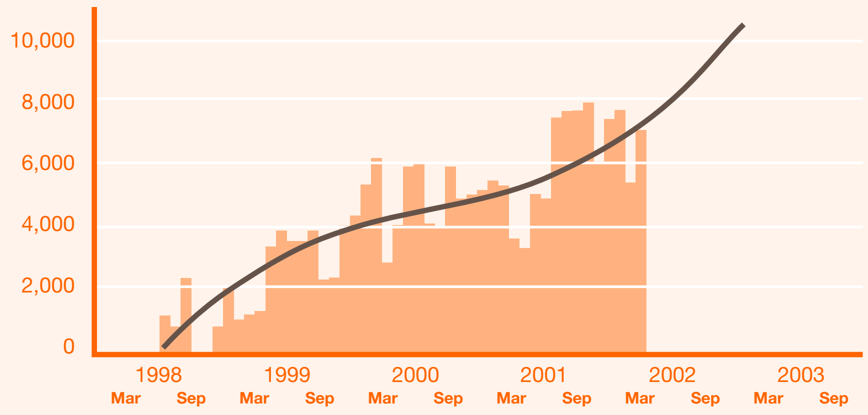

Figure 1: Sales of lettuce bags

Three demonstration hydroponic gardens were set up, which served as a tool to train more than 100 households. Sixty percent of those trained were women. This lead to the establishment of 43 household hydroponic gardens for self-consumption, all of them located on rooftops. Their produce improved household nutrition and reduce expenses, as less money was needed to buy food.
In view of generating income, **market-oriented household gardens** were developed in the human settlement of Delicias de Villa, in the district of Chorrillos, Metropolitan Lima, employing idle household labour and using unproductive spaces (rooftops and backyards) owned by the participants. In total, 18 lots were financed by the project and an additional 8 were self-financed by the participants. After 3 years, further development and extention of the project took place through a revolving fund, called Household Hydroponics Fund (FONHIDROF). This fund was a donation from the financial entity that co-operated with the initial project. It allowed the NGO that promoted and executed the project to administer two funds: one for investment and capital for household gardens; and another for investment and capital for the virtual marketing company.

Imagen Educativa

The surplus can be sold at good prices at city markets

Although household hydroponic micro-enterprises were not efficiently managed, they generated earnings through the sale of their products, well beyond the average income of international social projects. Average earnings per 40 day campaign were $116 per garden, with two hours of work per day, generating $ 87 a month. This improved income is significant, given the level of poverty of the participants, whose minimum monthly household income, for the most part did not exceed $ 116 at the onset of the project. If participants increased their production area to up to three times their current size, as several of them have already done, their income increases to a monthly average of $ 261, working full time.

In seeking a strategy that closes the production and sale cycle, an initiative to sell the produce of commercial hydroponic gardens, the Popular Virtual Company for the Commercialisation of Hydroponic Produce was established, Following a non-traditional business model, the company is a holistic combination of producers, consumers and the promotion agency. Producers participate as privileged suppliers within a scheme that is similar to a franchise; they have become micro-entrepreneurs, have access to credits and ensure their own progress.

Sales during the first 4 years of operations, between September 1998 and December 2002, and those projected until August 2003, are shown in Figure 1.

To date, the produce has been sold in Wong, one of the largest supermarket chains of Peru. Also, in March 2000 a new chain of popular supermarkets, called Metro, began operating in urban and periurban areas. Fluctuations in production and sales reveal a lack of regularity that could be explained by seasonal conditions (see in Graph 2), as well as other difficulties. There has always been permanent shortfall in supply and delivery.

In both chains, the demand is only partially met. The main problems that have affected the supply are related to availability and access to products.
Concerning the accessibility of products by customers, the main factors that influence the levels of sales in each store, in order of importance, are: the existence and location of exhibition displays, preservation of product quality in displays, demonstration and promotion of products through sales promoters, and advertising through brochures.

Imagen Educative organised an electronic conference on the subject of urban agriculture in April. The three main topics for discussion were: Food Security, Hydroponics, and Sustainable Urban Agriculture Development Projects.
You can read more on this (in Spanish) at www.imageneducativa.org

ORGANOPONICS, a productive option

Productive urban techniques are valid as long as they are adequately adapted to the physical urban setting, and as long as the expected productive results are obtained. Several initiatives have developed productive solutions for places where the land is not fertile, or where space restrictions make it necessary to exploit the available resources to the maximum. One of the most innovative technical and productive solutions developed in Havana is called 'Organoponics'.

Mario Gonzalez

Organoponics in Cuba

Urban Agriculture is highly heterogeneous, with respect to the places and people that practice it, and with respect to the technologies used. In Havana, several intensive production methods have been developed or adapted. These are substratum hydroponics (on water and an inert substratum), zeoponics (on zeolite) and organoponics (on organic substrata). Due to funding limitations for the application of chemical nutrients, many facilities that relied on chemical inputs gradually converted to organoponics.

The organoponics technique consists of creating furrows in soils with a low fertility and protecting them with different materials, these spaces are then used as "nurseries". A wide range of materials can be used, including wood, stone, or concrete slabs.

In cases where the soil fertility is poor, this technique allows to gradually create soil by applying organic matter. This allows for a more intensive exploitation, since this technique prevents the loss of the substratum due to rainfall or water flow. It can be applied to flat areas, but also to slopes, by constructing terraces. The use of localized irrigation systems is recommended in organoponic gardens, because their construction facilitates the maximum use of humidity.

Generally on Organoponics, legumes are can be grown intensively, due to the advantages obtained by the improved use of organic matter, and because of the possibility to grow these crops at distances close to where consumers live and work, thus offering fresh and newly harvested legumes. Certain crops are rarely produced on organoponics.

This method is similar to the production in traditional gardens, but because crops are placed in low-fertility soils, beds must be built and they must be protected like in "nurseries", adding a substratum made by mixing soil with different sources of organic matter. This allows preparing the soil for the selected crop. The variety offering the best yield for the season is used, crops are rotated and interspersed; adequate irrigation, integrated pest and disease management and systematic use of organic matter in beds allow the preservation of soil fertility.

Organoponics humanize farm work, by tracing furrows and paths. Likewise, if nematodes or fungi affect the soil, it is possible to change the entire substratum. It also allows making specific mixtures, obtaining the desired soil for certain crops.

In many cases, the gardens have been developed in such a way as merge with the urban environment where they are located. Their presence, far from being obtrusive, blends well the urban environment surrounding it.

Given the advantages of organoponics, concerning location, assembly and disassembly, we have been able to relocate complete production units, or develop organoponic systems on the foundations of unused building sites.

In Havana, the agriculture, physical planning, water resources and other provincial offices have work together in the selection of locations and assembly of organoponic units, measuring approximately 10,000 m^2 each. They have also developed the necessary irrigation systems, pest control systems and ensured an adequate management of the substratum. Today, the city has 19 units, called High-Yield Organoponics. Havana has nearly 200 organoponic gardens, a valuable option that can be replicated for the production of food and especially legumes in an intensive and organic way.

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Tomato seedlings for the dry and humid season, in Vientiane

The SUSPER project aims to increase the contribution of periurban agriculture to food security in the major cities of southeastern Asia (Hanoi, Ho Chi Minh City, Phnom Penh, Vientiane). This research effort is based on a multidisciplinary approach, involving social and agronomic views on the production, marketing and consumption of periurban produce.

Improving Techniques for Periurban Vegetable Production in South East Asia

The project's national partners are (i) in Vietnam, Dr Tran Van Lai, *Research Institute of Fruit of Vegetable*; (ii) in Laos, Mr. Kham Sanatem, Agriculture Department of the Forest and Agriculture Ministry; (iii) in Cambodia, Mr. Phat Leng, Agro-industry Department of the Agriculture, Forest and Fishery Ministry. Two international research centres are also participating in the project: CIRAD (Centre for International Cooperation on Agronomic Research and Development) and AVRDC (Asian Vegetable Research and Development Centre). Actions are undertaken in two targeted sectors: periurban vegetable production and fresh water fish farming. In these sectors, two aspects are addressed: the quality of the produce from periurban agriculture and the regularity of the urban market's supply.

FARMERS AND INTERVENTION ZONES

The project is concentrated on urban areas where vegetable gardens already supply produce to the cities' markets (table 1). In Hanoi, the farmers are periurban producers using an acreage ranging from 400 to 3,000 m². But for certain vegetables such as tomato, market surveys revealed that periurban production could not supply the market during certain periods of the year: three months for Hanoi (July to September), seven months for Vientiane (May to November), seven months for Phnom Penh (October-April). We have therefore chosen to develop these tomato crops during these periods, i.e. the hot and humid season. During this season, the minimal temperatures exceed 24°C on average, while the monthly rainfall exceeds 100 mm. Furthermore, the analyses carried out in the course of the different studies showed high pesticide residues in several samples, especially greens used in the daily diet of the population. .

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TECHNIQUES PROPOSED FOR MARKET GARDENERS

In order to ensure a year-round production, the sheltered crops technique is proposed to protect the crops from rain damage. For the production of tomatoes during this season, it has been recommended to graft varieties adapted to the heat, on some rootstocks resistant to various soil-borne pathogens such as Fusarium wilt or Bacterial wilt, caused by the *Ralstonia solanacearum* bacteria. These rootstocks could be tomatoes (Hawaii 7996) or eggplant. The EG 203 eggplant rootstock selected by AVRDC is particularly recommended in case of temporary flood risks. To protect the leafy vegetable crops, mainly crucifer, from insect attacks, farmers are advised to place tunnels of nylon nets with 500-micron stitches (or 32 mesh). The mesh is small enough to keep the diamond back moth (*Plutella xylostella*); a chemical treatment might be applied under the net if needed. For maximum efficiency, the net should not have any holes. To combat the stripe flea beetle (*Phyllotreta striollata*), the soil should be flooded 48 hours beforehand, which would kill all the pupae in the soil.

SHELTERED OFF-SEASON TOMATO PRODUCTION

Experimentation stations were set up in Hanoi, Phnom Penh and Vientiane, which consisted of:

- Shelters with a framework in galvanised or painted iron, and a transparent polythene film cover resistant to ultraviolet rays (150-200 micron thick). The shelters are widely opened on the sides and at the ends. The shelter is 4.8-metre wide under the peaked roof, and 24-metre long for the experiment shelters.
- A simple grafting chamber (15 m²)
- A nursery (17.5 m²)

In Hanoi and Vientiane, tests carried out during the 2002 raining season compared varieties of tomatoes grafted on two rootstocks – tomato (Hawaii 7996 cv.) and aubergine (EG 203 cv.) – with the same varieties but non-grafted, as well as with field-grown and the sheltered crops.

In Hanoi, the first tomato test was sowed on 21 May 2002 and transplanted on 26 June 2002. The harvest started on 21 August to end on 3 October 2002. Four heat-resistant varieties were used as grafts: CHT 501 (small fruits: 25-35 g / fruit), CLN 2026D (small to medium size fruits: 45-65 g / fruit), CLN 5915 (small to medium size fruits: 50-60 g / fruit), VL 2000 (big fruits: 100-150 g / fruit). The rate of success of the tomato grafting (50% to 78%) is lower than that of the aubergine grafting (92% to 95%). There was a slight increase in the overall sheltered crop production compared to the field-grown crops by 16 percent. A few non-grafted plants died of bacterial wilt.

In the second tomato test in Hanoi, harvested from 13 September 2002 to October 31, 2002, it was not possible to notice significant effects of the shelters and rootstocks on the overall production

The author would like to thank the French Foreign Ministry, which is the main donor of this three-year project (2002-2004). Our thanks also go to the Strategic Initiative on Urban and Periurban Agriculture co-ordinated by the CIP for its financial contribution to the works on the use of pesticides by farmers in Hanoi.

for the different rootstock/graft combinations (cvs. HS 902, VL 2000, CHT 501). However, the marketable yield appeared higher in the sheltered crops. For the two species of medium size fruits (HS 902, VL 2000), a rise in the marketable yield was recorded thanks to the field-grown aubergine grafting (13.6 t/ha against 10.00 t/ha ; 12.88 t/ha against 9.61 t/ha respectively).

In Vientiane, the varieties used as grafts were CHT 501, SIDA and SR 382. The young plants were transplanted on 7 July 2002. All the field-grown non-grafted tomato plants died before harvest, probably due to bacterial wilt, while the plants grafted on aubergine and tomato produced satisfactory yields.

An evolution was noted from June to October as to the sheltered cucumber, yard long (asparagus) bean, sweet (green) pepper, and mini-cabbage crops, compared with the field-grown crops. No difference was noted for the yard long bean. The sheltered crops of cucumber (25.3 vs. 19.4 t/ha), sweet pepper (8.4 vs. 1.3 t/ha) and mini-cabbage (14.9 vs. 10.5 t/ha) produced higher yields. This was due to higher resistance to diseases, which reduced plantation densities and the number and size of the fruits.

PRODUCTION OF SAFE VEGETABLES IN HANOI AND PHNOM PENH

In Hanoi, a vegetable production programme was launched in 1996. At present, 776 ha are cultivated with 40 species. Three cropping patterns proposed: water culture, sheltered and field-grown crops. All the market garden produce is expected to show lower than maximum residue levels of pesticides, micro-organisms, heavy metals and nitrates. However, it is very difficult to convince consumers that the produce is safe for consumption.

In Hanoi, it has been suggested to simultaneously compare the results of the different techniques of integrated pest management and control the quality of the produce through analyses. The first tests began by comparing the use of the nylon nets and the chemical control on amaranth and choysum crops during the hot season. With the sheltered crops, fewer plants were damaged by insects compared to the field-grown crops on which several insecticide treatments were used. Concerning the amaranth, the marketable yields have risen from 4.2 and 8.7 t/ha without the net, to 19.1 and 18.0 t/ha with the net, without and with respective insecticide application. For the choysum (*Brassica rapa cvg. Choysum*), the marketable yield has risen from 3.6 and 6.2 t/ha without the net to 11.1 and 11.3 t/ha, without and with respective insecticide application. The insecticides used were (dimehypo, dimethoate, cartap) and some residues were observed during five to seven days following the harvest. The methods used for this observation were the quick biological test and the gas chromatographic analyses.

In the experiments conducted in the Dey Eth station in Phnom Penh using the same treatments, the Chinese kale and the water bindweed were cultivated. The treatment did not have any effects on the water convolvulus (kangkong or morning glory) yield. The Chinese kale showed an impact depending on whether the net was used or not (14t/ha against 10 t/ha). Likewise, an impact was noted with the insecticide application (13t/ha) compared with the non-use of insecticides (10t/ha).

In both cities, the 32 mesh nylon net appears to be an efficient solution against insects.

CONCLUSION

These new techniques introduced in the three cities have been successful. This year, numerous plants grafted on tomato or aubergine have been distributed to the farmers. Training sessions on this technique were also organised, using two varieties of rootstocks that are easy to reproduce. Some difficulties were encountered with the use of nylon nets and plastic shelters.

The farmers are fully aware that the economic results are not the same every year. In fact, the beneficial effects of the two techniques depend on external conditions: very rainy humid season and heavy insect attacks. Moreover, a relatively high investment is required. Despite of the existence of enterprises specialised in the construction of shelters, the investments small periurban vegetable farmers can do in Vietnam still need to be carefully analysed. A participatory approach is therefore needed to examine the most appropriate technical and economic solutions.

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Table 1: Administrative data on the main cities covered by the project

Cities	Surface area (km^2)	Farming lands (km^2)	Population density ($inhab/km^2$)	Overall population -thousands	Farming population -thousands
Phnom Penh	375	89	2,568	963	80
Vientiane	3,920	833	145	569	178
HCMC	2,094	980	2,434	5,097	448
Hanoi	919	435	2,952	2,712	829

Basic Cultural Management Practices for Urban Vegetable Production in the Philippines

Like most cities in the tropics, Cagayan de Oro is located in the lowlands. Such locations place constraints on year-round vegetable production when compared to the rural highlands, due to the elevated night temperatures of 20°C and above, and the unfavourable biological, chemical and physical properties of soil and water.


Robert J. Holmer

Ceremonial planting of tomatoes during the launching of the first Cagayan de Oro allotment garden

Vegetable production in Cagayan de Oro can be classified into three categories (Potutan et al., 2000):
(1) Commercial, on an overall area of about 60 ha (average farm size 0.5 ha),
(2) Subsistence, in 40 % of all households and in recently established allotment gardens;
(3) School gardens in 75 out of 78 public schools.
The most popular vegetables in the city in terms of consumption, are horseradish tree leaves (*Moringa oleifera*), eggplant (*Solanum melongena*), squash (*Cucurbita maxima*), string beans (*Vigna sesquipedalis*) and tomato (Agbayani, et al., 2001).

CULTIVAR SELECTION

Urban growers prefer to grow high-value crops that will provide a good return. However, most of these are temperate crops, only grow well in upland areas of the tropics, where temperatures are cooler. Continuous crop improvement by plant breeders has resulted in cultivars of these crops that perform well even in the hot climates of the tropical lowlands. Among those that were successfully tested and introduced in Cagayan de Oro, were cultivars 'Busecorp 7' for tomato, 'Trinity' for bell pepper, 'White Shot' for cauliflower and 'Tenjiku' for broccoli (Holmer, 2000).

METHODS OF PLANTING VEGETABLE CROPS

Vegetables can be classified into three categories depending on the planting practice: crops that are usually *transplanted* (e.g. cabbage, pepper, cauliflower, tomato, lettuce, eggplant); crops that are usually *direct-seeded* (e.g. melons, cucumber, beans, kangkong, onion, sweet corn); and crops that *should be direct-seeded* (radish, carrots). Direct seeding requires three to four times more seeds than transplanting. Some crops, such as legumes, do not easily regenerate roots, hence; do not easily recover from transplanting shock. The opposite can be said of solanaceous crops and crucifers.

Soil is the universally available medium for germinating seeds and growing seedlings, but not necessarily the best medium. In the urban setting of Cagayan de Oro, a mix of 2 parts rich top soil, 2 parts compost, 1 part chicken dung and 1 part river sand has been proven as best nursery medium for all vegetable crops.

SOIL MANAGEMENT AND FERTILISERS

Research under the PUVeP shows (Holmer, 1998; Trüggelmann et. al., 2000), that the best yield and quality results for vegetable production in Philippine soils are obtained, when a combination of organic and inorganic fertilizers is applied. *Organic fertilizers* such as manure and compost are needed to improve the biological, chemical and physical properties of the soil while *inorganic fertilizers* supply the required amount of nutrients. Organic fertilizers supply the same essential plant nutrients as inorganic fertilizers. The major difference is in their availability and concentration.

The best method is to apply all of the organic fertilizer, all of the phosphorus, and part of the other inorganic fertilizers into the soil just prior to planting. Fertilizers should be covered with a 3-4 cm layer of soil before setting the plants to avoid burning of the roots. One half of the nutrient amount for nitrogen and potassium K and other nutrients are applied one week after transplanting as first side dressing. The remaining balance is given two weeks thereafter (Holmer, 1998).

