Agrodok-series No. 24

Urban agriculture

growing vegetables in cities

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Agrodok 24

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Growing vegetables in cities

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Foreword

Getting the subject of urban agriculture down to manageable and practical proportions in an Agrodok has been a cherished dream of Agromisa. The aim was to describe carefully considered, sustainable and practical methods for small-scale farming of crops in urban areas.

The diversity and extent of the topic of urban agriculture seemed almost impossible to define at every inch of the way, from drawing up the main structure right up to the translation stage of this Agrodok. The result is that this is a sort of “unfinished” edition.

I wish to thank those whose ideas and writing contributed to the creation of this Agrodok, in chronological order: Pim Henstra, Gijs Spoor, Esther Kuiler – now a successful urban farmer in Wageningen – and Jan Los. I also thank all the successive Agrodok coordinators for their constructive input. And, I am indebted to Wilfred Hertog (ETC) and Marjan van Dorp (IAC) for their comments on the content. Finally, the translator and the illustrator, each in their own way, added shape and form to the comprehensibility of the subject and quality of the result.

We wish all those who undertake urban agriculture much success, and we leave it to them to judge the extent to which we have succeeded in realising our aim towards a satisfactory result. We invite the response from readers and users of this Agrodok. Additional and practical descriptions will be most welcome. Critical readers can help feed discussion – also here at Agromisa – on topical developments in urban agriculture.

Agromisa realises that the urban animal husbandry theme has not yet had explicit exposure in the Agrodok series. Well aware of this gap Agromisa will do its utmost to bridge it.

Jeroen Boland
Writer and editor in chief

Wageningen, December 2001

Contents

1 Introduction

1.1 Target group and outline of the subject

Urban agriculture can be described as follows:

"All forms of agricultural production in or directly adjacent to the city, which mainly provide urban markets with food products for sale to consumers or for consumption by the city-dwelling growers themselves."

This Agrodok has primarily been written for women and men involved in urban agriculture: those new to crop growing in towns, as well as the producer with prior experience in rural agriculture or horticulture who plans to grow food or market garden crops in urban areas.

Figure 1: Papaya and banana trees in the courtyard

It will also prove useful for those responsible for guidance of urban agriculture: district information services and community workers of community based organisation, non-governmental organisations, government services, agricultural and nutritional extension.

Urban agriculture covers a whole range of production systems, methods, techniques and socio-economic aspects. The diversity of the products can be divided into:
- vegetable horticulture,
- animal husbandry,
- fuel and food forestry, including agroforestry,
- integrated waste-water aquaculture, including fish production.

Other specialisations include the cultivation of herbs, ornamental plants, fruits and the production of silk.

This Agrodok concentrates on a number of facets:
- it mainly focuses on vegetable growing,
- primarily intended for one's own food supply,
- which can be achieved by means that are simple, cheap and locally available, and
- based on small-scale techniques.

The wide range of vegetable species grown in towns by horticultural techniques will only be mentioned in general terms. However, if you are thinking of producing a particular kind of vegetable or fruit, there may be another Agrodok that could give you the information you need. You may be able to consult the other sources in the list for further reading.

This publication helps you to make specific choices (Chapter 2) and describes aspects of safety, environment and health (Chapter 3). It contains techniques for small-scale horticulture around the (own) house or in the yard (Chapters 4 and 5). Soil and water problems get extra attention (Chapters 6 and 7). Although socio-economic aspects are not the main objective of this book, they are important enough to be mentioned (Chapter 8).

1.2 Choosing and experimenting

A great variety of material has been used to compile this Agrodok. It ranges from the important classical production principles of agriculture, such as the health of soil and crop, to the typical urban facets (like roof cultivation). Furthermore, local variants of methods and techniques often have their own specific and practical usefulness.

The choice is yours. The urban context offers opportunities for production, use of raw materials and marketing, which people living in rural areas do not have. But, this may also have its limitations. In the next chapter we will deal with questions that could help you choose your crops, location or technique.

You should experiment. There is a great diversity of technical aspects pertaining to urban agriculture and there is little universal that one can say about it. This is why this Agrodok contains a selection from a wide range of techniques, locations and conditions for urban agriculture.

Your first choice will not necessarily be the best. First, try out what will work under your own particular circumstances, in response to what you wish to cultivate and, last but not least, try out what gives you satisfaction. There are very many successful, locally-adapted variants of small-scale urban agriculture, worldwide. However, techniques are not always transferable from city to city or from country to country.

2 Opportunities within urban agriculture

The purpose of this chapter is to address issues which are important for making choices. For working successfully, these choices need to be specific, effective and efficient to suit the targeted crop, the size and location of the plot, and the cultivation method. Your own living and working conditions and circumstances will determine what you can do and what is wise to do.

2.1 Individual circumstances and choices

The following questions can assist you mainly with cultivation and economic motives:

- What is my cultivation target? (Section 2.2)
- Where and on which scale do I want to produce? (Section 2.2)
- Which type of production should I choose? (Section 2.3)
- Can I influence the prevailing opportunities and constraints? (Section 2.4)
- Do I want to, and can I reuse the starting materials? (Section 2.4 + Chapter 4)
- What are the health aspects? (Chapter 3)

You may be growing vegetables on a small scale around your home primarily for your own food supply. You could then sell a surplus production at the market. In other words: you may give food security priority over economic efficiency.

You may, on the other hand, be involved in large-scale farming for the market at a location at a reasonable distance from this market. Household income from sales is then your main target, and therefore you should take into account cost-effectiveness. Economy involves not only finances: expenditure, investment and market sales. It also embraces the level of inputs, time investment and labour input.

2.2 Size and location

Often, the key question is: "What is your aim: self-sufficiency in food, extra income from sales – or both?" You should assess a few important socio-economical and political factors pertaining to your own circumstances. Then, the questions that would arise are:

- Do I want to grow crops for sale to create supplementary income?
- Or do I want to grow crops for further processing?
- Are the crops for myself for daily consumption?
- Or do I want to grow crops for my own use in times of scarcity?
- Or have I simply no choice and must grow my own food (eg, when scarcity occurs because food transport lines have been cut off, or when the local food prices are too high)?
- Or… combinations of the above.

You may be interested in trade, marketing or selling – in what ever shape or form (see figure 2). These are the questions you need to ask yourself:

- How much effort can I and do I want to spend on starting material, transport, rent, seeds and planting material?
- Will I be free to decide what to do with the income from the sales?
- Is the market I have in mind easy to reach?
- Will I need (own or rented) means of transport and, if so, is it available?
- What is the potential market?
- How big is the demand and purchasing power?
- Are the selling prices (especially day-fresh vegetables and fruit) in the town favourable?
- Would it be better for me to work for someone else or spend my efforts on something other than horticulture, something that would bring me higher (extra) income?
- And…what inputs are available: starting material, seeds, planting material, water, soil, construction material and equipment, plus own labour and expenses?