WATER MANAGEMENT

Proper water management is one of the most crucial points for successful vegetable production since most varieties are very sensitive to any kind of water stress, either to drought or to water logging.

If water is limited crops should be selected that will grow well under drier conditions

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Abstracts or the full version of most of the above-mentioned articles can be accessed under www.puvep.com/rjhpublications.htm.

(e.g. mungbean, eggplant). Short-term vegetable crops can be grown near a source of water such as a water well, the drain from washing areas or a water tank. Where feasible and affordable, drip irrigation systems (such as the bucket system) could be used (Holmer & Schnitzler, 1997) to reduce water consumption. The soil around plants should be covered with a mulch of leaves, cut grass or rice straw. If plastic mulch is used, only silver-coated ones should be applied since black mulches heat up too much and can cause burning of stems and other plant parts. Young plants should be given shade to keep them cool. Compost or organic material should be incorporated in the soil to improve the water holding capacity of soil. One large sack of composted organic material should be sufficient for an area of about $10m^2$.

In the wet season, crops should be planted in high beds to improve aeration and to avoid water logging. Another option would be to plant crops that grow well in wet conditions, such as taro (*Colocasia esculenta*) and kangkong (*Ipomea aquatica*). For controlling weeds, the ground could be covered with 6 cm of mulch to prevent weeds from receiving sunlight. Weeds cut by hoe or knife can be used as mulching material or for composting. Quick-growing vine plants will also reduce weeds by covering the ground. Examples are legumes, squash and sweet potato.

PESTS AND DISEASE MANAGEMENT

Findings of a survey revealed that more than 80 % of vegetable growers in Cagayan de Oro are using chemical pesticides. Most of the farmers are not using sufficient protective devices while spraying and the majority of them are experiencing negative health effects after the pesticide application. Only very few farmers received training on integrated pest management. Of the farmer trained, only one-third changed their pesticide application practices to use less toxic products with better effects on pest control. Respondents would favour natural control measures with less chemical applications. However, these technologies are not as readily available to them as chemical pesticides. In addition, some of the non-chemical alternatives such as bacillus thuringiensis products or commercial neem extracts are more costly (Holmer et. al., 2001).

Weak plants suffer more from attacks by insects or pathogens than healthy plants. Good crop management, including attention to water, soil and weeds will help reduce damage from insects and pathogens. Furthermore, the cultivars used should be adapted to the local climate. Crop rotation based on differences in the botanical families of plants, will also prevent a build-up of disease and infection in the soil. Plants, such as lemon grass, basil, marigolds, and others are known to repel certain insects and other pests. If application of pesticides cannot be avoided, the instructions on the label have to be strictly followed. It must however be pointed out, that some "natural" pesticides such as tobacco, chilli extracts or others, can be very toxic to man, animals and beneficial insects.

CONCLUSION

Growing vegetables in urban areas plays an important role in providing food, income, and ecological services to cities in the Philippines. Research to support urban agriculture is on going at universities, government and non-government organizations.

Priority areas on which further information is needed include:

- Improved vegetable varieties with adaptation to the tropical lowland climates, resistance to pests and pathogens, higher nutrition values, and longer shelve life,
- Technologies for composting biodegradable city wastes,
- Integrated crop management including the introduction of local predators; intercropping technologies and soil mulch for weed control. The objective is to minimize the application of chemical pesticides in densely populated areas;

Robert J. Holmer

Protection of crops from insect attacks using nylon nets

- Efficient and economic irrigation systems such as the bucket drip irrigation system which minimises water requirements
- Safe use of wastewater for irrigation.

At the heart of urban agriculture lie the livelihoods of farmers, food security, and ecological and social sustainability. Any crop production paradigm or technology should result in these benefits. Farmers need to be educated and encouraged to make the best choices that suit local conditions.

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Rooftop Gardening in Senegal

Rapid urbanisation in Senegal, is giving rise to rapid housing developments and diminishing land available for urban agriculture in the city. It is also creating an increasing demand for vegetables. Although land in the city is scarce, many houses have flat concrete roofs, which provide space for growing vegetables. Crops can be grown throughout the year under the semi-desert climatic conditions. The Rooftop Gardening Programme of the United Methodist Church promotes rooftop vegetable production in Senegal. Women's' groups have already established rooftop gardening projects in Dakar and Thies, through which more than a 100 persons have already been trained and many more are applying for training.

Ndeye Fatou D. Gueye

The roof gardeners are satisfied with the technology

The rooftop gardening programmes promote the use of compost and natural plant protection methods. The use of expensive inorganic fertilisers and dangerous pesticides that may create long-term health problems are discouraged. Compost is a granular, stable, material, which is high in organic matter and plant nutrients. Using compost will help to grow healthier plants and also saves money on inorganic fertilizers. Compost improves soil structure, nutrient content, biological activity and plant yield when applied to land. It is made from organic waste material such as garden and household refuse, weeds, grass clippings, leaves and a host of other organic materials.

Ndeye Fatou D. Gueye

Beds made of wood

There are several other institutions in Senegal involved in rooftop gardening, but their methods have proven to be too technical and expensive for the majority of the population, who are poor and illiterate. For instance hydroponic gardens require a daily application of soluble fertilisers, which are not only expensive, but also require some mathematical calculations before application.

BEDS FOR GROWING CROPS

Two types of beds are used in rooftop gardening: brick and wooden box beds.

The *brick bed* is constructed by using bricks of 10 cm in height, 20 cm in width and 40 cm in length (size 10 bricks). Therefore, if the size 10 bricks are laid properly, the space that will be created for planting within the bed, should measure 80 cm in width and 10 cm in height. This neatly accommodates the one-meter wide plastic sheeting that is widely used in Senegal. The bricks are laid flat with the open, weaker, side facing the inside toward the plants, (visitors consider it convenient to walk on top of the bricks, instead of in the narrow pathways).

Since the brick bed does not have any outlets, these should be created during the rainy season. To do so, the compost that is in the bed should be dug directly down the middle to create 2 equal parts on each side of the bed. The end of the plastic sheeting at the bottom of the bed should be dropped to make room for drainage. The 2 bricks at this end should be replaced on top of the plastic sheeting, to serve as a gate to stop the compost from escaping with the water. But the problem with this is that nutrients are quickly washed out. To replenish the nutrients, the regular use of manure tea is recommended. Manure tea is prepared by putting some nutrient rich compost into a half-full sac and dropping it into a container (preferably a 55-liter drum) for about 14 days. It is called tea because of the tea like hue of the solution. The tea is then used to water the plants. This method will help return some nutrients to the nutrient-depleted compost in the bed.

The *wooden box bed* is constructed like any other box, using wood. Discarded wooden platforms that are used as packaging for tiles are particularly useful, because they already form a half completed bed. The platforms measure 80 cm by 120 cm. After acquiring the platforms, 10 to 15 cm wide wood is mounted on all 4 sides of the platform, thus creating a contained space of 10 to 15 cm deep, 80 cm wide and 120 cm long. A hole is then drilled on the side of the lower end of the box, about 10cm from the end of the box. The floor of the box is then covered with cardboard to prevent the eventual caving in of the growing medium. (But those who can afford some extra investment may use wood to seal the open spaces). The entire box is then covered with plastic sheeting and a drainage tube is fitted in the already drilled hole using glue to hold it firmly in place.

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Before planting in the wooden box bed during the rain season, the compost should be pushed back 10-cm from the 4 sides of the box, thus creating a little channel all around. The vegetables are planted in the middle of the box and the surrounding channel allows the access water to flow through the drainage tube.

A wide variety of crops, especially those with fibrous root are recommended for rooftop gardening because the space provided by the box (10 – 15) cm or the brick frame (10 cm) can only support shallow fibrous root crops, for example, tomato, hot pepper, egg-plant, etc. Provisions can be made to grow tuber and other crops with larger roots like cassava and potatoes. This is made possible by increasing the size of the wood that is mounted on the sides of the boxes, or by standing the bricks upright to increase the volume of the compost in the beds.


Ndeye Fatou D. Gueye

Beds made of bricks

EXPERIENCE AND IMPACT OF THE TECHNOLOGY

The experience with this technology in Senegal has been remarkable. When the technology was introduced late 1999, and despite time-consuming efforts to highlight the benefits of roof gardening, the response from the communities was very lukewarm. The main obstacle had been the erroneous belief, that rooftop gardening would destroy the house; that the weight of the bricks would cause the roof to cave in and watering would bring about leaks that would stain the painted walls. By emphasizing the use of lightweight compost, wooden structures and by setting up a demonstration garden, we were able to overcome these obstacles. Thereafter, a steady increase in interest was noted, mainly from women. (Almost 99 % of those we work with on rooftop gardening are women).

The major problems associated with this technology are birds, insects, and funds to meet the initial investment. To deal with birds and insects, gardeners are encouraged to set up bird screens and apply natural insect control methods.

The impact of rooftop gardening in individual households has been quite substantial. It has created self-employment (at times of very high unemployment), and diversified and increased incomes. Equally important, if not more, is the increase in food security. Vegetables are expensive in urban areas and poor families cannot afford such luxuries. Now, with many households engaged in rooftop vegetable gardening, more food is available for home consumption and sale. The smaller growers consume most of their produce, while the bigger growers both consume and sell their harvests. Those who sell, do so at home, as neighborhood buyers come to their gardens for purchasing.

Based on participatory evaluation, the trained and practicing roof gardeners are satisfied with the technology, as it is cost effective, and relatively easy to learn and use.

Rooftop Gardening in St.Petersburg

In the early nineties it was considered that there was a niche for rooftop gardening, on apartment buildings and on the roofs of institutions in urban Russia, where there is no access to land except to the 'dachas' outside the city. (A 'dacha' is a plot of land outside of the city). The first experimental kitchen gardens on roofs of a public building and apartment houses appeared in St. Petersburg, in 1993.

There are some main organizational rules of kitchen gardens on a roof. Conventional garden soil is not suitable on a roof because of its weight. The use of the facilitated peat soil eliminates this problem. Another reason for using compost is that urban soils have been the recipient of acid rain for decades. Compost may even have lower heavy metal content than the soil in rural gardens. Organic matter in the soil also tends to tie up heavy metals and render them unavailable to the plants. The soil should be fertile enough to provide fertility for a long time, because new soil delivery, means hard physical labour.

Efforts were made to organise the apartments as a loop system of production, consumption and processing. The kitchen garden on the roof is where cultivation of vegetables, flowers and berries takes place, while in the cellar, processing of kitchen wastage into organic fertilizer (bio humus) is undertaken. The latter process, known as vermicomposting, consists of adding food waste (primarily vegetable and fruit waste), to an aerated container housing a colony of red worms in a moist environment. The red worms used are known as red California worms (*Eisenia fetida*). Shredded paper, regularly discarded from apartment complexes, can also be added. The decomposers of this food waste include bacteria, fungi, protozoa, and other organisms. When the process is carried out in the presence of oxygen, there is surprisingly little odour. The red worms excrete quantities of manure, known more commonly as bio humus or vermicompost.

The biggest constraint against the more widespread adoption of kitchen gardens, is the conviction that it is not safe to eat vegetables grown in the city. However, the vegetables grown on rooftops were analysed for heavy metals, and it was found that they contain the same amount or less heavy metals, than many vegetables from the countryside.

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Ms. Devi and Ms. Patil (catering officer in Mumbai Port Trust) on the rooftop of the canteen

M. Gayathri Devi

After retirement, Dr. Padmashri R.T. Doshi, started working on his farm at Kamshet, near Pune, and discovered the immeasurable problems faced by farmers. He discovered that if farmers include the cost of their labour in the calculation of farm profit and loss, all farms would be unprofitable. This led him to think very seriously about reducing the costs of farming and labour. Dr. Doshi has experimented with a number of farming practices that enable city dwellers to grow their own food on every available square inch of urban space, including terraces and balconies.

City Farming - the Natural Alternative, Experiences in India

An example of sustainable agricultural and sustainable initiative, using traditional and indigenous knowledge and appropriate technology

None of the innovations recommended involve high costs, nor does the farming require long hours of work. Every member of the family can be involved in the maintenance of the city food garden, including the elderly. The farm can provide the family with ample nutrition from plant sources, eliminating the need to purchase one's vegetables and fruits from the market, where inflation makes a mockery of housewives' budgets.

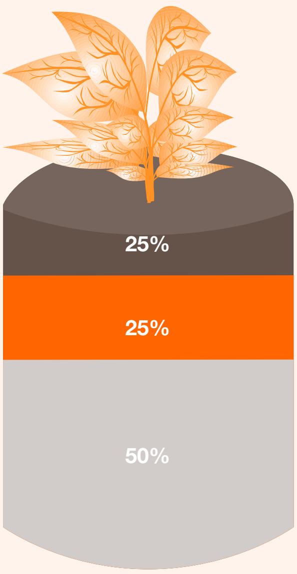

Figure 1. The different layers required in the containers to grow the plants

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INNOVATIVE EXPERIENCES

High-density polyethylene bags are used for the growing vegetables and cereals (the kind used to pack 50 kg of cement or fertilizers), with a diameter of around 22.5 cm and a length also of 22.5 cm. For crops like sugarcane, bags with large diameters are essential (35 cm). Fruit trees like fig, guava and mango have to be grown in bags, which have a diameter from 45 to 52.5 cm. The bags must be open at both ends; hence the base of the bag must be cut open.

After selection of the appropriate bags according to size, the next step is to fill them with soil. If soil is put as it is into bags, it will fall out the other end, which has also been opened. To prevent this, the bottom half of the bag is tightly packed with biomass of any kind. Dr. Doshi often uses waste sugarcane stalks, collected from a sugarcane juice vendor outside his house. The material is for free and sugarcane juice vendor is glad to get rid of it. Functioning as a kind of giant plug, the stalks keep the soil in the bag, but at the same time, are sufficiently porous to allow the water given to the plant, to drain out easily.

After the base is plugged, half of the remaining space inside the bag is filled with compost, either made in the house, or purchased from garden stores. At the institute compost is produced by putting cow dung, organic material and water in polyethylene bags and leaving them to break down for six weeks (as illustrated in Figure 1). Compost can be made in many ways, but the suggested method requires the least amount of labour. It is ideal for city homes since the bags are kept closed and therefore, there is little change of them being infested with vermin or other undesirable insects like cockroaches.

The remaining space at the top of standing bag is filled with normal garden soil; approximately 2 to 4 kilos of soil would be required for every 0.11m^2 of area. The bags are soaked with water two to three times and the water is allowed to dry. It is now ready for planting.

Seeds should be carefully selected. They can be taken from one's own kitchen (groundnut, cereals like wheat), or bought from the store. The important point here is how one plans the planting. The Institute recommends "chain-planting", where plants are grown to provide for small quantities of vegetable at staggered intervals and not a large quantity all at

Dr. Doshi set up the "International Institute of City Farming" which is headed by Miss Vandana Shah – CEO (Chief Executive Officer) and Mr. Sunil R. Doshi – President. They started out with modest expectations and have been blessed with grand success. A patent for Dr. Doshi's scientific invention known as "in-situ compost" has been granted. The United Nations, World Bank, BBC, local newspapers, radio and TV have provided media coverage. The Institute conducts lectures and awareness programmes, provides consultancy services, develops publications, and provides assistance in setting up city farms.

Water use in this so-called "Doshi System" is also considerably less than in conventional soil farming. Since the plant grows in sealed bags or other cylindrical bags or containers, considerably less water is needed when compared to growing on fields, where most of the water would evaporate.

The system is suitable for any scale of operation and in any open space. Dr Doshi uses these bag systems to grow a variety of fruits, vegetables and cereals. He has also grown 1,0000 sugar cane plants. Both small and large farmers can use this method, since it is easily replicable and depend, very much, on materials available in the local environment.

Dr. Doshi's good practices could have a significant impact on policies relating to food production. Today, most governments have fallen into the trap of reallocating all the food production to the countryside. New policies supporting such forms of urban agriculture should now be encouraged.

Urban farming brings health and other benefits (including recreation and physical exercise) to city folk. Farms of the kind promoted by Dr. Doshi can also reduced food prices. Even if the vegetables and fruits produced are not destined for the market, their availability to households in the cities can help to reduce food scarcities.

once. Seeds, cuttings or grafts can be placed in the bag and with the right amount of watering; they begin to take root and flourish. Seeds may be placed 1.5 to 2 cm below the soil level and three weeks later, the plant would have fully emerged from the soil. Leaves may be given foliar sprays and pests should be dealt with, as far as possible, using non-toxic, home made solutions.

Photo: M. Gayathri Devi

Rooftop with plants using kitching waste (according to Mr. Doshi's technology)

Recycling of Kitchen Waste at Central Kitchen, Mumbai Port Trust

After a training programme on "city Farming" given by the international Institute of City Farming, Mumbai Port Trust has developed an organic farm on the terrace of it's central kitchen (which is about 3000sq ft (279 m^2) area). The farm was started firstly to dispose of kitchen organic waste in an eco friendly way. All kitchen staff members, after their daily work in the kitchen, tend the garden, which has about 275 plants. Besides the eco-friendly disposal of waste, the employees, who are not professional gardeners, experience creative pleasure in a friendly social environment.

In a span of five months fruits like pomegranate, guava, sugarcane, and a range of vegetables like ladyfinger, tomatoes, and radish are produced. Many people visit the farm, and the workers take pride in showing them around the garden. The positive response has helped add to their self-esteem. This can be seen from their enthusiasm and changed attitude. The farm was awarded the 2nd prize by the National Council of Friends of Trees in the annual show held in February 2003.

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Agriculture is the mainstay of the Ugandan economy. Due to the growing population and high demand for land, urban agriculture is a major issue. Currently, Kampala has an estimated population of over 2 million people. It is a city experiencing large migration flows in search of employment and better living conditions. Most of the migrants are poor young men and women searching for jobs and services like piped water and health facilities that are lacking in rural areas. They are landless and often their spouses and extended family members follow them, which results in slums developing in public resource areas, like urban wetlands. Without the security over the land they occupy, these families tend to carry out short-term investments like mushroom cultivation. Mushroom cultivation is a space-confined technology and requires relatively small capital input.


Angelika Kessler

Women vegetable farmers in Burkina Faso

Mushroom Cultivation in Urban Kampala, Uganda

Urban dynamics and the market economy assign different gender roles and responsibilities to women and men. In Kampala, the poor women are well positioned to working closely with urban natural resources (Kigula 2001:32). These women form the majority of people who engage in urban agriculture. Because of the need to supplement household income, many wives start low- income generating activities. One of these activities is mushroom cultivation in the dark nooks of houses or the wetlands. Mushrooms fetch extra income and can be used to replace for other vegetables. It is also being included in micro-finance projects for urban women farmers to enhance sustainable livelihoods.

Women's mushroom cultivation reduces workload, increases income and food security and uplifts the status of women

Mushroom growing utilises residues as substrate and requires limited land area. It is a cost effective way of growing food. Extensive research of improved varieties is available, due to the involvement of the government in promoting programmes like the Plan for Modernisation of Agriculture (PMA). The PMA considers gender participation important for economic development, and mushroom farming enables the voices of women to be heard. Mushrooms are also a good food supplement as they contain minerals and vitamins (Beetz and Greer 1999). Mothers argue that mushrooms provide increased resistance and immunity against early childhood infections and diseases. They also enhance food security in times of hunger. Women have historically held knowledge on wild mushrooms, and can well adapt to cultivating them in limited spaces.