Before you spend time and money or invest in urban agriculture there is something important that you must take into account. Research

shows that investing one's own savings in urban agriculture *can* be interesting. However, an investment may be slow in showing any return – especially if you first need to experiment with risks and time investment, or if you use your produce for your own consumption needs. For further information, we refer to Agrodok 26: Marketing for small-scale producers.

Figure 2: Woman selling a variety of vegetables at a Havana marketplace stand

In small-scale agriculture for self-sufficiency purposes around the house or in the courtyard, the direct expenses are less significant. What is important is to ask yourself:

- Are the time, trouble and labour to grow my own food worth the effort?
- Does the quality, yield and security of the crops make growing them worthwhile?
- Can I get on well with my neighbours, or do my activities bother them? (or is it possible that they will complain about it)
- Are there inputs available?

Naturally, the biggest advantage is that growing crops close by or in your courtyard or on the roof gives maximum control of production

including the quality of your produce, and you will have direct access to your fresh harvest. You will have less influence if your production is some distance away from home, in which case you should think about the following:

- Does the size of the available surface area justify the effort taken for growing crops, e.g. transportation effort?
- If you are not the owner of the cultivated area: does it belong to a private proprietor or company, to a community or the municipality? Or is the ownership and access unclear or poorly organised?
- For how long can the land be used and accessed: permanently or temporarily?
- Who will deliver the labour: yourself, family members, any co-workers or partners?
- Which crop risks (apart from the weather) can you cope with: loss or theft of harvest, loss of access to the ground, damage caused by free grazing, by flooding (rivers) or by traffic or other large-scale economic activities?

2.3 Division according to types of products

We have divided up the broad spectrum of systems in urban agriculture as follows:

Horticulture

The techniques described in this Agrodok have to do with urban horticulture. They are especially about growing vegetables in combination with the preparation of good quality compost and garden soil.

Potential locations of urban horticulture include: houses and courtyards, parks, open spaces for public access, flat roofs, balconies, walls, containers of all sorts, greenhouses, wetlands (floodplains of rivers), terraces and slopes.

Aquaculture

These are systems that focus on the culture of fish and other water organisms, or on the cultivation of water plants such as seaweed. There

are many types of naturally-occurring surface water suitable for one or other culture or scale of production. Cultivation in ponds is also a possibility. We refer you to Agrodoks 15: Small-scale freshwater fish farming, and 21: On-farm fish culture. Even though it has not been written especially for urban environment, you may find useful information there.

Hydroculture or hydroponics

These are small-scale vegetable growing on a medium that does not contain any soil; usually it is only water with minerals. These mainly are highly specialised and vulnerable cultivation techniques involving rather high investments. For this reason, they are not dealt with in this edition.

Animal husbandry

There are a number of Agrodoks devoted to small-scale animal husbandry; see the back cover.

Agroforestry

Arboriculture or tree breeding is useful for the production of wood for fuel or for building, producing fruits or nuts and for providing compost. Furthermore, trees give shade, purify the air and keep the soil healthy - provided that the soil around the tree is not misused for other purposes. We refer you to Agrodok 16: Agroforestry. Even though it has not been written especially for urban environment, you may find useful information there.

Non-food and minimal processing products

This has to do with ornamental plants, flowers, (ingredients for) medicines, herbs, spices, ingredients for drinks, (ingredients for) insecticides and fibre crops. Animal production involves sericulture (silkworm breeding), worms and honey bees. It is about the production of plant parts or animal products that mostly need a little processing to give them added value. Relatively good earnings makes selling these products often more interesting than using or consuming them oneself. For instance, if they have good keeping qualities, can be transported

over longer distances, or are attractive for consumers with spending power.

2.4 Opportunities and constraints in urban agriculture

Successful urban agriculture requires an understanding of the growth processes of plants. This Agrodok is designed to assist you mainly with assessing the *technical* aspects in urban *vegetable culture*. Biological, physical and chemical factors also play a role. The right choice of techniques and applications of soil, water and crop will enable you to optimise your cultivation. You will be able to observe and sometimes measure many conditions. As a rule, if you alter a condition you will get a logical effect. This is how you can create the situation you want.

Technical aspects that are important for successful urban agriculture are:

- degree of diffuse pollution of soil and water (Chapter 3);
- factors that often require optimisation, such as depth of the rooting layer and availability of good soil (Chapters 4 and 5);
- availability of planting material and seeds, water, soil material or growing medium, starting material, construction materials (Chapters 4 and 5);
- suitability of a soil or self-prepared earth for plant growth (Chapter 6).

At times of scarcity of suitable planting material, you will find reuse of valuable waste products as starting material most valuable. Effective recycling of water and organic waste is all about reuse of nutrients, such as minerals, proteins and trace elements.

This edition gives useful techniques and starting information that you may apply in your situation. Agriculturists and biologists will be familiar with the theories about the value of all *inputs* and *outputs*. However, this background knowledge is not absolutely essential. You

can learn a great deal through practice and the skills you gain from experience. We offer practical descriptions, whereby experimenting, practical experience and insight becomes more important than theoretical knowledge. From the knowledge gained through experimenting and trial and error, anyone can work out what is necessary and achievable in a given situation.

3 Safe application of urban agriculture

The reputation of urban agriculture often comes under close scrutiny. Indeed, problems could arise with regard to health, hygiene, environment/ecology and burdening of the human environment. Unfortunately, this gets more attention from the media and local politics than the positive effects: most importantly, contribution to the local food supply and economy. Sometimes the problems can be blamed on poor practice: lack of good information, lack of good material and inputs, lack of support from qualified advisers or experienced trainers.

This chapter is about the health risks and environmental aspects from using organic waste on a small scale. The objective is the safer use of inputs and the production of healthy food. The use of human excreta is risky and too complex to be discussed here. The relationship between hydroculture and the reuse of waste water will also not be dealt with specifically here.

3.1 Risk sources

Much waste is produced in cities where very many people live and work in close proximity to each other. Organic waste can be reused by converting it into compost (see figure 3). Reuse of organic waste in urban agriculture has its advantages, but it can also lead to health problems. Household refuse, industrial waste, refuse along roads as well as wastewater often contain toxic substances. If waste is polluted biologically or chemically, it can be damaging to the health of man, animal and/or plant, either directly or on the longer term.

Pollution from industrial, domestic and commercial activity affects the scarce resources that are essential for urban agriculture: soil, air and water. This pollution in turn poses health hazards to workers, producers, handlers and – most of all – to consumers. Poor management of compost piles can lead to increase of disease-causing particulates and gases, which could cause lung afflictions or headaches. Consumers of

produce can be affected by diseases linked to crop contamination from, for instance, heavy metals that plants absorb from the soil or wastewater.

Figure 3: Separating organic parts from domestic refuse is a common activity in many towns

It is important to differentiate between toxic or rather poisonous substances and disease-causing organisms or pathogens. We will discuss heavy metals and organic pollution. Toxic substances can be absorbed through the roots of vegetables grown on contaminated soil, or through their leaves.

Also noteworthy is that an excess of artificial fertiliser can affect vegetables, causing too much nitrate in the leaves. A high nitrate content in leafy vegetables is dangerous for young children and people with circulation problems. Nitrate excesses can occur from artificial fertiliser application, but also from the use of untreated effluent or wastewater from sewerage.

3.2 Heavy metals

Naturally-occurring heavy metals like copper (Cu), lead (Pb), mercury (Hg), arsenic (As) and cadmium (Cd) may be needed in really tiny

quantities for growth of vegetables and fruits. Too high a concentration, however, can be harmful to health. The problem is that the metals accumulate in the body's internal organs, such as the kidneys and liver, and can disturb vital functions. In children, in particular, the effects can be alarming because they have a low bodyweight. Therefore the risks of unwanted effects from heavy metals on their growth and development is even bigger. Old or sick people are more vulnerable too.

Sources of heavy metals are:
- natural soils or rocks;
- damaged batteries;
- wastewater from tanneries;
- dyes for cotton and woollen fabric;
- wastewater from textile dying;
- spent oil from cars and combustion engines;
- exhaust fumes from motor vehicles.

Exhaust fumes contain lead (Pb) and cadmium (Cd) that are emitted into the atmosphere and then settle on the crops. They adhere to the surface of the leaves. Most of it can be removed by washing thoroughly. Factories as well as small-scale home industries in urban areas, like tanneries or dyeing, discharge effluent into surface water, which can contain toxic heavy metals. Leachates from industrial areas can contain heavy metals.

Differences between plants in absorption of heavy metals make generally difficult to advise against reuse of waste and cultivation on refuse dumps. Heavy metals are only really hazardous if they have been absorbed by the plant and have been stored in the plant parts that humans will consume. The uptake of heavy metals is dependent on the properties of the crop and soil. Usually, the leaf crops are the most susceptible to the uptake of heavy metals; root and fruit crops less. Watery crops like water cress, parsley, melon and lettuce are among the vegetables most vulnerable to exposure from heavy metal contamination.

In basic soils the absorption of heavy metals is substantially reduced because there is less of it in the soil water. The lower the acidity, the more the heavy metals dissolve and the greater the uptake by the plant. Addition of decayed organic matter on the soil fixes and retains the heavy metals, also if crops are being grown. Applying chalk on the soil makes it more basic.

3.3 Organic pollution

Toxic organic substances cause a reduction in the functioning of organs or reduced resistance against organisms, thus harming the health of human and animals.

Potential sources of toxic organic substances include:

- organic poisonous substances in most fuel and other petrochemical products, such as gasoline, diesel, mineral (engine) oil, detergents, degreasers;
- empty containers of the above agents, either poorly or not cleaned at all;
- exhaust fumes from cars and combustion engines (also, partly, containing inorganic components);
- chemical pesticides for vermin in buildings or in stocks and for crop protection, and the packaging of these substances.

Problems with chemical protection agents occur usually through faulty application. But even with good information and advice, the use of pesticides in urban agriculture by inexperienced growers is not without risks for them, the environment and for the consumer. It is better to do without as much as possible.

- Application demands good protective measures: contact via the skin or via inhalation through improper use gives rise to health complaints.
- The “normal” dosage for use in a field crop is based on a full field situation and is not appropriate for small-scale farming: a limited number of plants in pots and containers or on a small plot.

- Storage and use of these agents in residential areas is risky, especially for children.
- Some herbicides make the soil temporarily unsuitable for the cultivation of other crops.
- Insecticides can have reverse, negative effects on useful insects or natural enemies of pest eg insects, like for instance birds.

There are biological, cultural or mechanical alternatives to chemical crop protection methods. In Appendix 1 “Protecting the plant” we mention a number of simple and risk-free methods for protection from insects.

3.4 Biological disease-causing organisms

In urban areas, many human activities and other uses of scarce space take place close to one another, as is shown in Fig. 3.2. This causes different, and sometimes bigger health risks than in rural areas. Eg water, especially in the rainy season, improves conditions for plant growing but at the same time implies health risks by enhancing growth of micro-organisms.

Multiple health problems can occur when mixed solid waste is processed, human excreta is applied to fruit and vegetable farms, or wastewater is used for irrigation or for fish farming. Pathogens, viruses and parasites in waste can cause infections, worm infestation or skin diseases. These biological, disease-producing organisms or pathogens reduce the activity, physical condition and resistance of man and animal, thus causing diseases in man and/or animal. We distinguish between primary and secondary pathogens.

Primary pathogens are truly dangerous, as they can weaken the physical condition of man or animal: bacteria and micro-organisms. Organic waste from the kitchen and from markets consist of vegetable residue (leaves, roots, peel, chaff and bran from grain) and animal

residue (bones, skin, meat remnants). Animal residue or offal, in particular, contains many primary pathogens.

Figure 4: In towns, diversity and number of activities on limited space imply health risks

Secondary pathogens are decomposers: they attack tissue that is already dying. They are therefore useful because they take care of the composting process of vegetable residue and do not harm healthy organisms. Chapter 5 describes how good composting can eliminate primary pathogens and promote the growth of secondary pathogens.

Vegetables irrigated with polluted surface water are often biologically unsafe because of the presence of disease-causing organisms. They need careful washing and boiling to remove and kill the organisms. Sewage water for irrigating vegetable crops undoubtedly increases opportunities for urban agriculture. Sewage-based cultivation makes

use spate of nutrients that would otherwise disperse into the environment. Pathogenic micro-organisms in household wastewater make this practice extremely risky. Most consumers are unable to differentiate between vegetables grown with or without sewage irrigation. Some consumers know which villages or quarters use sewage water and can avoid buying vegetables that come from there by asking the vendor where the vegetables came from. So it is in your own interest as a grower to use clean water. Wastewater can be treated biologically in large sewage tanks by using an intermediate plant or animal such as algae or duckweed. This however is unlikely to be within reach of private households or producers, and requires cooperation.

3.5 Prevention of contamination

Much can be achieved by not using contaminated waste, raw materials and water of unknown quality. Chapter 6 describes how you can prepare your own healthy planting earth, and Chapter 7 describes how water can be used safely. However, you must always question: where do the inputs for the soil come from and where does the water come from? Also, find out which soil components, which compost or raw materials for composting and which water you can find from around where you live. Do the raw materials and the water come from a clean, reliable area that you know; or are they from an unknown, potentially contaminated source?

You can differentiate circumstances according to risk categories and choose your production aim, see table 1:

Table 1: Choosing your production aim according to risk categories

Non-polluted area	**Polluted area: soil, water or air**
leafy vegetables	non-leafy vegetables
food production	non-food production
human food	fodder for non-consumed animals

Growing leafy vegetables for human consumption carries the most health risks and should be done exclusively in places where soil, water and air are relatively safe. Growing root crops and fruits that one peels is least risky. Non-food crops are largely always free from direct health risks for man and therefore suitable for polluted areas, if only plant growth is not inhibited by the pollution. Of course all crop categories from the right column in the small table can also be grown in non-polluted areas.