There is gender imbalance in land ownership (titled towards men) because of paternal inheritance traditions. Women make up 7% of all landowners in Uganda (Busingye 2002:4, Ovonji 1999), while 93% have access with usufruct rights or are landless. Typically, men determine decisions over land use and the control over farm produce. Land shortage is another reason for women to take up mushroom cultivation. It can be done inside a house or on open access (urban natural resource) areas. The house space is considered a private sphere belonging to women. Men prefer to find work outside the home (due to traditional practices on the division of labour). Men also control income from farm produce, but mushrooms can be sold by women and needs little capital input, which attracts more women to this activity. However, female-headed households are on the increase due to high rate of divorce or HIV/AIDS.

Declining soil fertility is also a growing problem. Most poor men and women used to grow coco yams and vegetables in the wetlands, but climatic changes have led to the drying up of the swamps, while construction of houses or factories have displaced many, rendering them landless. Evictions and land insecurity is leading people to adapt to limited space agriculture. Soil degradation has meant that mushrooms can no longer be found in rotten wetland masses as the water table has decreased. Hence, the space at home is ideal for the cultivation of the introduced varieties of mushroom species from Kawanda research station.

MUSHROOM CULTIVATION AS CONFINED- SPACE AGRICULTURE

Mushrooms are intensively grown indoors or outdoors in

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wetlands. The climatic conditions and dark rooms inside houses favour the growth of locally improved and available mushroom species, such as oysters and shiitake. Mushrooms have both a nutritional and medicinal value (Hobbs et al 1995). This makes them suitable for improving the diet of families in urban centres. Many people are knowledgeable about edible mushrooms and appreciate their consumption as part of traditional cooking, in central Uganda. There is also a ready domestic market for packaged fresh mushrooms by the quickly sprawling supermarkets in Kampala like Uchumi and Shoprite, originating from Kenya and South Africa.

The main source of income for poor women has been growing cocoyams and selling sweets and tobacco on the streets. However, with the government focus on micro finance schemes, (funded by the World Bank), a number of women acquire loans to grow mushrooms. Marginalized poor and landless male migrants are also able to find work as casual labourers in households growing mushrooms and assist with farming or selling.

RUAF

Irrigation of the crops by hand is mostly done by women

People believe that wild mushrooms are rare today, because increasingly, on the market, are the oyster and shiitake species introduced by the scientists. The small type of wild ones with names like *Obubala, Obunaka naka, Ggudu, Kinyulwa and Nampama,* can still be found, but are seasonal, as they grow in wet areas, bushes, rotting tree trunks, or in debris of banana gardens and anthills. The farmers grow mushrooms for sale or home consumption.

Oysters are the most commonly grown mushroom species. The spawn is prepared in the cultural laboratory at 25-28°C. Black plastic bags of 3 to 4 Kg capacity containing agro-industrial residues, like cotton seed hulls or sugarcane trash, are prepared. A drum or boiler is used for pasteurising the substrate by steaming and is then stored on a raised rack as it cools, retaining 70% moisture. Spawn is added and the bag sealed for incubation for 3 weeks. During this period, the mycelia from the spawn grows and colonises the substrate. This is then moved to a humid room with light and holes made in the bag. In 2 weeks, mushrooms are ready. 4 kg of substrate produce 3 Kg fresh mushrooms. As entrepreneurial agriculture, it is estimated that a small farmer produces 15 Kg each period, harvesting 5 times a year, earning U.Shs.150.000 (about 80 USD) per year.

Mushroom cultivation reduces the workload of women, because they don't travel long distances in search of free pieces of land. The improved mushroom growing technology that increases income and food security, uplifts the status of women in decision-making.

Mushroom cultivation has encouraged the increase of women's associations. Women organise themselves and pool resources to establish rotating funds. They also share knowledge on mushrooms or entrepreneurial skills. Mushroom cultivation has the added advantage of providing employment and income for housewives.

HIV/AIDS is having widespread impact on the agricultural sector, affecting people and the household income. If a husband is taken ill, the wife stays at home to look after him. With the decline in household income and subsequent suffering of family nutrition, women are forced to seek employment like mushroom cultivation.

CHALLENGES

Some farmers state that there is no secure market for mushrooms. For example, African Growth Opportunity Act (AGOA), that enhances the sale of finished products from third world countries, does not include mushrooms. Still, growers need to step up their production if they are to satisfy a ready market like AGOA.

Due to the lack of dryers for the drying of mushrooms, farmers tend to sell only fresh ones. As these poor farmers cannot afford refrigerators, their produce rots. Although, the solar drying of mushrooms is well accepted, farmers do not have the capital to invest into these machines, as they produce on a very small scale. There is also a lack of information being disseminated on mushroom processing.

There is limited knowledge on the nutritional characteristics of mushrooms amongst consumers and many farmers. Information on growing is shared only within small groups of farmers (some farmers give out photocopied mushroom growing manuals). The high illiteracy level among women, bars them from travelling to increase education and obtain improved seed varieties. There are only few urban extension workers, due to low levels of resources and retrenchment in the public service sector. Those remaining are mostly male and target male farmers.

Technologies at the Kawanda research station need to be fine-tuned to fit into advanced farming systems. With the advent of decentralisation, local leaders need to be assisted to play a leading role of modernizing agriculture in their particular localities. Mushroom cultivators, if adequately empowered, can also play a very vital role. Realisation of women's rights to land and household property, may further improve investment in mushroom cultivation.

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Micro-technologies for Congested Urban Centers in Ethiopia

This article describes the experiences of Yilma bio-consult, specializing on promotion of urban agriculture in Addis Ababa and other urban centres in Ethiopia.

Addis Ababa sustains 2.5 million people on a total area of 50,000 hectares of land, of which the concrete and asphalt build environment takes up around 20,000 hectares. In this congested city, the availability of land for food production is becoming very scarce.

The Government of Ethiopia had begun to promote urban agriculture. It is included in the research agenda of the Ethiopian Agricultural Research Organization (EARO), in the teaching agenda of Addis Ababa University, and in the development agenda of GOs, NGOs and CBOs in Ethiopia.

Addis has a 40% unemployment rate and a great majority of the unemployed are youth. The city produces an estimated 400,000 tons of solid waste annually, the bulk of which is household organic waste (CSA 2001). The city has a population of around 60,000 dairy animals with around 50% of families rearing sheep and goats (Tegegne *et al* 2002). A huge amount of livestock manure is therefore available. The average available garden space in the city is not more than 25 m^2 per family, while the rivers in the city are highly polluted with heavy metals and sewage making the vegetables and fruit cultivated along these rivers unsafe for consumption (see also Getachew, in UAM No.6).

Rapid uptake of technologies was possible, as they are cheap, simple and dependant on local materials


Yilma Getachew

Faith Garden

Under such setting, the need for technologies that enable high-level outputs in the smallest possible space is paramount. The technologies must be cheap, simple and dependant on local resources. The choice of technologies presented here considers these principles and is based on natural processes. About 30 technologies have been identified for promotion by the Agency, but only three are detailed in this article.

BARREL GARDEN TECHNIQUE

Imagine producing over 25 plants of Swiss chard or strawberries in a space less than one square metre? The materials needed to do this are a 200-litre barrel, a corrugated iron sheet, soil mixture (preferable 2 parts soil to 1 part aged manure or compost and 1 part sand), and manure tea.

Several incisions of about 12 cm each should be made around the barrel as shown on the photo. The upper lips of the incisions are hammered inward and the lower lips outwards. The incisions should be made intervals of 15 cm horizontally and 20 cm vertically. The barrel top is open while the bottom is perforated with about 10 holes. A rolled corrugated iron sheet is place in the middle of the barrel and filled with sand. The space between the inner wall of the barrel and outer wall of the corrugated iron is filled with the soil mixture described above. Vegetables or fruits of choice are planted in the space between the two lips of the incisions. Regular watering is done through the sand in the middle. Manure tea is applied on a weekly basis through the sand in the middle. The barrel should be maintained over gravel for better aeration and drainage.


Yilma Getachew

Swiss chard on barrel

The benefits of this technology is that it enables families to increase the availability of micronutrient food and encourages the reuse of

- ❖ Old barrels and trashcans (which are freely and cheaply available), the composting organic solid waste
- ❖ Livestock waste as manure tea.

Used barrels can have several uses to urban farmers, as shown in table 1

THE FAITH GARDEN TECHNIQUE

The FAITH garden uses the abundant availability of organic waste to produce food. The

Table 1 Alternative uses of used barrels.

Production techniques	Water management	Fertilizer production	Other uses
Barrel garden (see above) Ring culture Potato growing Hydroponics garden	Drip irrigation Solar distillation of polluted water. Roof water harvesting Solar water heater	Compost making Manure tea making Plant tea making	Pesticide preparation- growing, mixing, boiling, pesticide plants. Biogas digester etc.

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technology uses cheap material: bottom-less baskets (available to the poor), organic solid wastes, seeds and seedlings. A hole has to be dug in the ground with a diameter of 30 cm. The basket is placed on top of the hole and all the available organic solid waste is placed inside the basket and the hole below it. Four to eight selected plants are planted about 20 cm away from the basket. After harvest, the composted waste is used to fertilize other garden activities like the container gardens. The procedure is further improved by including a series of 12 basket garden units, which are planted in succession, with an interval of 1-2 weeks. After the first harvest is made, a continuous supply of vegetables and fruits are available for home consumption.

Table 2 Alternative technologies for congested city centres

Farming technologies	Water management	Fertilizer production
Tire garden	Soddis water purifier	Earthworm husbandry
Bottle garden	Pither irrigation	Cow horn manure
PVC garden	Tube well	Portable chicken roost
Growing walls	Ferro-cement jars	
Hydroponics PVC	Rus pumps	
Window sill garden		

Yilma Getachew

Training of Trainers

The benefits of this technology include lower volumes of waste, an increased availability of micronutrient food, a better skilled and environmentally aware population and increases in family incomes.

THE TRENCH GARDEN

The trench garden method is interesting in situations where malnutrition (of macro-nutrients) and excess of livestock manure go hand in hand. The technology required seed potatoes, aged manure and mulching material. To develop the trench garden, one needs to dig a 30 cm wide, 30 cm deep and 6 meters long trench. At the bottom of the trench, the soil should be cracked to a depth of another 30 cm to allow better aeration and drainage. After planting the seed potatoes at intervals of 30 cm, the trench is completely filled with aged manure in between plants.

After two months each potato plant will yield one or two tubers per week, or about 2 kg per week, per trench, for duration of two months. After two months, the trench is refilled as before, which will continue to supply the family with potatoes for another two months (see photo on page 24). Depending on the availability of garden space the family can build several such trenches.

TRAINING AND DISSEMINATION

In addition to the technologies described in this article, several other urban farming technologies have been installed by the consultative agency. Some of these technologies are listed in Table 2.

To date, Yilma Bio-consult has disseminated the above technologies to over 800 families all over the Ethiopia. The families were also trained on how the install and maintain the technologies. The training strategy commenced with initial classroom discussions to explain how and why the technologies need to be installed and maintained as recommended. This was followed by an in-situ demonstration, the site being set up a month prior to the training programme. Finally, the technology is installed on-site (practice area and/or a individual garden plots). Each trainer is required to train 10 families following the above strategy.

These technologies are highly replicable. In one locality, training was provided to 10 trainers, who in turn trained 100 families. After three months, a thousand families were trained and the technologies were improved through hands-on experience.

The rapid uptake of these technologies was made possible, as they are cheap, simple and are dependant on local materials. Due to diversity of crops farmed through these technologies, the damage by pests and disease was minimal. There are also no difficulties with odours or wastes. The technologies however, require water, and clean water in urban areas is in short supply. It is therefore advised that these technologies are coupled with water harvesting practices.

These agricultural practices are also acceptable to policy makers as they demand little land, promote the recycling and reuse of both organic and inorganic wastes and create employment. However, the uptake of these technologies by the richer urban inhabitants, with larger garden spaces, has been low.

To promote urban agriculture, the Ethiopian government has established the Addis Ababa Urban Agriculture Office, probably the first of its kind in East Africa. Furthermore, as of May 9, 2002 the Addis Ababa city has become a signatory to the declaration “Feeding Cities in the Horn of Africa” which promotes urban and periurban agriculture. The poverty reduction strategy of the Ethiopia has also included urban agriculture as a priority.

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Agriculture in Botswana's urban and periurban areas is not widespread. Some poor families have taken up farming to supplement their incomes, while a few entrepreneurs have chosen urban and periurban farming as business ventures. In the capital city, Gaborone, most commercial and subsistence farmers are situated in freehold, municipal or tribal land in the north and south of the city. The farms operate as private ventures or as a project of an academic or scientific institution. Farming activity consists of poultry farming (40%), horticulture (20%), pig farming, (10%) and diary farming (8%).


Yilma Getachew

Trench Garden

Innovative Urban Agricultural Technologies in Botswana

Innovative agricultural technologies are being used in several urban areas in Botswana, which address the issues of poverty and food security at the grassroots level. The climate in Botswana is very harsh and the soils are quite poor in terms of nutrients. Hence, farmers cannot depend on conventional agriculture, which relies on annual rainfall and surface water. Some of the technologies adopted are described below.

These technologies, if adapted to the socio-economic needs of the urban poor, do seem to offer a great potential for increasing nutrition standards and supplementing incomes. They can also be incorporated into urban planning and the design of housing areas. However, for these technologies to be widely used, urban planners need to be educated on their benefits and feasibility. Quite a few farms have already begun to use these technologies, for example, the SANITAS horticultural farm in Gaborone; hydroponics farms in the periurban areas of Gaborone and Francistown, and pilot farms at the Botswana Agricultural College.

THE PRACTICES

The concept of the ***'Productive Homestead'*** was designed with the aim of both increasing food production and rainwater retention on the plot. Most urban homesteads are surrounded by yards, which on there is little or no surface vegetation due to the harsh climate. Houses are usually situated in the centre of the plot, surrounded on all sides by well-swept bare ground. This is done, according to most people, to prevent snakes around the home. Most houses have no water catchments to collect run off when it rains. The *Productive Homestead* technology enables rainwater to be collected in underground tanks and used for irrigation. Another feature of the 'Productive Homestead" is the *'Growing Wall'*. Concrete growing boxes are built into either the actual house, or into the boundary wall surrounding the plot. These growing boxes can be made using a block machine. The boxes use sand as the growing medium, and this is placed on top of a bed of fertiliser (e.g. chicken manure). Water can be applied manually or by using a drip-irrigation system.

The growing bench is designed so that crops can be grown using less water and produce higher yields than in traditional soil cultivation. A cement and river sand mix is used to form concrete edges, which are then arranged to form a rectangular bed. The bottom of the bed is also covered in concrete. At the bottom of the bench a layer of farm or chicken manure is placed, which is then covered by the growing medium - river sand. On top of this, a further layer of manure, phosphate and a mix of trace elements (usually missing in sand) are added. The bottom of the bench is made slightly convex, so make certain that water from irrigation does not settle. The convex base allows water to run off, and holes are left at the end of the benches to allow water to escape that can be reused. The bench is then ready for planting.

The benches can be irrigated manually, by using a drip irrigation system of plastic drip pipes, or by capillary action, which involves the placement of clay pipes at the bottom of the bench. Water simply seeps out of these pipes and up through the sand. It is estimated that approximately 1.2 cubic metres of water is required per year to irrigate 1 sq. metre of the growing bench.

This method involves a certain level of investment that may be out reach for individual farmers. However, costs can be minimised if a number of farmers join forces and cultivate communally. Experience has shown that the growing boxes are a very successful technology and are suitable for a wide variety of vegetables, important to supplement both income and nutrition requirements.

Trench Gardening is a variation of the growing bench. It involves digging a knee-deep bed about the same dimension as a door. This is half filled with organic waste, topped with soil and covered with a blanket of mulch.

The permanent strip method is based upon the principle of growing in strips, in which the soil has been loosened by a special tool to allow for increased water retention. This is a crucial element considering Botswana's climate. The strips are 0.6 metres in width and are separated by banks built of compacted earth. These strips can control weeds, but most importantly, can help channel the flow of water down into the growing strips. Organic matter can also be applied to the strips in order to increase the fertility of the soil.

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Permaculture

Permaculture is an agricultural and environmental technology, which combines growing of fruits, vegetables and grain and the raising of livestock by creating a symbiotic ecosystem.


SOS Environnement

In 1996, the 3rd International Ecovillage conference was held in Dakar. This conference, organized by the Association for the Economic, Cultural, and Social Promotion of Yoff (APECSY), had, as its main theme "Integrating traditional African wisdom in a global process of ecological reconstruction." At the end of the conference, around twenty members of the Yoff community were trained in the principles of permaculture with the advent of the APECSY's Eco-Yoff program.

In June 2002, a partnership was created between CRESP, USAID's DynaEntreprises programme, and the NGO, SOS Environment, and a permaculture garden, the first in Senegal, was started. The garden aims to promote permaculture to farmers as well as private and public decision makers, by demonstrating its viability, effectiveness and business opportunities offered by such agricultural and environmental technologies.

Permaculture incorporates the principles of sustainable and organic agriculture. Organic farming, as a part of a sustainable agriculture, uses no chemicals as fertilizers or pesticides. Sustainable agriculture seeks to make the most of the land without degrading the soil, whether working with a small plot or a large arable field. The scientific foundations of permaculture are the same all over the world, but the socio-cultural approach is specific to the community that practices it.

Permaculture could also be seen as a miniature model of a sustainable society. It is a way of life: an economic and cultural reality, or a way of regarding nature and finding its place therein. The permaculture garden is also a source of renewable revenue, in as much as it can produce both food and money. Permaculture is a viable option for urban agriculture, since its integrated approach and flexibility, it is perfectly suited to prevailing city conditions, in the fight against poverty, food insecurity, loss of biodiversity and atmospheric pollution.


SOS Environnement

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Mobile Kitchen Gardens

Despite legislation that tends to discourage urban farming in many cities in sub-Saharan Africa, urban farming has thrived and has been identified as priority practice amongst the town dwellers. In the highly populated residential areas, where arable land is too scarce to facilitate meaningful farming, it's advisable to plant vegetables in space-confined gardens.

These gardens can be created by using materials like a fabric sack, polythene bags or plastic drums with a capacity of 90 to 100 kg. Between 70 to 100 small holes are cut all over the bag, which is then filled with nutrient rich soil. The farmer can use as many bags as required, as long as there is sufficient material and space.

After 2-3 weeks of bag preparation, the propagation of cuttings and seedlings (of kales for instance) can be done in the holes of the bag. This initial stage of propagation demands a lot of intensive care, like watering every morning and evening. Alternatively, propagation can be done by using seeds, but using cuttings or seedlings have proved more promising and viable.