Finally, minimising the contamination of organic waste and wastewater helps to alleviate health concerns and economic constraints. Many public health risks will decline and the end product will be more marketable. Good and responsible measures for reuse of waste and refuse in urban agriculture can minimise health risks for both growers and consumers. A few measures are mentioned below.

Crop choice:

- grow crops that are less susceptible to contamination: fruit that needs peeling will transmit fewer pathogens than a leaf crop;
- crops that are used for livestock are a step away from human consumption and therefore usually present fewer health risks;
- if you find suitable sales opportunities, and if you need not necessarily grow food crops: try and grow crops for fuel, construction and ornamental purposes, as these are completely safe for health.

Choice of growing location:

- try to avoid growing food crops in the immediate vicinity along roads, by refuse heaps and rubbish dumps, on places where factories, companies or households discharge their wastewater, and on former factory sites;
- if you need to grow leafy vegetables near public roads, then take into account a minimum distance of 10 metres;
- plant trees or quick-growing shrubs close to and along the road as a protective hedge, and grow susceptible, eg leafy crops immediately behind it (see at section 5.4);

- choose places where you can avoid disease-carrying vectors (flies, mosquitoes, cockroaches, rats).

To get relatively pure and clean organic waste:
- collect and keep the waste separate and away from fruit, vegetables and flower markets, restaurants and canteens;
- also separate organic waste from domestic origin and institutional waste.

Soil care:
- put more organic matter in the soil;
- always use clean soil when filling pots and containers and making new planting beds.

Water care:
- avoid irrigation of leafy vegetables with untreated sewage;
- monitor compost production to ensure that pathogens are inactive.

Preparation of consumables:
- wash edible parts of the plant in lots of water with diluted vinegar, salt, lime juice or a drop of washing-up liquid, soap or bleach; always rinse thoroughly afterwards;
- peel fruit before use;
- cook vegetables (that can be cooked) at least for one minute to kill most micro-organisms, but no longer than necessary to avoid loss of nutritive value and taste.

At government or municipality level:
- reduce contamination by waste by restriction of the industrial waste effluent in sewage;
- regulate human consumption of certain products.

At extension level:
- educate handlers and consumers in protective practice.

4 Small-scale growing methods

In this chapter, different small-scale, above-ground growing methods are being treated. They have in common that individual plants or crops are grown in soil that has been prepared or to which compost has been added.

Below, are descriptions of growing techniques:
- container culture: in pots or other containers or tyres
- in sacks
- in shallow beds
- in a compost pit, or variants thereof (compost trench or bed; dung pit)

Accompanying each technique, we describe:
- the features
- possible crops
- materials and construction
- maintenance and care

4.1 Above-ground cultivation

Four important advantages of the non-soil-dependent methods make them optimally adaptable and therefore an excellent choice for the city.

- The growth is either barely or not at all dependent on the availability of a fertile rooting surface in the open ground.
- They need little space. A few containers near the entrance of a courtyard or on a roof terrace are enough for a start.
- Some forms are also mobile (pots, sacks, some hydroculture systems).
- They are adaptable: micro-gardens and courtyards close to home can be adapted and organised to meet the demands for food, the market or the season.

These are highly-productive methods that demand the right inputs, as well as efficient timing of fertilising and irrigating. Inputs for suitable soil are: earth (for the minerals), compost (for the natural supply of nutrients), artificial fertiliser if needed, water, seed and enough time and labour to keep everything running smoothly. Next, sufficient water of good quality must be available during the growing season. If one of these inputs is lacking, the risk of failure is considerable.

The location for growing your plants must have the right amount of sunlight. It is advisable that you avoid places that are too sunny, hot or dry, or places that are cool and shady. Very windy places are not good, but poorly ventilated places are just as bad. Soil that stays wet for long after it rains will give the plants too much stress.

4.2 Cultivation in pots or containers

Features

The production of crops in all kinds of containers is widespread. You can grow plants in round or rectangular synthetic packaging of any size and material, as well as in car tyres. These by-products are easily available in urban areas and you can place them almost anywhere, anticipating the changing environmental influences. You can reduce the loss of minerals by leaching. All you need is: water, soil or compost and, naturally, containers of the right size for the crop you have in mind.

Figure 5 shows a few examples of cultivation in containers, pots – or even cardboard boxes possibly coated with plastic – or in plastic crates.

Crops

In principle, you can grow all kinds of vegetables, herbs and flowers in containers of different sizes and materials. Space for the roots is more restricted than that of shallow beds, but the advantage here is that optimum use can be made of the nutrients. Growing a second crop in the same soil is strongly discouraged: the soil is exhausted and

much less fertile, and there may be soil diseases or soil-based pathogens present, so it would be better to use fresh soil.

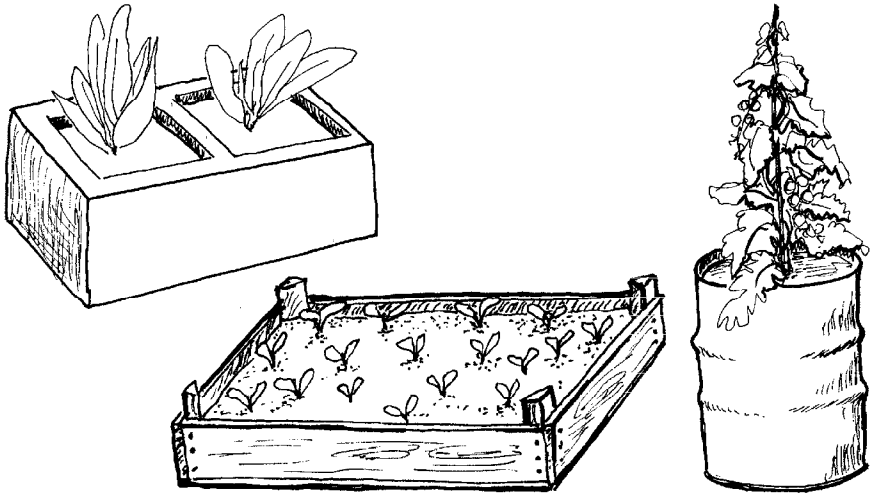

Figure 5: Examples of crop production in pots or containers

Materials and construction

This is what you will need:

- a container
- growth medium/soil
- reliable water supply
- compost and/or fertiliser

First, choose a crop and then a suitable container. A wide variety of locally available and free or inexpensive containers can be used for planting including: pots and pans with holes in the bottom, baskets, steel cans, wooden or cardboard boxes, trays and cut plastic bottles.