Up to 150 seedlings or cuttings of sales can be raised in one given bag. This can sufficiently sustain an urban family for a period of time, and thereby drastically reducing drastically expenses otherwise spent to purchase the same. Managing pesticides is very important to this practice, but weeding is not necessary which reduces labour requirements. Very little water is required for irrigation. As the bags are moveable, it's possible the re-position it where convenient and can be transferred near the house to receive water from the roof catchment.

In many learning institutions in Nakuru, Kenya, this farming practice has been promoted to homes through demonstrating the methodology and benefits to children. It is currently being used by a number of residential estates.

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The Abundant Harvest Garden

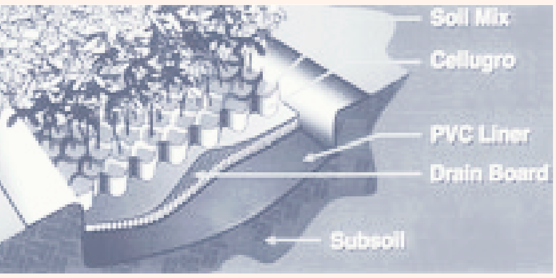
The goal of "Hunger Grow Away" has been to cultivate food security "One Family at a Time." To achieve this the Abundant Harvest Garden (AHG) was developed, which is a micro-intensive food production system that can grow the produce needs for a family of four in 1.44m².

Too often, the space available for urban food production is distant from the home, making it difficult to protect from predators or theft. A conventional garden is labour intensive, making great demands on the time and energy of the women who tend them. The AHG puts the garden close to the home. Water is frequently in short supply or must be carried great distances, and the water itself may be a source of disease. Frequently the garden plots are located on soil that is polluted or chemically contaminated.

The possibility of frequent harvesting of fresh vegetables from the AHG is a great health advantage. When a family can grow a dependable, varied and nutritious diet, with minimal cost in money or time, the first steps out of poverty can be taken.

MICRO-ENTERPRISES

In our trials we grew moringa (Moringa Oleifera: Horseradish-tree or Drumstick-tree) in part of the garden while vegetables were being cultivated in the remainder of the cells. If a garden was planted in only moringa seeds, over two hundred plants could be produced every two or three months, in a space only four foot by four foot. Other trees, shrubs and perennial plants could be propagated with this system to establish orchards, erosion control programs and more. Herbs grow exceptionally well in the AHG and can be a source of income. In Lagone, Haiti, around 38 gardens will be used for the production of both culinary and medicinal herbs as a cash crop.



Cell System Drainboard and Liner

Tomi Jill Folk & Hank Bruce
Hunger Grow Away, USA, ✉ tomifolk@mail2.Lcia.com

THE ABUNDANT HARVEST GARDEN

The CelluGRO system

This system has a proven track record in the professional nursery industry in the United States. It offers maximum use of space and resources with a minimal impact on the environment. It also offers the greatest return for a family's investment in time and labour. Furthermore, it is permanent, self-contained and can literally be folded up and taken with a family if they move. The system will last for years and is non-toxic. It is available in two sizes, the 1.4 m² family garden unit, and a larger 2.4 x 6 metre community production unit.

Without the cellular growing system the AHG would be nothing more than a growing box. The cells are 21 centimetres deep; the optimum average depth for a healthy root system. Each plant grows in its own space or in a micro-community of compatible plants. So, plants with aggressive root systems don't crowd their neighbours. Transplanting can be done with little root disturbance or transplanting shock, while harvesting or replacing spent plants can be carried out without disturbing those remaining. Finally, the plants grow so close together that they serve as their own surface mulch, keeping soil moist, maintaining even soil temperature and controlling weed growth.

The dimpled drain board provides efficient drainage of surplus water and it creates an air space that prevents soil fungus problems. The permeable filtration fabric covering the drain board permits surplus water to gradually drain. The soil and the roots have time to absorb the required moisture. The drainage outlets can be channelled for the recovery and recycling of surplus water. The liner prevents the loss of valuable water and nutrients do not leach out of the soil. Less fertilizer is required. There is no contamination from soil borne organisms or chemical pollutants and invasion from soil insects and nematodes is prevented.

ADVANTAGES

❖ The AHG requires *limited space*: in the dooryard, on a rooftop or the pavement, and can be used where there is poverty of space, water, labour, time and finances. For example, in urban areas and where there is a need for an adaptable system to accommodate children, the elderly or the disabled.

Advantages of the Abundant Harvest Garden:
- ❖ Saves water, time and labour (no tools required other than bare hands, one time financial investment)
- ❖ Adaptable, to accommodate individuals with disabilities
- ❖ Flexibility in what can be grown

❖ The gardeners have control over what plants will be grown, how they will be grown and what will be done with the harvest. As this system is so compact, water efficient and adaptable, gardens can be productive during droughts, monsoons and cold weather.

❖ The system is forgiving of the problems of neglect, planting errors, over watering and under watering: the gardener can make mistakes and still put food on the table.

❖ The AHG system can be emptied, rolled up and moved if necessary. It can be re-established and productive in as little as three weeks.

❖ Cultivating plants that provide food in more than one form can increase the productivity of a vegetable garden. Local favourites and indigenous vegetables should also be a part of the garden.

❖ The development of green spaces, even micro-spaces of productive green, are a valuable community resource and may become a teaching tool.

CONSIDERATIONS

❖ The micro-intensive gardening system can be use under extreme conditions: where there is poverty of space, water, labour, time and finances, like in urban areas. On its own, however, it cannot be used to reduce poverty.

❖ Wise and efficient water use is needed to prevent breeding grounds for mosquitoes.

Abundant Harvest Garden in full production

❖ The family size AHG costs approximately $225 (US) or more in materials and transportation. This is also one of the reasons that Hunger Grow Away was formed, to raise funds to help supply these gardens where they can be used most effectively.

❖ The AHG is not manufactured locally, although the food grown in them is. Soils, soil building materials and compost will all be supplied locally.

EXPERIENCES

The work of the *Osceola County Childrens' Home in Kissimmee, Florida, USA* was invaluable to the development and where the research actually began. The residents of this childrens' home did experiments with five different gardens using a variety of growing mediums and plant materials.

Community Development Program (CODEP) is working with Hunger Grow Away in *Lagone, Haiti* where most of the gardens are used for food production, some in a nutrition program at several schools, and others as a micro-enterprise producing herbs for market.

Residents of a homeless shelter *Anthony House* near Orlando, Florida, USA, and student volunteers assembled and planted four of the AHGs. Twenty-one days later they had their first harvest, which was sufficient to produce a salad for each of the sixty-two shelter residents.

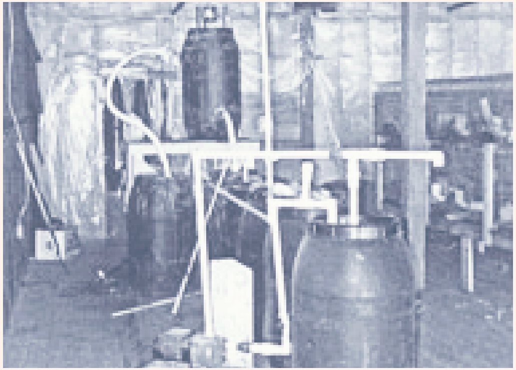
Plans are being developed with the Greater Albuquerque Habitat for Humanity to use the AHG as a way to improve nutrition and teach important life skills. The first garden for this program was planted April 26th of this year. The African Assistance Plan (West Africa) is exploring ways to use these gardens at a number of schools throughout Ghana.

ONE TIME INVESTMENT

Rooftop gardens are a logical solution to the question of where to grow fresh produce in urban centres. Due to its water and space efficiency, the AHG is an ideal, cost efficient and permanent rooftop system. Beyond the obvious food production, rooftop gardens can provide a number of environmental benefits including, providing thermal insulation for those living below, absorbing rainwater to control runoff, filtering pollutants out of the air, enhancing the oxygen supply and controlling noise pollution.

If we can use these AHGs to cultivate family food security, improve nutrition and halt the poverty spiral, it is a wise investment. It will serve as a cost efficient green space programme, that decreases the need for food relief, alleviates poverty, decreases crime and promotes micro-enterprise.

Aqua-Terra Gardens


Frank McNeely

Biodigester

Aqua-Terra Gardens is a newly formed corporation located in the heart of the United States, Springfield Missouri. Frank McNeely, owner and operator, has converted an unused old graining mill near the downtown area into an urban agriplex. The goal was to establish a facility that would address sustainable agriculture, use renewable energy and educate the public in these concepts.

Part of the old mill has been opened as a year-round indoor farmers market. Aqua Terra Gardens has also constructed small systems that are adaptable to schools, universities, low-income families and low-income communities to teach them how to grow a healthy food product in a small area.

Many different items were used in the construction of Aqua-Terra Gardens, including bathtubs taken from a remodelled apartment complex, and corrugated metal siding lined with plastic as grow tables. The so constructed greenhouse area enables Aqua-Terra Gardens to produce tomatoes, cucumbers, lettuce, spinach and fish, that finds its way to the farmers market and to local restaurants.

Located in the southwest corner of the large building are three rooms that equal 528 m^2 of floor space. The entire outer siding along the southwest wall was removed and replaced with two layers of the same polyurethane material that was used on the greenhouse. This construction allowed Aqua-Terra Gardens to transform a warehouse setting to three large hydroponic growing rooms. Rectangular tables of 1to 2.5 meters are lined with heavy mil plastic. Pieces of Styrofoam with holes drilled in a pattern are used to grow lettuce, that after germination in rooting cubes, are placed in these holes and float in a mixture of nutrient solution and water. This is aptly named the Floating Bed type of hydroponics. A product from the bio-digester is used as an organic nutrient solution instead of the conventional chemical base or inorganic supplements used in many other large hydroponic growing facilities.
Another of the large rooms holds 60 rabbits and 30 chickens, which supply manure for the 7-stage bio digester

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located onsite. Aqua-Terra Gardens is working in collaboration with "Integrated Agrisystems" an organization that does research in many different types of alternative agriculture. This particular type of digester is designed to take livestock waste and through a special flow-through process produces a nutrient rich slurry, free from biological and chemical demand for oxygen. Simply put, this product allows the use of an organic product into the water to supply the nutrient for hydroponic systems. The system also captures the resulting methane and reuses it to provide hearting for the rooms.

A number of water ponds on the property hold a variety of water plants for sale to the public. The waste from the fish feeds the water plants and the fish get much of their nutrients from the roots of these plants. Inside the greenhouse there are four 324 litre tanks that hold Tilapia, a good marketable fish that supply the nutrient solution for many grow beds. Tilapia is a hardy, disease resistant fish that grows rapidly and is a very light tasting fish. Using the fish waste to feed the plant is a type of alternative agriculture that is a form of hydroponics called aquaponics. Like hydroponics, where one suspends the root system of a plant into a nutrient rich solution for the plants growth cycle, aquaponics uses the already nutrient rich water from the fish and pumps it to gravel grow beds where the plants uptake what nutrients they need. The natural self-occurring bacteria living in the gravel cleans the water that is returned to the fish.


Frank McNeely

Hydroponics

An important aspect of urban agriculture is dealing with the governmental entities that rule the city or area. As anyone who has renovated an old structure knows, there is a list of regulations one must follow to make the building habitable for the public. The final aspect to the operation is education. Aqua-Terra Gardens now hosts monthly aquaponic home kit classes.

Visit the Aqua-Terra Gardens website: www.aqua-terragardens.com

'Worms turn garbage into gold in Lismore'

If you're into garbage, worms are the buzzword of the 21st Century and definitely in Lismore, Australia. Here, innovation in ecologically sustainable development (ESD) has resulted is the biggest 'state-of-the-art', fully automated worm farm in the world, employing 10 million worms to turn 6,000 tonnes a year of organic waste, into brown gold.

Meeting the waste reduction targets requires an integrated approach to manage waste across several fronts. Lismore City Council recognises that the key to successful waste management for councils today, involves innovative partnerships between local government and industry. In this particular case, synergistic effort between the Lismore City Council Waste Minimisation Department and Tryton Waste Services was required. After overcoming many challenges in technological and management solutions, particularly to managing contamination, both partners are now reaping the rewards for their efforts.

The three year action plan of the City Council sets out a program of waste education projects and campaigns aimed at increasing the volume of organic resources, reducing contamination and meeting householder, business, industry and school education needs. A major part of the approach is changing fundamental human behaviour through education. Programmes include learning packages for schools, including a half-day tour, and "sustainable school waste auditing" workshops. An education campaign 'Do The Right Bin', features the 'Lizzie' worm character (Lismore's favourite recycler) as a way of connecting with children and adults alike. Lizzie features in all educational advertising, for example on brochures, stickers, colouring books, newspaper, radio and television advertising. Lizzie also rewards those recycling right with $50 gift vouchers, and an invitation to an afternoon tea with the Mayor, during the 'Ambassador Competition' (annual bin inspections).

Lismore's contamination management programme also includes annual 'bin-runners', who check every organics bin for contamination ahead of the collection truck, and do a 'blitz' on issuing rejection stickers. This complements the ongoing quality control process, where each organics bin is inspected on pick-up for plastics, glass and other contaminants via colour cameras on the truck, and colour monitors in the cabs. A staged procedure of educational support, offers solutions to assist the household with each rejection sticker. In very few cases has the Council been unable to work with the resident to find a solution, and withdraw a service.

Involving and maintaining the goodwill of the community to separate their food waste, green waste, paper and cardboard into the organics bin, involves keeping people involved and informed. To this end, Lismore City Council recently threw open the doors to it's waste facility and greeted over 500 visitors to a grand open day, with a welcome pack, a self guided tour around the revolve centre, recycling centre, compost demonstration area and gardens, worm farm and landfill. The day included 4WD guided tours, tours of the worm farm and a number of environmental theatre groups performing waste reduction shows throughout the day. It was considered a great success and received much praise from the community and local media.

Lismore City Council thinks it's on the right track with a win/win system to divert the available 75% of organic material from the waste stream into a useful product, returning it back to enrich the soil. With a solid approach to waste education and sound contamination monitoring procedures, Lismore is now diverting over 50% of waste to organic reprocessing through it's Integrated Waste Service and feeling great about ESD!

Lesley Trott, *Lismore City Council's (LCC)*
✉ *Lesley.Trott@lismore.nsw.gov.au*

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Francisco J. Arroyo G.D.

Experiments and tests using fermented human urine in the production of legumes, medicinal and aromatic plants in containers, began 10 years ago [1] in the Rural Research and Training Centre A.C. (CEDICAR). This cultivation system has been called "organoponics" or "urineponics". It is a cost-effective system, saving money and water, is capable of producing an average of 25 kg of legumes per year per m^2, and has been culturally accepted by most of the families and institutions with which we have worked.

Organoponics: the Use of Human Urine in Composting

The main advantage of this cultivation system, especially where land is scarce, is that after 10 months of growth, the initial substratum has decomposed, resulting in compost, rich in organic matter.

ORGANOPONICS

The organoponic system developed in Mexico, mainly in urban areas, is extremely simple. First, containers are filled with leaves and/or grass trimmings up to 85% of their capacity. Then they are inoculated with fermented urine and filled with an additional 15% of topsoil. Finally, the seed is transplanted or sown.

Urine is fermented by placing one litre of urine in a container and adding a spoonful of black soil, compost or vermicompost. It is left to sit without cover for 28 days. The process is completed when the smell of ammonia becomes pervasive and the colour changes from light yellow to dark brown.

ENVIRONMENTAL HEALTH

The use of urine as fertilizer highlights the added benefits of dry toilets, as well as edible backyard and rooftop gardens. Families are also encouraged to donate their urine to the municipal system for treatment and use in peri urban agriculture.

Urine is innocuous, its use is guaranteed and carries no health risks (2). Most of the pathogens that cause human diseases die quickly once urine leaves the body. If some subsist, the lactic bacteria and the Actinomycets would destroy them during storage and during the fermenting process.

ORGANOPONICS AND OTHER COMPONENTS OF URBAN AGRICULTURE

The technique allows the recycling of organic matter (used as substrata) and promotes the sorting of household wastes and the development of household, neighbourhood and municipal composting centres. It also saves water, promoting dry, urine-separating toilets, which alleviates the accidental discharges from toilets and septic tanks reaching water bodies, causing their eventual eutrophication.

Although household gardens are not conceived as a business or a small undertaking, a 10 m^2 garden can bring a family savings of 80 to 100 US$ per month. The household diet is improved as healthy and fresh legumes become more easily available.

The practice can be used as participatory environmental education process for the poorer segments of the population, which will reinforce community ties and neighbourhood organizations. Gender studies and surveys on the distribution of household work are being conducted. The provision of support and incentives to environmentally conscious families needs to be included in environment, public service, health and economic policies of local authorities. It would also be feasible and desirable, for local authorities to set up urban agriculture divisions and integrate urban agriculture into municipal agricultural initiatives. Having a municipal greenhouse and composting centre that supplies seedlings and compost is, without doubt, a strategic action that will help to achieve continuity and maintain family gardens in good condition.

The use of human urine as fertilizer in urban agriculture requires that it be developed as a local authority backed programme. Systems to collect, transport, store, treat (ferment) and apply, need to be developed. The same farmers interested in using urine can take part in this programme and develop an enterprise for the handling both of urine and faeces and their secondary treatments before being used as fertilizers. The role of the municipality will be to facilitate these activities and perhaps, find funds to partially subsidize the process.

Use of the ferment:

❖ In organoponics, 3 litres per bucket with 19 litres of compressed leaves, (15 litres per m^2 of leaves, 20 cm deep). This is the initial dose. Then, it is diluted at a ratio of 10:1, (10 parts water to 1 part ferment). A quarter of a litre of this is applied per bucket, three times a week (Monday, Wednesday and Friday).

❖ On the soil, it is applied combined with irrigation and/or rainwater in doses still being tested for different crops.

Composting activator: as urine ferments, significant populations of Actinomycets emerge, which are microorganisms especially apt to degrade lignin and cellulose. For this reason, it can be applied at a dose of 5 to 20 litres per m^3 of carbon rich material, to substitute and/or complement other manure.

(Consult www.laneta.apc.org/sarar)

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Notes

1) Based on a brochure published by the State of California, USA, written by Dr. Barbara Daniels (Fairfax California. USA, year unknown).

2) Vinneras Björn "Possibilities for sustainable nutrient recycling by fecal separation combined with urine diversion. Doctoral thesis. Swedish University of Agricultural Sciences. Uppsala 2002. Esrey A. Steve, et.al. "Cerrando el Ciclo. Saneamiento ecológico para la seguridad alimentaria. UNDP-SIDA. Mexico, 2001.


Andrew Bradford

Easy to operate 'Suame' compost tumbler

In Kumasi, Ghana, pollution and waste disposal problems are most acute in the periurban areas, where waste management services are seldom provided. These transitional areas are characterized by squalid and hazardous waste.

Container Composting in Periurban Kumasi, Ghana

Daily domestic waste consists mainly of vegetable and fruit peelings (cassava, yam, coco yam and plantain) and wood ash, with only small quantities of sand and plastic bags. Composting domestic waste for use in urban agriculture is one strategy which can be adopted at the household level.

CONTAINER COMPOSTING

When left long enough, all organic matter decomposes due to breakdown by bacteria and other living organisms. Composting is a method of controlling this process by accelerating the decomposition rate while also minimising the nutrient loss. Backyard composting in residential areas requires suitable composting containers to stop disease vectors and vermin from being attracted to the compost pile, thereby ensuring that the composting process remains safe, hygienic, acceptable to local residents and conforms to district and municipal sanitation by-laws. Compost containers can be used to obtain the optimal decomposition conditions by regulating the air, humidity and temperature during the composting process. With appropriate handling the decomposition rate can be greatly accelerated; good practices include the cutting up and shredding of the organic matter, sprinkling water on the pile if it becomes too dry (dusty with ants), mixing the pile to increase aeration and keeping the container closed during heavy rains to prevent (the pile from) water logging.

For effective decomposition, it is equally important to supply the microorganisms within the compost pile with the optimal carbon/nitrogen ratio of 25-30:1 (C/N ratio). To obtain a suitable C/N ratio, materials with a high C/N ratio such as sawdust (C/N ratio up to 400), must be mixed with materials with a low C/N such as chicken manure (C/N ratio of 7). If the C/N ratio is incorrect and there is too little nitrogen, decomposition will be slow and the compost of low quality; and conversely if there is too much nitrogen the compost will become putrid, acidic and compact and the quality will deteriorate (Agromisa, 1999). Turning the pile and adding dry porous materials (carbon rich), such as leaves, sawdust, or straw, can easily rectify this problem.

COMPOSTING DEMONSTRATIONS

During a participatory action research (PAR) project into community based waste management strategies, several container-composting micro-projects were implemented at the household level in six periurban areas of Kumasi (1). The micro-projects have been strategically distributed at prominent points throughout each of the six areas to provide simple demonstrations that can be easily replicated by other community members. By increasing the number and distribution of micro-projects in each village and by conducting composting workshops, the dissemination capacity is increased and a wider community audience can be reached. However, interventions must be well planned due to the time required for compost production, hence local people must be actively participating in all stages of the planning and implementation process.

The main container-composting method being demonstrated was **block-built compost bins** (bricks may also be used). This method was chosen because of the wide availability of clay, wooden and concrete building blocks in the localities. The bins consist of a double-chamber with wooden lids that cover each chamber. Mortar can be used when a permanent structure is required. Otherwise the blocks can be left without, for temporary use or portability (the blocks on the front of the bins are better left unmortared to provide easy access when removing the compost.). Gaps are provided between the bricks in the bottom course to facilitate airflow, while making holes with a sharp stick and mixing the compost pile provides additional aeration. The chambers are filled sequentially and once the second chamber is full, the compost in the first chamber can be emptied and the mature compost stored until ready for use. Each compost bin is sufficient for a household with an extended family. Larger versions consisting of three high-capacity chambers were also demonstrated.

Unlike the brick-built compost bins the '**Suame compost tumbler**' has a smaller capacity and is therefore only suitable for smaller households (2). It is designed to accelerate organic decomposition while ensuring hygienic conditions are maintained; specific design features were included to ensure suitability for local conditions and ease of use by children. The tumbler consists of a 250litre drum mounted horizontally onto a steel axis that is supported by a frame made from 50mm angle iron. The opening is made by cutting out a section in the side of the barrel, which is then reattached with hinges and a hasp to provide a means of closing the barrel when tumbling the waste inside. With the barrel in the upright position (door opening uppermost) two rows of six holes (4mm diameter) are added

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underneath the barrel to allow drainage and 11 holes (4mm diameter) are added at each end of the horizontal drum to allow additional aeration.

Other container composting methods that were demonstrated included **barrel composting** and **vermicomposting** (use of earthworms), both of which were constructed using recycled materials found within the localities. Old 250litre drums can be used as composting containers simply by making aeration holes around the drum and providing a cover on top. If the base of the barrel is still intact then drainage holes need to be made in the base; any draining runoff that is collected (stand drum on some bricks and place small container under drainage holes) can be diluted 1:10 and used on crops as a liquid fertilizer. If the drum has no base it can be placed directly on the underlying soil. Similarly, old 250litre drums or plastic drums can be used to build simple vermin-composting units. First aeration holes are made around the drum before locating the drum in a shaded area, place stones in the bottom up to a depth of 10cm for drainage, cover the stones with a perforated wooden board or nylon sacking with slits (which stops the worms escaping while still allowing drainage), add mature compost to a depth of 10cm for the worm bed and then add local varieties of red worms (e.g. *Lumbricus rubellus*) and brandling worms (e.g. *Eisenia foetida*). Then add a few handfuls of organic waste to start the process, being careful not to overload the container, as until the worm population has increased they will only cope with small amounts of waste. Keep the compost covered with several layers of damp newspaper or plantain and/or banana leaves sprinkled with water to prevent the compost from drying out. Once the container is full, carefully remove the top 10cm of compost for use as the next worm bed as it contains most of the worms. The remainder of the compost in the drum can then be emptied and is ready for use and the cycle can be started again.

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PERFORMANCE AND PROBLEMS

After construction of a compost bin or allocation of a tumbler, the respective household members received training in waste separation and composting techniques. In addition, information leaflets in both English and the local Twi language were distributed, which provided clear instructions in environmental sanitation, household waste separation and container composting. The demonstrations were monitored over several weeks during which further training and technical assistance was provided, particularly if any problems had arose.

All the containers proved to be effective for decomposing organic waste, particularly when good composting practices were followed (shredding of organic materials and frequent aeration). Problems that have occurred have resulted when containers are filled rapidly and the waste inside compacts and then putrefies. Removing the top layers and increasing aeration of the remaining compost pile has remedied this. Teething problems were also encountered with the compost tumbler due to insufficient aeration holes, which was easily rectified by making the additional 11 holes (4mm diameter) at each end of the horizontal drum.

In economic terms the most cost-effective have been the containers that were constructed from recycled materials and hence required no financial inputs. These included the barrel composting and vermin-compost containers and unmortared block-built compost bins constructed from recycled blocks. Whereas the average construction cost of each double chamber block-built compost bin was approx. EUR 13, the construction cost of each compost tumblers was approx. EUR 58. Despite the compost tumbler being highly effective in decomposing small quantities of organic waste, the construction cost exceeds the purchasing power of many periurban farmers and therefore could only be viable if financial assistance was provided. Conversely, the wide availability of building blocks (both modern and traditional sun baked) increase the viability of block-built compost bins, particularly the larger triple chamber container as the cost can be divided by several households.

POLICY IMPLICATIONS

Separating and composting domestic waste at the household level can lead to substantial decreases in waste outputs and thus contribute to a cleaner environment, particularly in periurban areas that are plagued by open waste dumps. Furthermore, composting and reusing domestic organic waste is a means of recycling nutrients and restoring soil fertility, contributing to soil structure and humus, increasing organic matter and improving the water holding capacity of soils. However, the implementation of backyard composting programmes requires substantial educational and training inputs, with the beneficiaries participating in all stages of the planning and implementation process. Successful implementation can be enhanced through providing demonstrations and information leaflets and by conducting composting workshops. Financial assistance may also be required to purchase any required materials to build compost containers.

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Block-built triple chamber compost bin being used at Apeadu Junior Secondary School, Kumasi

Notes
1) Acknowledgements to the Communities of Adagya, Apeadu, Asago, Domeabra, Esereso and Kyerekrom for their project participation. Research funded by the UK Economic and Social Research Council (ESRC grant no. R42200134386). Micro-projects funded by the International Water Management Institute (IWMI), Ghana Office. Research conducted in collaboration with IWMI, Ghana Office.
2) The tumbler is an outcome of collaborative work between the Centre for Developing Areas Research, Royal Holloway, University of London and the Intermediate Technology Transfer Unit, Kumasi.

Faecal Sludge Application for Agriculture in Tamale, Ghana

Tamale Municipality is the largest settlement in Northern Ghana with a population of about 300,000. There is no functional sludge treatment facility in the city, and sludge is discharged into open lands and in nearby streams on the fringes of the city. Part of the faecal sludge is used by Tamale farmers, on which this article reports.

The area has distinct rainy and dry seasons and a unimodal rainfall pattern with about 1000mm of rainfall per annum (Ghana Meteorological Services Dept., 2002). The annual population growth rate is 2.7%. On the average, the Tamale urban area covers a radius of about 25-30 km from the central core of the city in all directions (Balma, 2003). Records of the Municipal Sanitation Unit (MSU) show that an average volume of 30.607m^3 of faecal sludge (FS) is generated annually. About 83% of the FS generated by the population is collected and disposed by the MSU, while 17% is disposed off by individual households, particularly those who use the bucket type of toilet facilities. Toilet facilities are not adequate; hence 12% of the inhabitants resort to unorthodox places of convenience.

USE OF FAECAL SLUDGE BY TAMALE FARMERS

According to the MSU, there is no particular single point for the disposal of faecal sludge. Over ten locations are in use around the city. The waste is disposed off on available land perceived to be in a "convenient" environment. Although the MSU has no official reports on farm delivery of this waste, the suction truck drivers reported that, farmers do request for the faecal sludge to be discharged on their lands during the dry season. Sludge is later incorporated into the soil at the start of the farming season. Generally, men are solely responsible for the acquisition and application of faecal sludge, on all the farms. This is because men generally own land due to the traditional set-up, and there are no women's fields. These are subsistence rural farmers who have been farming for many years in communities surrounding Tamale, but now find themselves within the expanding township boundaries. Crops cultivated are mainly maize, millet and sorghum (cereals).

The preferred type of sludge in use is the partially stabilized sludge from septic tanks (septage). According to the farmers, faecal sludge has been used in their communities for the past 25 years. Its effect in improving the productive capacity of the soil was identified as the main reason for use. Higher crop yields are obtained from fields fertilised by FS compared with other sources of organic and inorganic fertilisers.

From the farmers' experience over the years, five trips of the suction truck with capacity 4.45m^3 are used to fertilise one acre of land (0.4 ha). This works out to an average application rate of about 56m^3 per hectare.

Based on the current FS application rate by farmers, about 550 hectares of land can be fertilised annually using the faecal sludge that is generated in the municipality at the current collection volume.

Through this practice, significant amount of plant nutrients in terms of nitrogen (N), phosphorus (P) and potassium (K) is returned into the soil, and in addition, the level of organic matter is gradually built up. Based on the average concentration of nutrients in human excreta as reported by Drangert, (1998), estimated amount of N, P, K and carbon in the applied sludge is presented in Table 1. This estimate does not consider loss during sludge storage in septic tanks and the amount lost in the field beyond the reach of plants.

METHODS OF CULTIVATION WITH FAECAL SLUDGE

The farmers employ two methods in sludge application for crop production: surface spreading and the 'pit' method.

Surface spreading of sludge involves the discharge of faecal sludge at various random points (accessible to the septic emptier), on the farmers' plot. The period of application is during the dry season (end of October – December). In February and March, at the end of the dry season, the faecal sludge so applied becomes very dry, and farmers gather and redistribute this material evenly on the field before cultivation.

Table 1. Estimated amount of nutrients applied in faecal sludge by Tamale farmers

Nutrient	Nutrient concentration (kg)		
	Total in human faeces (kg/0.55m^3) *	Total in kg/m^3	Amount applied (Kg/ha)**
Nitrogen (as N)	4.5	8.18	455
Phosphorus (as P)	0.	1.09	61
Potassium (as K)	1.2	2.18	121
Carbon (as C)	11.7	21.27	1183

* Source: calculated after Drangert 1998 based on the nutrient concentration in human faeces per person-year.
** Approximately 56 m^3 of raw sludge is applied per ha in Tamale

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Discharged faecal sludge in farmers' field in Tamale Municipality

The 'pit' method involves digging pits on the farms and placing of rice /maize straw or bran at the bottom of the pit and then pouring faecal sludge on the straw. The FS is then covered with another layer of straw and this process is repeated until the pit is full. This mixture is left to compost for months (November to end of March). Before cropping season starts, the pit is emptied and the dry mixture of faecal sludge and straw applied evenly on the field.

The 'pit' method is not as widely used as the surface spreading method because it requires quite large quantities of crop residue in combination with the faecal sludge. Nevertheless, those farmers who can spare enough crop residues favour the method. Advantages of the 'pit' method are in easier FS application and mixing with soil when dry, and improvement of soil characteristics, such as bulk density (BD), etc. This method has been used for over 20 years, and is an ingenious innovation; which according to farmers interviewed in 2002, has not been introduced by any particular agency.

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Pit prepared in farmer's field for storage and drying of faecal sludge

Over the years, farmers have been able to take advantage of the savannah climate in the use of faecal sludge. As shown in Figure 3, the long dry season starts around November and lasts till about end of March/April every year. Temperatures and solar radiation at that time of the year are high, while relative humidity is low (generally less than 50% and in some years as low as about 5% in January). These conditions lead to effective drying of the discharged sludge and allow the sludge to be handled easily during its incorporation into the soil. Moreover, the health risk associated with use of FS is reduced, as most microorganisms contained in the sludge would have been inactivated due to the long drying period.

By the time of the first seasonal rains (usually in April) the sludge is completely dry and ready for use. It is then evenly distributed on the field prior to land preparation and planting.

The farmers mention itching and swollen feet as main problems when incorporating FS into soil during land preparation period. Related studies are in progress to determine the extent of health risk involved with the use of FS in Tamale. Staff of MSU who convey FS to farmers' fields (mostly septic tanker drivers) while fresh, are also being studied regarding the health risks they are exposed to in the course of their work.

PROBLEMS ASSOCIATED WITH THE USE OF THE SLUDGE BY TAMALE FARMERS

During focus group discussions with farmers, the following problems emerged as affecting the use of FS for crop cultivation:

- ❖ Increased urban population, resulting in agricultural lands being turned into human settlement areas.
- ❖ Farmers who have fields near large housing areas are prevented by the neighbours to use faecal sludge due to its bad odour.
- ❖ Landowners do not allow farmers on hired land to use sludge, despite its positive effects on soil fertility.
- ❖ Some people shun the consumption of crops cultivated with faecal sludge.
- ❖ Excessive weed infestation after the application of faecal sludge.

CONCLUSIONS

There is a general consensus is that fresh faecal sludge contains high levels of organisms that cause gastro-intestinal infections (GI) in man (Strauss, 2000). It is also necessary to study the health consequences of the long-term use of faecal sludge and the consumption of crops grown with this method in Ghana. Faecal sludge is not processed or treated in any way before application on farmers' fields at present. In this condition, it poses an obvious threat to health of both farmers and suction track drivers involved in this process.

Farmers are taking advantage of the local climate to facilitate the drying and FS application. However, there is the need to study the process thoroughly in order to suggest sustainable measures for its long-term use. Future sanitation plans for Tamale, by the Municipal Sanitation Unit and other relevant agencies, should consider its consequences on this enterprise.

Further studies on this practice is on going, with the objective of documenting the impact of sludge use on agricultural productivity, livelihoods and health of the farmers in Tamale. Perhaps the farmers' ingenuity in the use of FS is a worthwhile consideration as an alternative method of sludge disposal with a view of reducing environmental pollution, while at the same time supplying the needed input for crop production.

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Conversion of Urban Waste to Energy by Anaerobic Digestion

Although the technology of generating and using biogas dates back 3000 years (Lusk 1997), it is still seen as a risky and new technology. In Malaysia, about 41% of the land area is cultivated. Urban agricultural activities improve food security and income generation, and enhance public health by providing more food and a diversified diet, but also by improving resource management through excreta, wastewater and organic solid waste reuse.

In Malaysia around 60% of waste generated arises from urban sector consisting mainly of sewage, domestic and agricultural solid waste, whereas the agro-industrial contributes to 20% and the rest from the industrial sector and construction. The existing treatment method for solid urban waste is either by landfills, composting or incineration, whereas in the case of sewage aerobic oxidation process is adopted, resulting in huge power input and land area for the treatment process.
The Federal Territory of Kuala Lumpur and Selangor State alone generates approximates 8300 tons/d of urban waste out of which 60% is organic with a total solid content of 30% and a volatile solid content of 70%. By adopting anaerobic process, assuming the digester efficiency as 50% and the biogas produced as 0.72 m^3/kg of VS destroyed could have resulted in 15,687 m^3/hr biogas with a net power generated as 683 MWh/day.

Malaysia's palm oil sector is a major source of renewable energy in which 360 mills churn out 30 million tons of empty fresh fruit bunches (EFB) every year. For every ton of fresh fruit bunch (FFB) processed about 0.9 m^3 of effluent is generated with a COD of 52,000 mg/l. Assuming the digester efficiency as 70% and gas generation as 0.42 m^3/kg of COD destroyed. The amount of biogas generated per ton of (FFB) processed would be 13.75 m^3. Hence, adopting anaerobic digestion will reduce green house gases (GHG) and generate energy.

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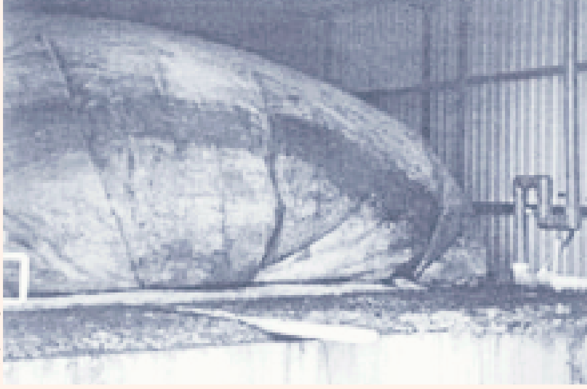
TYPES OF ANAEROBIC DIGESTERS

Batch and Dry type digester
This is the simplest of all the processes. The operation involves merely charging an airtight reactor (made out of concrete, brick wall or MS / SS with epoxy coating) with the substrate, a seed inoculum's (sewage sludge or cow dung), and in some cases a chemical (regularly a base) to maintain almost neutral pH. The reactor is then sealed, and fermented. When fermented with a solids content (6 - 10%) is known as batch digestion, and solids concentrations (>20%) is known as "dry" fermentation.

Fixed Dome digester
Fixed Dome (Chinese) digester was built in Jiangsu, China as early as 1936. The reactor consists of a gas-tight chamber constructed of bricks, stone or poured concrete. Both the top and bottom of the reactor are hemispherical, and are joined together by straight sides. The gas produced during digestion is stored under the dome and displaces some of the digester contents into the effluent chamber.

Floating Dome digester
Floating Dome (Indian or KVIC Design) biogas technology has developed since 1937. In 1950, Patel designed a plant with a floating gasholder, which caused renewed interest in biogas in India. The digester is designed for 30 to 55 days of retention time. The main material fed is cattle manure. The drum was originally made of mild steel, and later on replaced to fibreglass reinforced plastic (FRP).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Bag digester

Bag digester
Bag digester is essentially a long cylinder (length: diameter 3:14) made of PVC, a Neoprene coated nylon fabric, or "red mud plastic" (RMP), a proprietary PVC. The digester acts essentially as a plug flow reactor. The Taiwanese evolved the bag digester primarily to treat swine manure, due to its low cost and excellent durability. One advantage of the bag is that its walls are thin, so the digester contents can be heated easily if an external heat source, such as the sun, is available. The average temperatures in bag digesters, compared with dome types, are 2° - 7°C higher.