Avoid aluminium containers because aluminium in suspension can be toxic for the plants. Galvanised steel containers are not appropriate because these release toxic zinc salts. It is advisable not to use old synthetic paint, fuel or pesticide containers: these organic substances

could still be present in small quantities in the container walls and be a health risk for the plants and – ultimately – to humans.

Small pots made of woven leaves or other vegetable matter or fibres are excellent for growing seedlings because they can be transplanted pot and all. Put a layer of gravel or broken earthenware at the base to help the water to drain, and place the pot on gravel or a layer of wood chips.

Minimum or optimum container size is largely dependent on local circumstances and plant size, and whether they need to accommodate one or many plants. Generally, low and flat containers will not be suitable for plants with tap roots, while filling up a deep container to grow shallow-rooting plants is a waste of soil and water. The larger the container, the more water the growing medium can hold and the less frequent the watering. Very small containers such as cups are appropriate for growing seedlings.

Maintenance and care

Small containers with a relatively small soil volume may cause the soil to dry out rapidly. Containers should be kept in a convenient location with adequate shade and sunlight. The soil temperature in the container can rise and fall to extremes of heat and cold, all of which are harmful to plant growth. Under sunny conditions, light-coloured containers reflect sunlight and thus heat away from the soil in the container. In the cold season or in cold areas, dark-coloured containers can absorb sunlight and thus maintain a favourable soil temperature for some time during the night. You can reduce the influence of fluctuating temperatures and humidity by covering the soil with compost, leaves or mulch.

Good drainage *and* water supply are more important here than for other cultivation techniques in urban agriculture. The soil must be able to hold some water but both soil and container must allow good drainage because water-saturated soil encourages diseases and suffocates roots. A sandy soil texture in the top 2-3 cm allows quick infiltration

and keeps water from collecting around the stem base. To avoid clogging of the drainage holes, place the container on gravel to make air spaces so that water can pass through to drain the wet soil in the container. Allow the soil to dry slightly before watering.

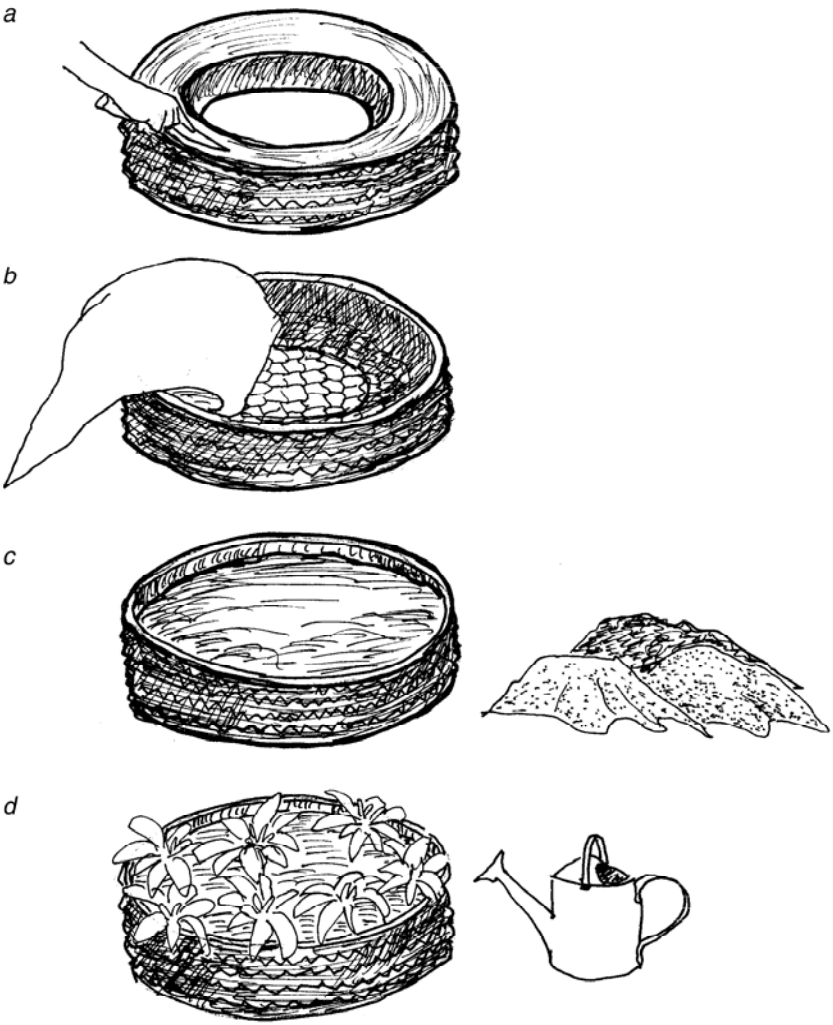

Figure 6: Construction of tyre container

Construction of a tyre container

Tyre containers are easy to make and to move about. Old and worn-out tyres are easy to find. Construct the tyre container as follows (See figure 6):

- Lay a car tyre flat on the ground.
- Cut off the top rim using a sharp knife or machete, but ensure that it remains in one piece (a).
- Press a round piece of chicken wire over the base.
- Cover with a piece of plastic large enough to cover all of the base and a little up the tyre sides (b).
- Now, turn the top rim – which you cut off – upside down. It will fit tightly over the bottom rim, holding the plastic firmly in place.
- Cut small openings in the plastic base to ensure proper draining of the growing medium.
- You can now fill the container with soil and do the planting (c, d).

4.3 Sacks

Features

Used (grain) sacks made of woven synthetic material are obtainable anywhere and are usually very cheap or even free as by-product. This is why planting in sacks is well worth trying out. The earth is held together all around and evaporation from the soil is minimal.

Even more than container growing, cultivation in sacks is very different from horticulture in open ground. The big difference compared to all the others is that the growth medium is closed on all sides. This restricts the soil ventilation (disadvantage) and prevents drying out (advantage). You should keep a close eye on the latter to prevent the occurrence of fungus growth in the soil or suffocation of the roots. Another advantage is the optimum nutrient use, which can even be better achieved than with container growing.

Crops

Suitable crops for growing in sacks are those individual plants that quickly develop and keep growing for a relatively long time like: to-

mato, potato as well as cabbage varieties. Figure 7 shows crop growing in grain sacks. Note: tomato and cabbage should be sown in a seedbed before being planted in the sack.

Figure 7: Crop growing in a sack

Materials and construction

You will need:

- sacks
- water
- growing medium/soil
- compost or artificial fertiliser

Method

- Get used woven polyethylene rice, coffee, grain or sewing seed sacks. Watertight plastic bags can also be used. Jute is not suitable as it rots too fast.
- Clean the sacks thoroughly and let them dry well. Sacks with small holes are also usable – the holes will be good for drainage.
- Prepare the soil: use compost and/or earth. Mix it thoroughly, for instance, in a large container or on a clean floor or in a wheelbarrow. Moisten the soil well and let the excess water drip out. Decide where you want to put the sacks and fill them on the spot with the soil, up to three-quarters full.
- Tie up the sack and lay it on its side. If the soil is too wet, then prick holes in the sack on the sides just above the ground, for drainage. Check if enough drainage occurs.
- Then, carefully cut holes in the upper surface of the sack at the desired planting intervals. Put plants or sow seeds in the holes.

Maintenance and care

Irrigate the soil regularly and according to your own insight and experience. Do not allow the soil to get saturated, thus watch the drainage. Depending on the condition and development stage of the plants,

fertilise accordingly. Refer to the description given for growing in shallow beds on impermeable subsoil.

The sun's rays quicken the breakdown of plastic. To prolong the life of sacks you can cover the entire sack with straw, dried dung or mud with husks, fine straw or chopped grass.

4.4 Growing on beds

Features

Crop growing on beds looks very similar to soil-based horticulture. A shallow bed consists of a thin layer of soil that is regularly watered. It is simple to construct provided there is enough (open) space, preferably with direct sunlight, a good growing medium and water close by. A shallow bed can also be constructed on a robust roof, roof terrace or big balcony, but this needs adjustments: raised edges and an impermeable (plastic) base, and the balcony will naturally need to have an adequate supporting capacity.

We discuss two types (see table 2):

- the shallow, raised bed (material and construction: see Section 4.5)
- the dug-out or sunken bed (material and construction: see Section 4.6)

Table 2: Types of growing beds and their features

Aspect	**Type of growing bed**	
	shallow / raised bed	**dug-out and fertilised bed; possibly compost pit, trench or bed**
Local (soil) conditions	solid floor or ground, impermeable to water	infertile soft rock, stony soil with gravel or infertile soft infertile earth layer
Special feature	soil ingredients to be brought from elsewhere	local soil improved with mainly organic matter
Crop choice, maintenance and crop care	see text below	see text below

Choice of crop

The choice of crop will largely be determined by the rooting depth of the bed. Some deep-rooting plants can adjust their root system in a shallow bed, which you will have to discover by trial and error. Plants grown for their tap root like taro or cocoyam, however, will be difficult or impossible to grow because they will have too little space to yield harvestable roots. Plants with thin and large, hairless leaves and with no natural wax layer lose too much water through evaporation during growing and that can be problematic.

You can increase the yield of crops grown as individual plants, for example cabbage, by more intensive use of the limited surface area of the bed. Plant in rows but zigzag the planting.

Maintenance and care

Regular watering is the most important aspect of daily maintenance, as the soil dries out quickly especially if it is a shallow bed. It is advisable to cover the bed when the seedlings are emerging, or the nursery plants are taking root. At the start of the growing season it is important that the organic matter is decayed, so that the nutrients can be released for the benefit of the plants. You can add artificial fertiliser during the gro- wing season, but ensure that you spread it evenly and that it dissolves well to prevent scorching. Adhere closely to the dosage and use no more than half of the quantity prescribed for natural soil in open ground.

Weeds compete with the plants for water and nutrients, but they also have advantages: they root rapidly improving the structure of the soil in a newly-laid bed, and their roots help to keep an established growing bed airy.

At the end of the growing season you need to check whether the bed is still high enough for the next crop. Soil with much organic matter in the form of compost subsides during the decaying process. It might sometimes become too dense for optimum root growth and will not

drain well. Therefore, after the harvest remove up to 5 cm of the used, composted bed and mix it loosely in the top layer on a newly-laid bed.

If after one crop a growing bed is still deep and loose enough, leave it after the harvest and do not turn it. Sometimes working organic matter into the soil together with artificial fertiliser – if needed – will be enough maintenance to start a new crop. Pay attention to soil-linked diseases: preferably, avoid planting the same or related crops in succession in the same soil.

4.5 Shallow raised bed

Figure 8 shows the "above ground" variant: a shallow, raised or piled-up bed.

Material and construction of a shallow raised bed

The materials you need to make a shallow, raised growing bed are:

- fairly fertile prepared soil, preferably available locally
- reliable water supply, by drip irrigation if necessary
- compost and/or fertiliser
- synthetic soil canvas or plastic sheet in one piece, if needed
- wooden planks to make side panels, if needed

Raise the bed to between 10 and 30 cm above the ground. The width should be 1 to 1.2 m at the maximum, so that you can easily reach the middle of the bed from the sides. You can make any length of shallow bed you like. However, an interruption by a path at intervals of 2.5 metres will be handy. A bed the size of a door opening is very practical.

Should you wish to construct a bed on a balcony or roof, then you would need to board up the sides. Of course it must be sealed. Use plastic sheeting with no joins at the base of the bed to prevent leakage of water. If the bed needs to be laid on contaminated ground, then lay it on a layer of plastic to help protect the soil and roots from coming into contact with the contaminated soil.

Use available and clean soil from the area, mixed with organic matter if possible. A thin bedding of crop and weed residue with a covering of mixed soil and organic matter is good. For more, see Chapter 6: Soil care and composting methods.

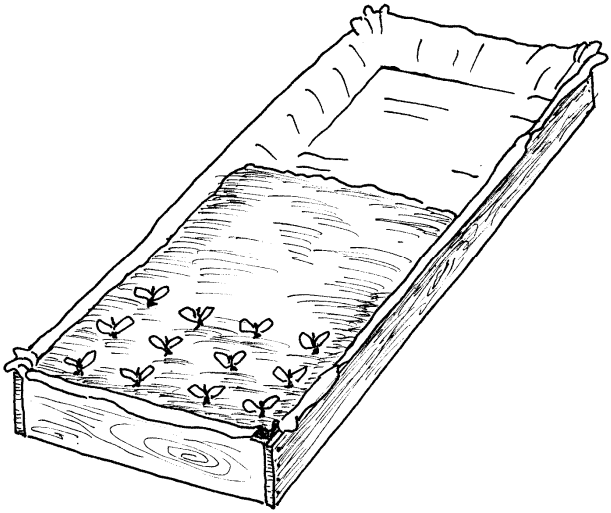

Figure 8: Shallow piled-up or raised bed

4.6 Sunken door-sized bed

Figure 9 shows another variant: a dug-out sunken door-sized bed.

Materials and construction of a sunken door-sized bed

You can make this bed by digging or hacking away in a stony ground that is not too hard. Dig or hack a trench or 'bed' that is a little bigger than a door opening or a single bed: 1 m wide and 2 m long and maximum 0.5 m deep. If the topsoil is clearly more fertile than the subsoil, carefully keep them separate.

Use soil of good quality, or use decayed compost which is made according to rules given in Section 6.4. Fill the bed or trench with alternating layers of compost and soil, like is shown in figure 9; preferably

not too much of soil material of inferior quality. Use this for the bottom layer with the fertile layer uppermost. When the trench is half full, spray water on it. Then fill it up to make a raised bed, finishing with a layer of topsoil. You can start planting or sowing straightaway. It would be better to first experiment with different plants to determine which type of crop germinates, grows and produces best.