Plug Flow digester
A typical plug flow reactor consists of a trench lined with either concrete or an impermeable membrane. To ensure true plug flow conditions, the length has to be considerably greater than the width and depth. The reactor is covered with either a flexible cover gasholder, anchored to the ground, or with a concrete or galvanized iron top. In the latter type, a gas storage vessel is required. The inlet and outlet to the reactor are at opposite ends, and feeding is carried out semi-continuously, with the feed displacing an equal amount of effluent at the other end. The first documented use of this type of reactor was in South Africa in 1957 (Fry 1975).

Anaerobic filter
In order to reduce reactor volume, a unit known as the immobilized growth digester has been evolved. One of the earliest and simplest types of this design was the anaerobic filter. This typically consists of a tall reactor (H/D = 8 - 10) filled with media on, or in which the organisms can grow or become entrapped, like river pebbles or plastic media. The advantage of attached growth process is that it can overcome toxic effect, organic shock loadings and low biomass washout from the reactor.

Anaerobic Baffled Reactor
The reactor is a simple rectangular tank,

with physical dimensions similar to a septic tank, and is divided into five or six equal compartments, by means of partitions from the roof and bottom of the tank The liquid flow is alternately upward and downward between the partitions, and on its upward passage the waste flows through an anaerobic sludge blanket, of which there are five or six. Hence the waste is in intimate contact with active biomass, leading to higher treatment efficiency.

Anaerobic Contact Process
This process in similar to the aerobic activated sludge process, in that cell recycling is used to maintain high biological solids retention at low HRT. The first recorded instance of use of the anaerobic contact process occurred in 1955 for treating meat packing house waste (Schroepfer et al. 1955).

Upflow Anaerobic Sludge Blanket (UASB)
This process was developed by Lettinga et al. (1979) in the Netherlands. The reactor consists of a circular tank (H/D = 2) in which the waste flows upward through an anaerobic sludge blanket comprising about half the volume of the reactor. An inverted cone settler at the top of the digester allows efficient solid-liquid separation.

Inclined Tubular digester
The inclined tubular digester is a modified form of the horizontal displacement digester. The digestion vessel is tubular, but inclined at an acute angle to the horizontal. Thus, the main advantages of a horizontal displacement digester are retained, while the exposed surface area of the digester contents, where scum and crusts can form, is minimized. It is also mechanically simpler to remove any scum and crust.

The main applications of this design are likely to be for treating particulate waste of <8% total solids concentration, where some settling will occur.

Closed Type Anaerobic Lagoon
Anaerobic lagoon has the advantage of handling wide waste characteristics including solids, oil and grease. The main disadvantage is that it requires a large land area, inefficiency in feed flow distribution and maintenance of geo-membrane cover

The choice of the anaerobic reactor selection depends on individual perception. Normally attached growth process are not employed for treating waste containing high solids concentration (> 3-4%), as it may lead to clogging in the packing media.

DESIGN CONSIDERATIONS
Design of anaerobic installations, is based on a fundamental understanding of the anaerobic processes, the type of waste, the amount of dilution water to be added, loading rate and the desired retention time with minimum "washout" of biomass.

Control Parameters In Anaerobic Process:
The raise in digester temperature should not be more than 1°C/day as it will lead to thermal shocking, optimum pH range (6.5-8.5) and volatile acids content in the digester (200-1500 mg/l). The ammonia which results from protein degradation should not be more than 3000mg/l as ammonium ion and 150mg/l as free NH_3.

Type Of Waste: The primary limitation on livestock waste loading rates is the high nitrogen (N) content compared to its carbon (C) content. The ratio of carbon to nitrogen in the waste added to the digester should be 20 parts C to one part N for optimum methane production. Crop residues and leaves, which are usually low in nitrogen content but high in carbon, could be useful in improving digester performance. Mixing crop residue with high nitrogen livestock waste provides a more favourable C:N ratio for biogas production.

Amount Of Dilution Water: The maximum solids content in the feed material to the digester can be 12%, above which causes frequent choking of feed pump and mixing of digester content become difficult. Wash water from domestic or animal holding area or primary sludge or treated sewage / industrial wastewater can be used for dilution purpose as it also serves as recycle.

Loading Rate: Loading rate normally ranges between 1.0 to7.2 kg VS/m³day, on average its between 1.5 to 3 kg VS/m³day. Above 3.2 kg VS/m³day toxicity of ammonia limiting may occur depending on the feed material and at any cost the loading should not exceed 6.4 kg VS/m³day

Desired Retention Time: The minimum retention time is 15 to 20 day, depending on the loading rate, type of feed material, mixing of digester content and type of digester, the retention may be increased to have maximum treatment efficiency.

Digester Mixing: This is done in order to have a homogenous condition throughout the reactor with respect to pH, temperature and volatile fatty acid concentration.


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Closed type anaerobic lagoon

CONCLUSION
The Biogas can either be used as fuel for burning lanterns, for cooking in domestic or other uses. Adopting the anaerobic digestion in the (urban) agricultural sector would help to treat the waste and would benefit the community in term of value added return in the form of biogas / power and nutrient. The anaerobically digested sludge is useful not only for raising the fertility of soil, improving soil, increases agricultural production, but also be used for feeding fish, finless eel, earthworm and pigs, breeding silkworm and hatching chickens.

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In India, night soil and wastewater reuse in agriculture is a traditional practice followed in irrigation for centuries. West Bengal is the pioneering state with 279 wastewater fed farms on an area of 4000 hectares, supplying more than 13,000 tonnes of fish per year to customers in the city.


De Borhegyi (FAO)

Carp raised in aquaculture pond in India

Waste-Fed Fisheries in Periurban Kolkata

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The use of municipal wastewater to fertilize ponds began in Kolkata in the thirty's, and it is now perhaps the largest wastewater fed aquaculture system in the world (Nair, 1944; Jhingran, 1991). Kolkata is a metropolis of 14 million inhabitants. The Kolkata periurban area especially where wastewater fish farming is practiced supports the livelihood of a large number of people through waste recycling and natural resource use. It is uniquely privileged in having a built-in tradition of using urban waste in fisheries and agriculture. The city sewage undergoes bio-treatment through production of profitable protein and environmental purification along with employment generation.

The vast low-lying area to the eastern fringe of the city is popularly known as East Kolkata Wetlands (EKW). The tradition of waste recycling is now in danger and under threat of encroachment, by urbanisation. The wetland ecosystem of Kolkata is a delicate, complex and under studied area, which requires immediate attention for the survival of the city. The 3 main production systems of this area, are sewage fed aquaculture; garbage fed horticulture and irrigated rice production.

EXISTING CULTURE PRACTICES

The culture practice of fish is basically a composite system using different species of fish, which utilize different ecological niches of pond ecosystem. The poly-culture practices followed in wastewater fed fish farms are Indian Major Carp, (IMC: i.e. *L. rohita, C. catla and C. mrigala*), Exotic Carps and Tilapia poly-culture system. In some places also mourala (*Amblipharyngodon mola*) and freshwater giant prawn (*Macrobrachium rosenbergii*) have been tried. Apart from these, two additional species of Indian carps (*Labeo bata, Labeo calbasu*) and one exotic carp (*H. nobilis*) also have been introduced in Kalyani Sewage fed fishponds.

In an attempt to utilize wastewater for the large scale of tilapia, Ghosh et al. (1980) observed that the production was not affected even at very high levels of ammoniac-nitrogen concentration of 5.13 milligrams per litre. (The maximum permissible concentration of ammonia is about 0.1 milligrams per litre). However, the pH level at 8.4 and the oxygen levels at 4.4miligrams were at the most favourable levels for production, which yielded volumes between 8100 – 9400 kg/ha/yr. Similarly, in Titagarh, the production of freshwater giant prawns in a wastewater pond receiving wastewater at a ratio of 1:3, yielded about 500 kg/ha/8 months is another trial (Ghosh et.al., 1985). In general, fish yields from wastewater fed ponds are 2 – 4 times higher than those from ordinary fish culture practices.

ACHIEVEMENTS AND FUTURE

The sewerage based fish culture with its ancillary activities in Kolkata, provides employment to about 30,000 people on full time basis. There are thirteen Fishermen' cooperatives and 38 Fish Production Groups formed by the Department of Fisheries of Kolkata. (One of the fishermen' cooperatives on lotus culture already was formed 75 years ago). Plans are underway to set up a cooperative for women involved in making by products from fisheries. In addition, there is several eco tourism developments, for example, the Nalban Boating Complex and the Mudiali Nature Park which is managed by a Fishermen' Cooperative, and provides shelter to 10,000 migratory birds.

The Department of Fisheries is trying to raise funds for the improvement of the East Kolkata Wetlands. This money will be utilized for increasing the depth of the 'bheries' (the embankment of fishponds) by one meter, developing more eco-tourism facilities, reconstructing the residential 'kuchcha' houses (built of bamboo/clay/tiles) into 'pakka'houses (built of brick and cement); support fish markets; and to support to the plantation of medicinally important plants.

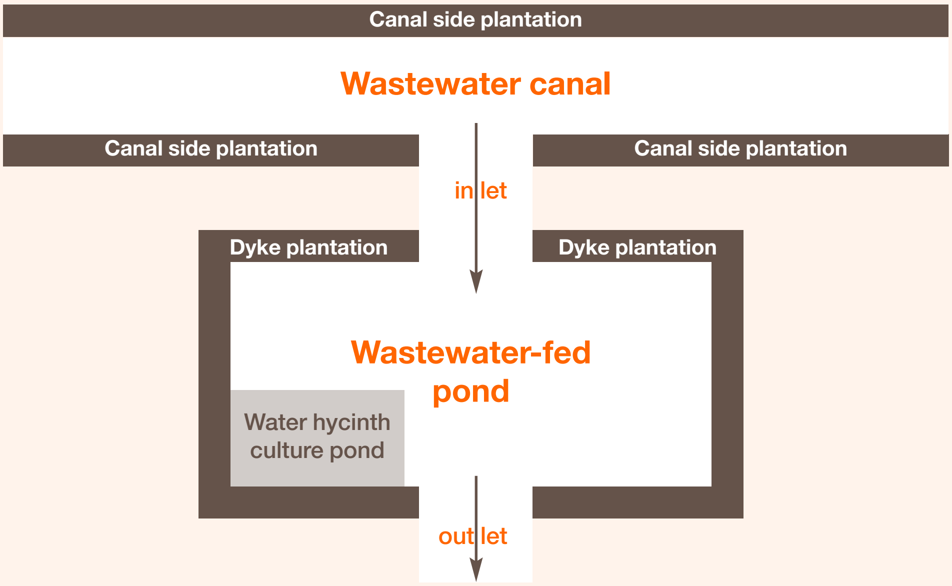
It is reported that only 30% of the total wastewater is used for aquaculture or irrigation purposes. The rest 70% of the wastewater is directly discharged into the Bay of Bengal, which pollutes the total estuarine region, and subsequently reduces aquatic biodiversity, causes large-scale deaths of fish seeds. Therefore, if the aquaculture farmers would use most of the wastewater, this problem may be mitigated.

Recent advances in information and data processing technologies have dramatically increased the capacity to analyse complex multiple resource-use options and to link up large numbers of people into integrated decision–making structures. There has also been new research on industrial ecology, where the waste product of one process is used as an input for others. Improved management along the industrial ecology model in Kolkata, would ensure the utilization of waste from one sector by another, but also improve environment quality, improve food security and guarantee employment.

A SUGGESTED MODEL

The dense plantations on the ***canal side*** maintain the environmental stability through preservation and restoring the ecological balance. It controls soil erosion as plants can absorb some amount of pollutants from wastewater and produce nutrient rich water for aquaculture. These mangrove plans (such as Neem, Banyan, Kadom, Mango, and Guava) decrease the pollution level of wastewater and as well as produce fruits, which bring an extra income for the local people.

Mainly different types of large, fruit bearing plants are used upstream (where the soil is not saline) of the wastewater canals of Kolkata. Neem, Banyan, Kadom, Mango, Guava etc. are planted on the both side of the wastewater canals. Downstream of the canals, where the soil and water characteristic is saline, different mangrove plants are used in plantation programme. The plants are mainly Sundari, Garan, Kankara, Keya, etc. These plants are able to control the soil erosion as well as maintain the ecological stability of this zone.



A schematic diagram of sewage-fed fish farming

Where the canal bed and adjacent area is not suitable for plantation, the different types of animal fodder crops could be grown. Such species are very resistant, need little care and creates new market opportunities for the local people. This new dimensional farming system may also encourage livestock farming in this region. Fodder crops absorb some amount of pollutants from the wastewater and so it has an added economic and ecological value.

The farmers should further be encouraged to start dyke plantation on the 'bheries', embankments of fishponds. Dyke farming is essentially about gathering excavated mud on the dyke of the pond on which vegetables such as drumstick tree (Sagne), mustard, and sunflowers can be grown. Dyke farming could also control the soil erosion, increase space for farming and to maintain the ecological balance of the wetland ecosystem. The independent and government fishermen' cooperatives could start lotus farming inside fish culture ponds. Lotus farming attracts aquatic insects and birds, which helps in pollination. The lotus flower itself has a high economic importance; it is the national flower of India.

INTEGRATED AQUACULTURE

In the waste-fed zone of Kolkata, integrated farming should be started for the best possible utilization of farm space and optimum reuse of waste. It is economic as well as environmental friendly. Ducks, poultry, dairy, pigs, and goat farming could be started along with the fish culture. Dyke cultivation is also a part of integrated farming.

The involvement of fishing community women in integrated farming efforts needs to be encouraged. They should also be assisted in increasing the production of fish by-products such as dried fish pickles. This would enhance their economic stability as well as they dignity and social status.

The author also recommends that every cooperative society maintain a freshwater pond, where the harvested fish are stocked for one day. This will enable the remaining sewage odour and any pathogens to be removed from the harvested fish.

This holistic approach will only be possible if social planners, who have a pivotal role to play in this process, engage in sensible land use planning. This no or low waste industrial ecology system for the East Kolkata Wetland, has been designed to involve people's participation, aiming at increasing economic growth and environment sustainability.

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Improving Agro-Enterprises in Duong Lieu Commune, Vietnam

Dong Lieu commune in Hay Tay province lies some 20km from Hanoi. The area is traditionally agricultural but has, since the late 1960's, specialized in household-level root crop – cassava and canna – processing, due to its proximity to Hanoi and access to its growing markets. Since that time this processing capacity has increased 3-10 times.

The average cassava processing has increased from 0.05 tons/hh/day in 1978 to 3 tons/hh/day in 2001, while the average canna processing has increased from 0.04 tons/hh/day in the 1960's to 9 tons/hh/day (partly because of increased demand and also because of improved technologies). The volume of roots handled by each trader has increased by 200 to 300% over recent time. Of the 2,193 households in the commune, 1410 households (64%) are directly involved in root crop processing, while others supply raw materials, trade end products, make use of by-products, or provide a wide range of support services (Table 1).

Pig farming using the residues from cassava processing, as a major feed ingredient is a common supplemental livelihood activity in the root crop processing households. Approximately 1409 or 64% of households raise pigs. Only 4% of households obtain a livelihood from crop production alone. In the 2000/1 processing season (approximately September to April) the commune processed 680 tons of cassava roots and 314 tons of canna roots daily.

DEVELOPMENT OF THE TECHNOLOGIES

Cassava and canna are different crops, in the type of roots, properties of the starch, and different profitability of the starch. Cassava starch contains cyanide which requires the skin to be peeled, and peeled roots to be well washed, for food safety. Canna on the other hand has a more uniform shape, which makes peeling easier.

The cassava starch is easy to extract; therefore up until 2001 most processors separated starch by hand, and only one separation was enough. Canna starch on the other hand, is difficult to extract and is usually separated by feet action in order to apply one's body weight to extract the starch. However, it requires less time to settle and less time to drain. One interesting technology employed by the cassava starch processors, is the use of a layer of ash on a piece of cloth laid over the starch in order to draw out the moisture. Once the starch is sufficiently dry, the ash is taken outside, along with the cloth, to dry.

The profitability has also affected the development of the technologies used for cassava and canna starch processing (Table 2). Processors were more willing to invest in canna starch, because it provided higher profits when larger buyers from the south came to Duong Lieu in search of cassava starch for industrial purposes. Once cassava starch began to yield higher profit, separators for cassava starch emerged.

Until then, the separating machines were generally purchased for canna processing. In addition to investing in separating machines some processors were observed to employ the "sour-liquid method" (a method of applying a certain amount of the used processing liquid to balance the pH level of the settling water), and a starch-stirring machine, both of which were designed to improve extraction rates. Such elaborate processing procedures have not been applied to cassava starch processing.

In summary, the processing procedures for cassava and canna are quite different from one another, as the processors in Duong Lieu developed technologies appropriate for the nature of the roots and starch and the profitability (Table 3).

THE CONSTRAINTS—HOW THEY EMERGED

As the starch processing developed, a starch-based cluster of enterprises emerged in support or in association with starch processing. The ever-increasing enterprises are packed in the small village area, with little space to operate and no space to expand. The major constraints facing the starch processors are not the technologies, as they are developed appropriately, but the limited space and the constraints to production associated with it.

As starch processing activities increased over the years, the procurement of the raw material (i.e., the roots) became increasingly problematic, as the village was not set up to accommodate the root trading in an organized manner. Since the village is already congested and the interior roads are too small to be passable by truck, all root trading must be handled in one market location.

During the processing season, the women queue for hours (some claim 3-4 hours) to obtain roots before pushing or pulling the heavy cartload back home. Thus, much time and labour is wasted on root procurement.

There is also limited space for drying starch or starch sheets for noodles. Many processors push cartloads of starch to the fields and spread them out to dry in the morning, and return in the afternoon to collect them. Again, depending on the

Table 1. Household types in Dong Lieu, defined by their main economic activity

Household type	Number	As % of households in commune
Agricultural production (only)	98	4
Cassava processing	656	30
Canna processing	143	6
Starch filtering	300	12
Maltose production	146	6
Noodle production	150	6
Other	786	36

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Table 2. The difference in profitability of cassava and canna starch and how it has affected the development of processing methods.

	Profitability	Implications for processing
Cassava	Starch prices were generally low until 2001	❖ Processors did not invest in separating machines and most separated starch by hand until the prices became higher in 2001
Canna	Due to the popularity of canna noodles, canna starch prices are generally higher	❖ Most processors invested in separating machines, those who didn't, separated 2-3 times to increase extraction. ❖ Some also were willing to invest in "sour liquid" (i.e., to balance the pH level) and stirring machines to increase extraction.

location of the house in relation to the field, this can also be a time-consuming activity.