If there is no ready-made compost available, but an abundance of fresh vegetable refuse instead, then you could make either a compost heap, or a compost trench, bed or basket. The latter are treated in the next section. For more details on composting in a heap, we refer to Chapter 6 and to Agrodok 8: Preparation and use of compost.

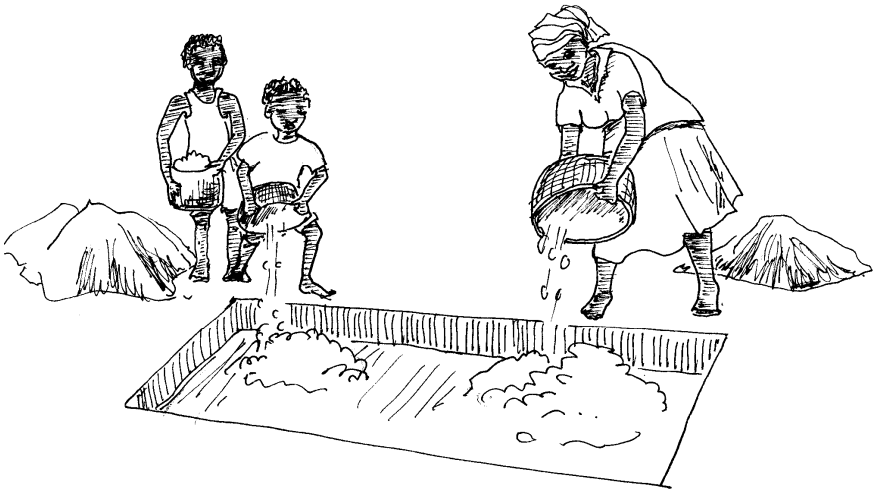

Figure 9: A dug-out bed being filled with soil matter and organic debris

4.7 Growing and composting in-situ

Features

Intensive small-scale growing methods are: trench, pit or basket composting. They can be carried out on your own courtyard. You can use

these methods if you wish to combine composting the material and cultivating vegetables on the organics–soil-mixture it at the same time. The compost pit, trench and compost basket are therefore good solutions if you have no room for a separate compost heap next to the growing bed for plants. If you wish to make organic household refuse compost on a small scale, organic matter can be composted on the spot, using it as nutrient medium.

In the case of trench composting, the planting is done on the top of a trench filled with organic waste, alternated by soil matter, see figure 10. The only difference with the growing bed, as shown in figure 9, is its size.

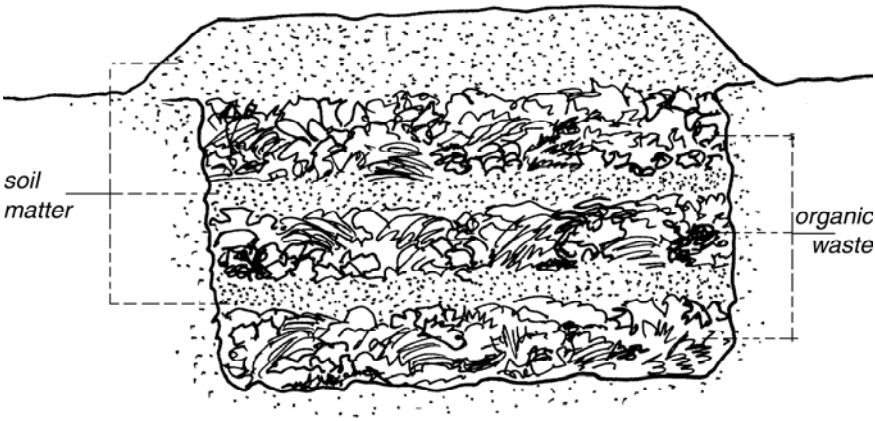

Figure 10: Crosscut of a compost pit

Basket composting consists of a pit with a compost basket made of woven organic fibres, leaves or twigs, around which the planting is done.

Composting combined with growing on the same spot has some noteworthy advantages:

- collected weeds are immediately converted into a continuous source of plant food;
- there is no need for construction and management of a compost pile that will take up valuable space in a small garden;

- soil fertility is maintained by the steady incorporation of organic matter; little need for extensive garden preparation;
- it is beneficial for the soil and for water conservation.

Some principles of composting are mentioned in Chapter 6: Soil care. For much more about the practical issues of composting, we refer you to Agrodok 8.

Crops

Plant short-term food crops that require good soil fertility for example, Chinese cabbage, spring onion, cucumber, tomatoes, capsicum and melons. Plant these directly on or around the compost trench or basket or the dung pit.

A bigger and longer compost trench or bed can accommodate low input, longer-term crops such as papaw, banana, sugar cane, cabbage and root crops.

Maintenance and care

A skilfully made compost trench or basket as well as the dung pit needs no maintenance. However, light and airy organic matter will subside in time and its level will need to be raised following the same methods.

If more than half the contents of the dung pit consists of decaying dung, the mixture will probably be too rich for leafy crops because they absorb too much nitrate. Therefore, do not grow these on the dung pit but leave the filled dung pit for a month, or first use it for growing another type of crop. Always ensure that the pit does not fill up with water. You can make a cover for the pit but do not seal off its bottom with plastic.

In many places the pit is also used as a place to put the dung collected from the streets. Add dung, soil and compost to it regularly and mix it in order to fix the nutrients. The pit is perfect for mixing by hand and shovel and, if covered, it ensures that the fertilising dung minerals are not washed away by heavy rain.

5 Areas for soil-bound cultures

In the previous chapter we described cultivation on beds of various sorts, and the art of cultivating and composting at the same time. These techniques, however, do demand a minimum surface area and/or rooting depth. Some of the techniques can also be applied by simply enlarging the surface area, namely, by making raised beds, sunken beds, the compost trench and pit and the compost basket.

Below, we discuss various types of locations where growing surface and rooting depth generally do not represent limiting factors. We briefly give the advantages and disadvantages of each. While emphasising the link with the special character of the urban environment, we will discuss how the growing techniques here differ from “regular” horticulture.

Urban agriculture is often practised in spacious locations in and around the town on larger areas in open ground, sometimes even with irrigation systems. This comes under the category of peri-urban agriculture, which is often for commercial purposes and essentially also different in technique from that described in this Agrodok. We will briefly outline peri-urban agriculture at the end of this chapter.

We recommend that you read Agrodok 16: Agroforestry, for there are many applications that we cannot highlight in detail here.

5.1 General: locations outside your premises or courtyard

You can create growing plots or strips on locations outside your direct place of residence. You can decide whether you want to make one of the types of growing beds, use an in-situ composting method or lay a “regular” vegetable patch. It would be ideal if you have a plot or strip of land at your disposal. If it belongs to someone else, you would of course need to have free access to it at least.