The limited space also contributes to low starch quality, as there is not enough room to set up various settling tanks to produce high quality starch. The starch quality is further adversely affected by drying on the very dusty or muddy roadside, as there is limited space available for drying. Thus, the limited space has resulted in serious wasted labour and low starch quality.

In addition to the adverse effects it has on production, the confined space has caused another serious problem—environmental pollution—as starch processing generates a large amount of wastewater and solid matter. On average, processing one ton of cassava roots generates 10.7 m^3 of wastewater, while processing the same amount of canna generates 12.9 m^3. Duong Lieu processed 75,000 tons of cassava roots and 50,000 tons of canna roots during the 1999/2000 processing season, thus generating almost 1.45 million m^3 of wastewater during this season. At the same time, an average of 47% of cassava roots and 33% of canna roots were turned into solid waste material. Thus, in the 1999—2000 season, and estimated 51,750 tons of solid wastes were generated.

Nearly all of the inhabitants in the processing villages said that the solid waste was odorous and unsightly. Most of the people in the processing village have had solid waste dumped in front of their houses, which has been a source of conflict among the residents. The most notable impact in the non-processing village was the processing wastewater in the canals. The residents in the non-processing village often complained about the pollution and odour and pleaded for solutions.

POLICIES, TRAINING, AND SUPPORT FOR ENTERPRISE DEVELOPMENT

After an extensive study of the situation, and during a stakeholders' meeting with the community leaders and processors, the main constraints to enterprise development were identified as limited space, wasted labour, and environmental pollution. The constraints were evident, but solutions were not so clearly obvious.

Subsequently, a trip to Dong Nai Province in southern Vietnam, to visit some medium-size processors was organized and funded by SIUPA, to generate ideas for possible solutions. A visiting delegation consisting of five people from Duong Lieu: two small processors, one large processor, one processing machine manufacturer, and one commune official in charge of local enterprises.

In Dong Nai, the delegation observed production systems, where processors were fewer in number than Duong Lieu, but larger in production sizes, processing 20-30 tons of roots per day per household. These medium-sized processors used more modern and advanced technologies and produced higher-quality starch. In addition to starch, they also produce a wide range of starch products for export. However, the two aspects of the production systems that impressed the Duong Lieu delegation the most were the *continuous filtering tank system*, which accounted for the high quality of the starch, and the way the wastes were processed and disposed.

Upon returning from the visit, the community brainstormed the idea of creating a processing zone in Duong Lieu, derived from the need to create a space to accommodate the continuous filtering tank system and a better-organized processing set up. In the discussion, it became clear that the processing zone they envisioned was very similar to that established in Pingying County in Shandong Province, China, where further lessons can be learned and training arranged.

CONCLUSIONS

The improvement of an agro-enterprise, whether urban, periurban, or rural, requires the accurate identification of where the problems and constraints lie. In the case of Duong Lieu processing, the processing technology was developed appropriately and effectively. The problems were limited space, wasted labour, and environmental pollution. The solution came from within the community itself, when they observed other production systems and compared it with the constraints they were facing. Concrete steps to implementing the solution may be learned in another visit to a processing zone of the similar nature.

This is a case of an innovative and participatory approach that has empowered the local population to solve problems and overcome constraints.

Table 3. Summary of the differences in cassava and canna starch processing procedures.

	Cassava	Canna	Reason for difference
Peeling	Peeled	Not peeled	Nature of roots
Washing	Well washed by machine	Roughly washed by hand	Nature of roots
Separating *(starch extraction)*	Separate once either by hand or by machine	Separate 2-3 times either by feet or by machine May use "sour liquid method" and a stirring machine also	Starch properties Profitability
Settling	8-12 hours	4 hours	Starch properties
Draining	12 hours	3 hours	Starch properties
Withdraw moisture	With ash	None	Starch properties

Treatment of Organic Household Waste Used as Pig Feed in Montevideo

The population of Uruguay is highly concentrated in urban centres. More than 90% live in cities and 42.5% of the country's population is found in Montevideo, the capital. Over the last decade the socio-economic crisis and an increase in unemployment forced a growing number of people to resort to alternative strategies to ensure their survival and the survival of their families. The informal collection, sorting and sale of household waste, is one of the most widespread activities and is strongly related to the domestic breeding of animals (mostly pigs and poultry). It is estimated that 25% of the 5,312 sorters (informal waste collectors) that roam the streets of Montevideo (IMM, 2002) gather 175.2 tons of organic waste per week, which is used to feed pigs in urban and per urban areas.

Municipal authorities are usually reluctant to accept this productive activity because of the environmental and health risks it entails. However, and in spite of the norms and regulations prohibiting it, it is practiced on a significant scale.

SEEKING ALTERNATIVES FOR THE MANAGEMENT OF PIG FEED

Due to the fact that feed represents 70% to 80% of the total production cost of a pig farm, they tend to establish near cities (and sometimes within cities), because it is in cities that the availability of pig feed is concentrated (as by-products of the food industry and household waste). Pig breeding in informal urban habitats (although illegal), implies a significant reuse and recycling of organic household waste, although in many cases this generates environmental problems and public health risks (Anchieri et al, 1998).

Traditionally, organic waste is given to animals with no prior treatment and, if treatment is performed, it consists heating the waste. This is costly and harmful, as the materials generally used for combustion, car covers and plastic, emit toxic gases when burnt. On the other hand, the risk of zoonosis (such as brucellosis, leptospirosis, trichinosis and cysticercosis) increases when pigs are fed with untreated waste.

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Based on this reality, the Veterinary School of Montevideo developed a series of experiments aimed at assessing and commercialising technologies for the processing and collection of organic waste, to be used as pig feed. The objectives are also to

- ❖ Reduce risks for public health and animals
- ❖ Lower environment impact
- ❖ Ensure the technologies are economically viable
- ❖ Ensure that they are replicable in cities and countries with similar problems (Anchieri et al, 1998; Anchieri et al, 2000).

In order to do this, the University used the organic household waste collected by informal collectors in Montevideo. The waste was placed in 200 litre containers and submitted to a controlled fermentation process with an addition of molasses (a by-product rich in carbohydrates obtained from the processing of sugarcane) and a proteolitic yeast (Hansenula Montevideo). The product remained under observation for 45 days; samples were taken every day to verify variations in pH (acidity) and every 5 days for microbiological indicative analyses (total coliforms and Escherichia coli). Also, meat morsels experimentally infested with Trichinella spiralis (trichina) were introduced in the containers and removed 15 days later to verify whether the larvae had survived or not. During the process, the pH dropped to 4.3 and total coliforms and Escherichia coli disappeared 15 days after the treatment began. Trichina larvae lost vitality, losing their normally rolled shape.

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CONCLUSION

The experience shows that this technology (controlled fermentation), applied at small scale, is very useful for the treatment of household organic waste, making contributions to four aspects:

- ❖ Health: the fermenting process kills microorganisms and parasites that cause serious diseases both for humans and animals.
- ❖ Environment: fermenting and storing organic waste in a controlled place, facilitates handling, decreases unpleasant odours, ensures clean facilities, considerably lowers the presence of rodents, flies and other insects, helping to control the vector-borne diseases).
- ❖ Nutrition: although the fermentation process does not improve the nutritional values of the waste itself, it favours the assimilation thereof by the animals, by hydrolysing proteins and lowering pH. In addition, the product lasts longer, making it available at times when it would otherwise be scarce.
- ❖ Socio-economic: the entire controlled fermentation process requires labour and as become a source of employment for the family.

RUAF Mid-Term Progress Review

During the past nine months, RUAF partners have been actively engaged in reviewing and evaluating RUAF's activities with the support of an external review mission.

The pre-review process began in mid 2002. All seven regional RUAF partners prepared self-evaluation reports, using the results indicators established at the start of the programme. Meanwhile ETC conducted a ten-percent sample survey amongst the users of the RUAF services that had email addresses, and another evaluation questionnaire was circulated to fifty urban agriculture experts (see page 43), to the participants of major RUAF events. The findings were consolidated by the programme coordinator into a comprehensive pre-evaluation report, which is published on the RUAF website: www.ruaf.org

THE REVIEW PROCESS

An external review team, set up by IDRC, consisted of Michael Graham, Canada and Axel Dresher, Germany. The team was requested to review the performance data, compile the 'lessons learnt' and provide recommendations for the remainder of the project as well as on an eventual phase two of the RUAF programme. Both, RUAF products and processes were considered.

In the period between November 2002 and January 2003, one of the two external reviewers paid short visits to three of the regional focal points (MDP, IAGU and UMP-LAC/IPES). In February 2003, both external reviewers visited ETC in the Netherlands for two weeks to review the products and services developed by RUAF, analyse the pre-evaluation report and the materials on which it is based, and to have individual and joint discussions with the RUAF partners. Towards the end of the second week, the external review team presented their preliminary findings and recommendations to the RUAF partners. This lead to valuable discussions on results realised, the effectiveness of the various RUAF strategies, and moreover, on the need and priorities of the eventual second phase of the RUAF programme.

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The external review team summarises the **impacts** of the RUAF project as follows:

> *"... a large number of high-quality products have been produced in topics related to urban agriculture. These products and services provide a wide range of information to identified stakeholders as demonstrated by their self-assessments and confirmed by the field visits. .....The project has achieved success with regard to the production of products and services and the establishment of process outputs that have resulted in clear but initial impacts on local authorities, researchers, NGOs, and international programs. However, much more work needs to be done, especially with regard to the integration of urban agriculture in the policies and programs of national and local governments and other relevant actors. ....Awareness has been raised effectively. ...The RUAF partners have advanced local networking and advocacy to different degrees. Latin America is most advanced; whereas, in Africa, and especially in most parts of Asia, and the Middle East these efforts are just starting".*

As the major **product outputs** of RUAF, the external review team highlights the:

- Eight thematic issues of the Urban Agriculture magazine, produced in five languages and which addresses the priority topics identified by the main client groups.
- Bibliographic database of over 5600 entries.
- Contacts database of over 4500 names and addresses of individuals and organizations with experience in urban agriculture.
- Main RUAF website as well as websites established by the regional focal points in English, Spanish, French, and Chinese.
- Various publications on urban agriculture, including an annotated bibliography, a resources guide, the leading publication "Growing Cities Growing Food, the video "Urban Agriculture", a CD-rom "Urban Agriculture Today". These products have also been translated into several languages.
- Round table discussions, poster sessions, presentation of papers and the distribution of three special issues of the UA-Magazine during international conferences.
- International and regional workshops, electronic conferences and expert meetings, often in cooperation with an international organisation.
- Assistance on the development and dissemination of policy guidelines and instruments.
- Collection and dissemination of reliable data on the presence and impacts of urban agriculture.
- Assistance on the preparation and evaluation of urban agriculture projects.
- Question and answer services.

As the main **process** outputs, the external review team identifies the:

- Seven Regional Focal Points on urban agriculture
- Capacity, commitment and local ownership of regional focal points, which were strengthened through:
  - training regional partners on the joint management of the RUAF databases,
  - involving the regional partners in the editing and publication of the UA-Magazine,
  - involving all RUAF partners in the yearly evaluation and planning of RUAF activities and in obtaining additional funding.
- Implementation of the regional analysis of information and communication needs, which led to the unearthing of ongoing initiatives and the subsequent identification of priority areas for future study and action.
- RUAF Partners contributions in strengthening of regional and national networks.
- Establishment of multi-stakeholder platforms, interdepartmental working groups, and city networks for situation analysis and action planning.
- Support provided to bilateral and international agencies and the RUAF response to their requests for information and technical support.
- Support provided on:
  - integration of urban agriculture into the international research system (CGIAR) and in regular programs of UN-FAO,
  - facilitating internal discussion on urban agriculture in UNCHS-UNDP, and the European Community (EC),
  - and stimulated the participation of bilateral and international agencies in the SGUA.
- Continuous cooperation with international organizations in the planning and implementation of RUAF activities and promotion of complementary funding.

RECOMMENDATIONS

The external review team made the following main recommendations for the future work on RUAF:

❖ Increase the visibility of the RUAF programme and its regional partners and publish the results of the first phase of the programme to a broad international audience.

❖ Further strengthen the information and knowledge management capacities of the regional partners as well as their capacities to assist local partners in the formulation and funding of development projects, to implement lobbying and advocacy activities and assist in policy review and policy formulation.

❖ Focus on the preparation and distribution of the most appropriate material to specific target audiences as a response to their specific needs.

❖ Develop methodologies for systematic monitoring of urban agriculture activities and quantification of urban farming activities and their economic impact.

❖ Upgrade the contacts database and to further enhance access to full text documents and abstracts of grey literature.

❖ Create an advisory group of persons with experience in gender and urban agriculture to advise RUAF partners on the mainstreaming of gender in urban agriculture and on the planned expert consultation on gender and urban agriculture related thematic issue of the UA-Magazine.

❖ Strengthen the efforts to facilitate policy change, including local policy lobbying, stimulation of the establishment of local stakeholder platforms and support to their development, as well as improved international links with such organizations as FAO, UN-Habitat, and other organizations that are implementing the Local Agenda 21 (LA 21).

❖ Launch a second phase of the RUAF programme. The main objectives should be to provide
- training and capacity development,
- information to support policy development and implementation.

During this second phase, a real effort must be made to further devolve responsibility and accountability to the Southern partners as well as increase the funding of the activities in the South. Also, further reflection is needed on what mix of partners would be best and what their roles should be. Capacity development and policy advice might require the involvement of new partners in the future.

❖ Review the position of RUAF among other international organizations engaged in urban agriculture (e.g., FAO, SIUPA, IDRC, and UMP-Habitat and the International Support Group on Urban Agriculture (SGUA). The role of the latter in ensuring coordination between such programmes has to be reviewed and perhaps revised.

CONCLUSION

The mid term review demonstrates the progress made in the past three years and the need to build on the results realised. It also clearly indicates the need and potential of the international RUAF network in capacity development, enhancing public – private partnerships and supporting policy development and implementation.

We sincerely thank all our partners and users' for their support and look forward to continued collaboration and exchange in building and expanding RUAF in the years to come.

RUAF Users Surveys

A sample of the users of the RUAF services and products were invited, through an e-mail survey, to comment on the relevance and quality of the RUAF materials and to describe how they use this information in their work. They were also requested to indicate their priorities for RUAF activities in the coming years.

The majority of the respondents were very positive about the RUAF products and services and requested that the programme be continued. Valuable comments on how products and services could be improved were also received.

When invited to rank 12 given RUAF services and products that were most used, the respondents ranked the *UA-Magazine* as highest followed by the E-mail Conferences; and the publication *"Growing Cities, Growing Food"*. Responses indicated an average readership of 10 for each copy of the *UA-Magazine*. Highest impact of the RUAF programme was regarded as: increasing exchange and discussion on urban agriculture, improving access to information and enhancing networking and capacity building. The three services identified as areas for improvement are: the organisation of 'Multi-stakeholder platforms', the upgrading of the Contacts Database and the supply of 'Direct Information and Support' to local initiatives.

These findings fit in neatly with the development objectives of the RUAF programme. At the onset, most attention was given to building adequate information systems and enhancing access to empirical information, awareness raising, networking and facilitating discussion. More attention is now being given to promoting local platforms for multi stakeholder dialogue and action, as well as the continuous review and updating of RUAF policies.

USE OF INFORMATION SUPPLIED BY RUAF

Respondents mention that the RUAF services provide them with **inspiration**. For example, one respondent from the Philippines writes that RUAF inspires them to the information provided to "bring real improvements for the urban poor i.e., more food on the table, lower costs and increase disposable income for other basic necessities such as education,

Cai Jianming

The RUAF Partners met in Johannesburg to discuss future activities

health and housing". Another respondent indicates, "knowing that similar actions are taken elsewhere inspires us to used the information provided by RUAF to validate our own experiences".

Many respondents frequently visit the website and use the UA-Magazine **to keep up to date** on recent developments, ongoing debates, new publications, upcoming events and results, etc. "RUAF assists us in defining the cutting edge in urban agriculture and resource availability and expertise". Many users also refer to the bibliographic and contacts information **to find relevant literature and resource persons**.

Respondents indicate that the RUAF services **facilitate networking**, finding partners and exchange of experiences, both within countries and internationally. For example, Action Aid in Ghana states that they used information provided by RUAF to establish working relations with organizations in Kumasi, Accra and Dar es Salaam.

Many respondents emphasised RUAF's function as a **platform to share experiences and new ideas**. The UVVP project in Dar es Salaam, Tanzania writes us "an initiative like RUAF is necessary and very useful to complement ongoing UA activities and initiatives on local and partially regional level. It can provide the environment for sharing of experiences and ideas beyond the local level. RUAF has helped to broaden the Dar es Salaam UA experiences and make them accessible to a wider and interested audience. This would not have been possible in this extent without RUAF and the channels maintained by them". A partner in Vietnam indicates that the information supplied allows to compare the situation in their own cities with those in other countries and to compare technical and institutional solutions.

Several respondents indicate that they use the information supplied by RUAF to further **develop or adapt research publications and to prepare research proposals**. A respondent from the Netherlands writes: "It broadened our perspective. We use this information to put our ongoing and new research projects in a wider context and to include certain research questions we would otherwise not have thought about. Through your network, we make contacts with potential research partners or clients, and collect case study material".

When asked **how RUAF information is used**, respondents frequently stated **staff training** and **teaching**, in the preparation of lectures, as reading and research material for students and for preparing presentations and papers for seminars and workshops. Ryerson University, Canada, extensively used the RUAF materials to develop modules and materials for their course on Food Security.

Some respondents, like ECHO in the USA, use the RUAF- materials for providing **Question & Answer services** in the field of urban agriculture. RUAF also learned that its materials are distributed **and used in other networks**. For example, CARE, in Peru, diffuses RUAF information in the environmental network GRUTA, and in Nepal, a respondent distributes the information to 12 partner municipalities of the Rural-Urban Partnership Programme.

Various users indicate that the information supplied by RUAF gives them more **leverage to convince local decision makers**. A respondent from Tanzania reports "The information provided by RUAF assisted us (the project) to intensify awareness of policymakers of the importance of urban agriculture, especially officials from the Ministry of Agriculture who did not believe in its potential". A partner from Uganda states: "A number of articles from the *UA-magazine* were distributed and discussed with the district policy makers during a sensitisation workshop on the situation in Kampala City".

A large number of respondents reported to use RUAF information to **facilitate policy and programme development** on urban agriculture in their organisation, municipality or country. As one respondent from the Philippines writes, "The information was useful as inputs in refining, detailing, moulding and grounding the concept of urban agriculture into practical, adaptable and realistic steps for implementation in urban poor food security". A respondent from Botswana reports "I have incorporated some of the knowledge acquired into the preparation of long-term physical development planning for one of the cities in Botswana (Francistown)". In Nepal the information received from RUAF is used in discussions with the Planning Commission of the Ministry of Planning in Kathmandu, leading to the incorporation of urban agriculture in the work plans.
A partner from Brazil writes" I have used the information provided to plan development policies for the North East of Brazil". An NGO in Burkina Faso writes: "The findings and recommendations of the workshop on reuse of wastewater in Ouagadougou helped us to reorient our work".

http://www.cipotato.org/SIUPA This is the official website of the Strategic Initiative on Urban and Peri-Urban Agriculture SIUPA. SIUPA was launched in 1999 by the Consultative Group on International Agricultural Research (CGIAR). In collaboration with the many national and international efforts that have started in recent years to address the issue of urban and peri-urban agriculture, SIUPA is establishing, in regional sites, a set of research activities collectively known as Urban Harvest. Summaries of the Regional Stakeholder Workshops in Hanoi and Nairobi, reported on in former issues of the *UA-Magazine* can be found on this site.

http://www.planetizen.com/books/ All-time greatest planning titles by PLANetizen Books Planning professionals may want to go down memory lane to some of the greatest "must-read" titles in urban planning. Visit to see the top twenty greatest as per surveys by PLANetizen Books and see whether you agree with their selection.

http://www.ucl.ac.uk/dpu/pui/ This is the website of the Peri-urban Interface Project: "Strategic Environmental Planning and Management for the Peri-Urban Interface", of the University College London. This research project aims to identify key components and principles of a workable strategic approach to planning and managing environmental dimensions of the rural-urban interface, which will benefit the poor. This website has been designed with the aim to share research findings and the views and other experiences of researchers and practitioners around the world.

http://userpage.fu-berlin.de/~garten/garten konferenzEnglisch.html Here you will find information on a conference held in Berlin, in July 21-25, 2000. The title was Gardening-Conference 2000, Perspectives of Small-Scale Farming in urban and rural areas - about the social and ecological necessity of gardens and informal agriculture. It was organised by the working group "Small-Scale Farming and Gardens in urban and rural areas" in co-operation with the working group "Agriculture and Social Ecology" of the Humboldt University Berlin - Faculty for Agriculture and Gardening

http://www.un-urbanwater.net/ Managing Water for African Cities (MAWAC) is a joint initiative of United Nations Environment Programme UNEP and United Nations Centre for Human Settlements UNCHS (Habitat): to build capacity in seven demonstration cities in the water sector to avail information on best practices in urban water management, and to link sector professionals working in the field of water management with each other and with other networks, institutions, governments, municipalities, NGOs and the private sector.

http://metrofarm.com This is a website on farming in the city, focusing on high intensive agriculture in the USA. According to a recent Census of Agriculture, the most productive farmland in the United States is in the Borough of the Bronx, while the second most productive farmland is in the City of San Francisco! One can order books or subscribe to regular radio programmes.

http://www.city.toronto.on.ca/food_hunger/index.htm The Food and Hunger Action Committee was formed in December 1999 to study food security in Toronto and recommend ways to reduce hunger, improve the nutritional health of Torontonians, and support food-based initiatives that benefit Toronto's economy, environment and quality of life.

http://www.ingenta.com Ingenta is a global research gateway serving online information needs of over 1.4 million visitors a month and is one of the UK's top 20 Web services. It provides a free online search service of published content from reliable research sources, information and links to a wealth of other institutions, a broad based article search and delivery service and subject-focused websites, built in conjunction with societies, publishers and university presses.

http://www.ems-sema.org/castellano/proyectos/solidaria/ppp/eng_index.html Information on the project "Study, analysis and proposals to strengthen public-private management programmes in the management of solid waste and environmental sanitation in the metropolitan area of San Salvador" is found on this website of ems-sema. Lots of other information on Latin America also can be found here.

http://www.ecoiq.com/urbangreening The Urban Greening website is for everyone interested in making choices about the green and living environments of communities that are both economically and ecologically intelligent. Of particular interest is the assortment of educational and media resources offered. USA focused.

http://www.ibiblio.org/farming-connection/fffconf/ On this site you will find information about the Summit on "the Future of our Food and Farms", which will be held in Philidelphia, USA. November 29 to 30, 2001. The Summit is creating a place where those interested can come together to share ideas about problems and solutions affecting the farm and food system in the USA.

http://www.sapling.org.uk/ Sapling is a multi disciplinary portal site around the fields of architecture, planning and landscape. Over 400 links are organised into nine key themes - planning, technology, design, housing, heritage, sustainability, construction, transport and regeneration - with additional 'Online Library' (information resources) and 'Web Search' sections.

http://www.nottingham.ac.uk/sbe/planbiblios/ A comprehensive list of bibliographies designed primarily for use by students of the Institute of Urban Planning, School of the Built Environment, University of Nottingham, U.K. The lists cover a very wide, but not comprehensive, range of current planning topics. Most of the bibliographies are regularly updated. The lists particularly focus on items on planning in England. There is a separate list of Planning and Planning-related organisations, contact details and websites.

http://urban.freeservers.com/agri.html This site called: "Urban Issues in Developing Countries", is presented as a portal site with urban agriculture as one of the issues. The site does not give institutional or personal information, and is a work in progress.

http://www.urban.uiuc.edu/faculty/talen/GISweb/main.html This site of the university of Illinois, USA, gives information about a project on the uses of computer-mapping software (geographical information systems) as a tool to survey neighbourhood residents about their local environment.

EVENTS

CONGRESS ON AGROFORESTRY (ORLANDO, USA)

27 June – 2 July 2004

Agroforestry professionals worldwide, from academic institutions and government organisations, the private sector and voluntary groups, will gather for this 1st World Congress of Agroforestry in Orlando, Florida, USA. The main objective is to share knowledge and develop strategies for research, education and training in agroforestry. Visit the congress web site for further details: http://conference.ifas.ufl.edu/wca

INTERNATIONAL CONFERENCE ON URBAN AGRICULTURE, URBANAG 2004 (BRISBANE, AUSTRALIA)

Mid-2004.

Urbanag 2004 will focus on the city of Brisbane, and its role as global leader in urban agricultural practices, as well as emerging urban agricultural tends in the Western Pacific region. More information: Geoff Wilson. Phone +61 7 3349 1422; fax 61 7 3343 8287; e-mail: fawmpl@powerup.com.au. www.urbanag.info Australia.

ASSURING FOOD AND NUTRITION SECURITY IN AFRICA BY 2020 (KAMPALA, UGANDA)

1-3 April 2004

Food and nutrition security remain Africa's most fundamental challenge.

However, Africa has climbed back on the agenda. There are new political initiatives gaining momentum both inside and outside the continent. This all-Africa conference will bring together the traditional and new actors and stakeholders to deliberate on how to bring about change and action to assure food and nutrition security. The International Food Policy Research Institute, under the auspices of its 2020 Vision Initiative, will facilitate an international conference in Kampala, Uganda, in partnership with the Government of Uganda. For more info: www.ifpri.org/2020AfricaConference/sponsors.asp

URBAN RESEARCH SYMPOSIUM (WASHINGTON, USA)

15-17 December 2003

In December 2002, individual researchers, representatives of public and private organizations and members of research networks from around the world joined World Bank specialists to review recent and ongoing research on urban poverty. That conference marked the Bank's renewed interest into urban research and allowed this institution to reconnect. The Bank likes to see the Symposium to become an annual forum. This second Urban Research Symposium is taking place at the World Bank Headquarters in Washington, DC and is titled "Urban Development for Economic Growth and Poverty Reduction". Contact: urbansymposium@worldbank.org; telephone: 202-473-0539; fax: 202-522-3232. or www.worldbank.org/urban/symposium2003

FIRST GLOBAL WATER, SANITATION AND HYGIENE (WASH) FORUM (DAKAR, SENEGAL)

1 - 5 December 2003

The Water Supply and Sanitation Collaborative Council (WSSCC) is organising this Forum, with the objectives of examining lessons learnt from successful water, sanitation and hygiene programmes; the impact of sector reforms and development partnerships on the eradication of poverty; and the strengthening of regional and national partnerships. Further announcements on this event will be made later this year. Web address: http://www.wsscc.org/load.cfm?edit_id=332

4TH INTERNATIONAL SYMPOSIUM ON WASTEWATER RECLAMATION AND REUSE (MEXICO CITY, MEXICO)

12 - 14 November 2003

This event is organised by the International Water Association (IWA), Mexican Federation of Sanitary Engineering and Environmental Sciences (FEMISCA), Mexican Association of Environmental Engineers (CINAM), Institute of Engineering - National Autonomous University of Mexico (II-UNAM). It will focus on regulations; integrated management; agricultural reuse; potable reuse; industrial reuse; and public services. Visit: http://pumas.iingen.unam.mx/isw/ or contact: Blanca Jiménez, Instituto de Ingeniería, UNAM, iwa at pumas.iingen.unam.mx or Alma C. Chávez Mejía, acm at pumas.iingen.unam.mx

ELECTRONIC CONFERENCE: "OPTIMISING AGRICULTURAL LAND USE IN THE CITY AREA"

3-22 November, 2003.

The objectives of this Electronic Conference are: to share and discuss local experiences on

- Alternative strategies to improve access of the urban poor to land within the city boundaries for food production;
- The development and enforcement of municipal by laws, norms and regulations on access to land for urban agriculture.

It is intended to base the conference on discussions within a pre-selected core group of participants that have valuable experience on the topic. The RUAF partners will select 5-10 resource persons in each region, who will be invited to actively participate in the discussions, drawing from the four main case studies developed by the resource persons. Other participants are invited to follow the discussion and make contributions. The discussions will take place via email. The first part of the conference will inventorize and analyse the strategies used to promote access to land, while the second part will discuss the development of adequate laws, norms and regulations. A summary of the discussions on each part will be available at www.ruaf.org/conference

THE PERI-URBAN INTERFACE IN DEVELOPING AREAS: APPROACHES TO SUSTAINABLE NATURAL AND HUMAN RESOURCE USE. ANNUAL CONFERENCE (LONDON, UK)

3 - 5 September, 2003

The periurban interface in developing areas is characterised by intense pressure on natural resources by increasing human activity. The Developing Areas Research Group of Royal Holloway, University of London (CEDAR, Department of Geography) is organising this event to present ongoing research and findings. The impacts of rapid urbanisation on livelihoods and poverty in the PUI and the resulting pressures on land and water are major issues. Presentations will focus on the implementation of sustainable solutions, the problem of reconciling human needs and with resource sustainability. Contact: Duncan McGregor (d.mcgregor@rhul.ac.uk)

NATIONAL WORKSHOP ON FOOD POLICY COUNCILS (DES MOINES, IOWA)

September 4 & 5, 2003

This National Workshop aims to promote the IOWA officially bodies of the Local and State Food Policy Councils, which comprise of stakeholders from various segments of state or local food systems. The workshop is sponsored by Drake University (Agricultural Law Centre) and the Iowa Food Policy Council. For more information, please check: www.statefoodpolicy.org

XI INTERNATIONAL CONFERENCE ON RAINWATER CATCHMENT SYSTEMS (MEXICO CITY, MEXICO)

25 - 29 August, 2003

This conference is an annual event organised by the International Rainwater Catchment Systems Association (IRCSA). The 2003 theme is "Towards a New Green Revolution and Sustainable Development Through an Efficient Use of Rainwater". The main topics to be discussed are: food security, prevention of land degradation, impact on society, economy and ecology; supply/sanitation concerns, water quality; mega cities and rural communities; promotion through educational programmes and women's participation; irrigated and dryland agriculture.

Contacts: Dr Andrew Lo, President of IRCSA, ufab0043@ms5.hinet.net or Dr. Manuel Anaya-Garduño, Coordinador General IRENAT, ircsa@colpos.mx Or check Web address: http://www.colpos.mx/ircsa

24th ANNUAL CONFERENCE OF THE AMERICAN COMMUNITY GARDENING ASSOCIATION (ACGA), (CHICAGO, ILLINOIS)

July 31-August 3, 2003

This was the yearly National meeting of the Community Gardening Association (ACGA) to gather people involved in all aspects of community gardening, food security, and greening programs to share experiences and learn from each other.

10th REGIONAL TRAINING COURSE ON VEGETABLE CROPS PRODUCTION (ARUSHA, TANZANIA)

July 7-November 7, 2003.

The Africa Regional Programme of the Asian Vegetable Research and Development Centre (AVRDC-ARP) was established in 1992 in Arusha, Tanzania, to help improve nutrition, health, employment, and income of the poor in Africa.

This intensive training course on vegetable crops production is offered to African professionals and involves a mix of lectures and hands-on laboratory and field studies. Emphasis is placed on vegetable crop species identified by African NARES as deserving high priority. The training course has been designed for research and extension personnel from national research and extension institutions, including Universities, NGO's and private sector.

For more information on future courses and the course curriculum, contact: The Director, AVRDC Regional Center for Africa, P.O. Box 10, Duluti, Arusha, Tanzania, Tel: +255-27-2553093/2553102; Fax: +255-27-2553125 E-mail: avrdc-arp@cybernet.co.tz

INTERNATIONAL WORKSHOP ON URBAN LAKE CONSERVATION AND MANAGEMENT (HYDERABAD, INDIA)

16 - 18 June, 2003

Lakes are important freshwater ecosystems that perform many important functions in urban areas. In the last 50 years, lakes have been degraded due to over exploitation and improper management. Scientists, Governments & Civil society will have to work together in order to preserve and manage this natural heritage. Hyderabad Urban Development Authority (HUDA) has undertaken conservation of lakes within the metropolitan boundaries of the historical city. Recognizing the need for such initiatives in other parts of the country, HUDA organised this 3-day International Workshop, in an effort to focus national and international attention on this long neglected area.

Contact: Vishwanath Sista, Planning Officer, HUDA, Website: hudalakesmission.org e-mail: visista@rediffmail.com

FOOD AND SOCIETY (FAS), HOUSTON TEXAS

May 2003

This was the third annual meeting of the FAS programme, a networking conference sponsored by the Kellogg Foundation. The focus of the discussion was on food systems that that promote healthy communities, people and ecosystems, and the main the driving forces. Remarkable events were the face to face conversation between Unilever and the Burlington, Vermont Intervale Collaborative of 15 small-scale urban farmers, and representatives of USDA talking directly to labourers, refugees and inner-city Youth. Jac Smit of TUAN (RUAF partner) ran a workshop Entitled: "Location, Location, Location", (which is a real estate slogan), examining the significance of promoting and actualising food production as close as possible to communities with a high level of food insecurity. Although this meeting was held in one of the five richest countries in the world, most of the emerging conclusions are applicable in towns and cities on all five continents and the discussions are relevant to low-income communities, global agribusiness, agriculture ministries and departments and municipalities and metropolises. Many of the Conference presentations are available at: www.foodandsociety.org

DESIGN, ANALYSIS AND MANAGEMENT OF URBAN AGRICULTURE FOR RESILIENT COMMUNITIES

January 12 – 23, 2004 in Wageningen, The Netherlands

A course for people involved in policy formulation and action planning, from NGO's, private and public sector involved in urban agriculture for poverty alleviation and management or even re-vitalization of new and old cities. The course discusses practical cases and theoretical backgrounds to the problems and opportunities of integration of urban agriculture in sustainable urban development. It also provides methodologies and participatory approaches to assist participants in preparing action plans for their own conditions. The range of specialists and experience represented by the organizers and the participants themselves guarantees access to up to date information and networks. The course is organized by the International Agricultural Centre (www.iac.wur.nl) and the Resource Centre on Urban Agriculture and Forestry (RUAF) of the ETC-Foundation (www.ruaf.org). More information from:
http://www.iac.wur.nl/services/training/urbag/
Contacts: hans.schiere@wur.nl or r.van.veenhuizen@etcnl.nl

Forthcoming Issues

THE UA MAGAZINE IN 2004

RUAF is in the final months of its first phase and the partners are working hard to continue the activities in a second phase of work. At the same time, the RUAF partners have decided to use this moment to look back and document in book form the state-of-the–art in urban agriculture, as well as the achievements and challenges ahead. One major result of this project is that only two issues of the *UA Magazine* will be published this year. We have decided that after this issue on gender and urban agriculture the next issue (no. 13) will focus on urban and periurban forestry. The planned issue on multi-functional urban land use will be postponed until next year. The articles submitted so far will be used for that issue, unless of course they are appropriate contributions for inclusion in issue no. 13.

NO. 13 URBAN AND PERIURBAN FORESTRY, OCTOBER 2004

Deadline for submissions is 1 July 2004.
This issue will be published in collaboration with the European Urban Forestry Research and Information Centre, the Danish Forest and Landscape Research Institute, and the Forestry Division of FAO. Despite the explicit reference to forestry in the name RUAF, we have not had a special issue as yet on the topic, since other issues have taken priority. But the call for attention to urban greening, parks, agroforestry, etc., has come from a number of different quarters. This special issue will therefore focus on the relation between urban agriculture and forestry in the city. Contributions are invited that discuss concepts and methodologies; advantages and potential; disadvantages and risks of different types of urban agroforestry, and the influence of site-specific conditions therein; the access to and the control over resources such as land, water, and inputs; and legal arrangements.

THE UA MAGAZINE IN 2005

The topics suggested for 2005, and on which you may start submitting your ideas, abstracts or articles, are:

- multi-functional land use and agro-tourism
- urban food systems and urban agriculture
- urban aquaculture
- contribution of urban and periurban agriculture to the Millennium Development Goals

Other topics suggested by the RUAF partners are

- strengthening urban farmers' groups and organisations
- agriculture in urban policy development; multi-stakeholder approach; mayors and senior municipal staff; NGOs
- urban soil and water pollution
- risk management strategies in urban agriculture
- urban and periurban-based food industry; chain of productionproduct quality management and private enterprises
- (transition strategies to) commercial urban agriculture

We welcome article contributions on urban agriculture of approximately 2,500 words (three pages), 1,700 words (two pages), or 800 words (one page), preferably accompanied by an abstract, references (maximum of 5), figures and digital images or photographs of good quality. The articles should be written in a manner that is readily understood by a wide variety of stakeholders all over the world. We also invite information on recent publications, journals, videos, photographs, cartoons, letters, technology descriptions and assessments, workshops, training courses, conferences, networks, web-links, etc.

NOW ALSO A PORTUGUESE VERSION OF THE UA MAGAZINE AVAILABLE

All back issues of the *UA Magazine* have been translated into Portuguese by Mr Joaquim Moura of Brazil, with the support of RUAF in collaboration with UMP-LAC. The articles are published on the web site http://www.agriculturaurbana.org.br/RAU/

VIDEO ON-LINE

A part of the RUAF Urban Agriculture Video has been put online, on the Cities Feeding People website of IDRC. The video has been produced to facilitate a greater understanding of urban agriculture among policy-makers, urban planners, NGOs, sectoral organizations and other people who can make a contribution to the integration of urban agriculture into urban planning policies, plans and development programmes. If you would like to have a look at it, please go to: http://web.idrc.ca/ev.php?ID=46121_201&ID2=DO_TOPIC or to www.idrc.ca/cfp and click on Publications and then Videos. The same will be done for the video, titled: "Making a living along the Musi river: Wastewater use in and around Hyderabad City", produced by IWMI-India in 2003, with support of ETC-RUAF and DFID.

Urban Agriculture Magazine

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The UA Magazine is translated into French, Spanish, Chinese and Arabic, and distributed in separate editions through regional networks.