Features that we think can be seen as common to “public” locations in towns are:

- Scale: can be tens, sometimes hundreds of square metres in size.
- Location: located outside the direct vicinity of the home, but often inside or just bordering the residential area.
- Ownership: the grower is not the owner of the land, but has access to it for at least the growing period of a vegetable crop.

For all types of locations one must take account of the following:

- Ensure you know what your rights are: pay attention to the availability and access rights; avoid the risk of sudden expropriation of the land or land use.
- Use clean water: ensure that you have control of the availability and transport of water – preferably with its organisation. Pay attention to the quality of the water. Avoid using surface water for the watering of leaf crops and other food crops for reasons of hygiene.
- Pay attention to peripheral influences: they play a dominant role, especially along roads, railways, rivers, streams and open sewers. They also occur on wasteland and in peri-urban agriculture and horticulture. Negative peripheral influences and problems including damage by playing children, inquisitive passers by or roaming goats or dogs. Also, nuisance can be caused by street litter and illegal rubbish dumping, and dust and exhaust fumes wafting in.
- Check whether the crops can be protected and kept clean. Someone needs to keep an eye on fouling by illegal rubbish dumping, animals walking through, stealing of crops and the other forms of hindrance mentioned above.

5.2 Roadsides and railway tracks

A large portion of towns is taken up by road verges. But strips alongside railways, viaducts, crash barriers and under high voltage masts can sometimes offer suitable space, see figure 11.

Figure 11: Growing crops alongside a road

Check whether there are strips of land in and around your neighbourhood that are not used as pedestrian paths or for driving cattle and that are not affected by street litter. These circumstances often make the soil unfertile or difficult to cultivate: soil that has a poor structure, that is polluted or that prevents root penetration.

If you are able to, get a hold of clean and free strips with good soil: these are generally flat and even and easy to work. You might have to pay rent, but the cost of renting public land is often not high. Do arrange to get a municipal license, at district level or as part of a growers group, if possible.

A road nearby increases the accessibility for inputs and transport to consumer markets. Sometimes, one can do the selling directly on the road. Naturally, theft and lack of control are the big risks. Check the risk of theft of your crop by passers by, or your crop being eaten and

damaged by roaming cattle: if the risk is great, then you would be wise to forget it. Think about putting up a barrier. This is not possible for an individual but a growers group can do much. Suggestions to avoid the risk of theft are: grow crops with a low market value or those difficult to harvest (eg, root crops); pick fruits early and allow them to ripen at home (eg, tomatoes); watchful neighbours or adjacent residents could keep an eye on things; or fence off the crop with wire netting.

Negative impact on the environment from dumping of rubbish, diffuse pollution from the air: dust, lead, soot, tar from roads and rubber from vehicle parts make growing of food crops undesirable. Pollution from bulky objects such as well-worn and dumped car parts and consumption refuse from pedestrians are also a nuisance. Places where these nuisances occur are more suitable for growing trees, perhaps even agroforestry and cultivation of fibres, wood and other non-food products. If you must grow food crops under these circumstances, then please pay close attention to the following:

- avoid uptake in the plant of lead from exhaust fumes by never growing leafy vegetables;
- always wash fruit well and peel root vegetables;
- pulses, grain and root crops are least affected by substances and heavy metals owing to the protective sheaths around the seed.

As an aesthetic argument, tended vegetables patches along road verges are a far more attractive sight in a town than poorly maintained strips with uncontrolled weeds or even rubbish. Some people see disadvantages in cultivating the road verges: drains can get blocked by vegetable residue that is washed away by heavy rainfall. However, this is nothing compared to blocking caused by floating debris like paper, plastic and litter.

A solution for much of the disadvantages put forward is: look for places for growing your crops that are more than five metres from roads or railways, and do not be tempted to go any closer. If you want

to cultivate for a longer period, then think about planting a strip of trees or shrubs next to and along the road or railway track:

- they will offer protection against dust and dirt;
- eventually they will contribute to improving the soil by organic matter (leaves, twigs, fruits);
- they provide shade;
- they form a natural barrier that you can accentuate with fencing or wire netting.

5.3 Banks of rivers and streams

The banks and beds of rivers and streams offer fertile ground during the dry season, especially if a regular sedimentation occurs of fertile silt with minerals when they flood in the rainy season. Flood and sedimentation plains are also rich in minerals.

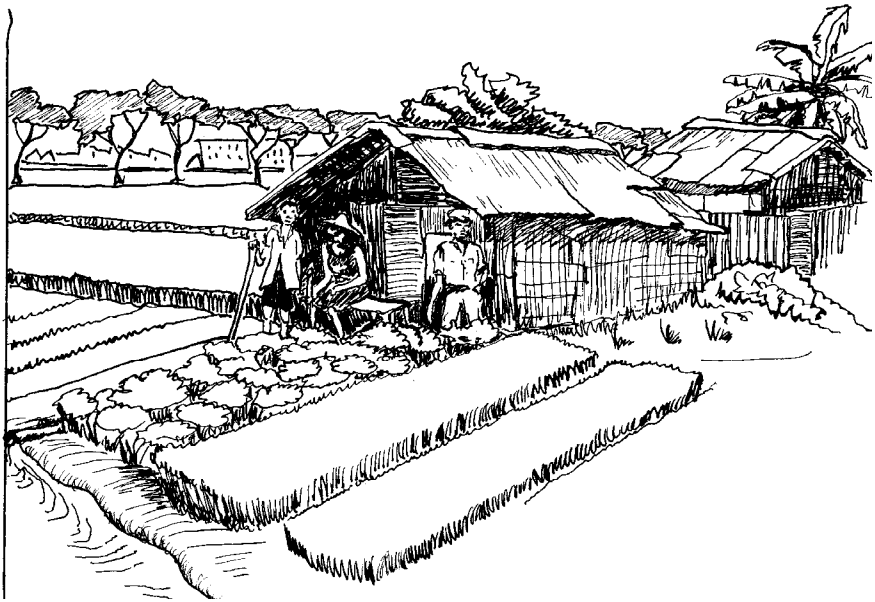

Figure 12: Crop cultivation on plots by the waterside

You can usually work in horizontal strips or terraces. Figure 12 shows cultivation of a crop right up to the waterside. Beds along a stream that are flat and even are indeed the easiest to cultivate.

Moreover, if the subsoil is silty, it will retain moisture even at higher elevations or levels above the water table along the brink. Usually, there is irrigation water near at hand, but you had better not use this for leafy vegetables as there is the danger of infection by pathogens (see Chapter 3). The quality of the water is particularly dubious if household waste water is being discharged upstream. In a residential area the water quality is also worse the further downstream one cultivates. Sudden heavy rainfall can rapidly result in flooding. The damage done to the crop by everything being washed away is not the only important impact, just as important is the debris that gets left behind after the water level has subsided.

5.4 Compound hedges and borders

Optimum use is usually made of space around the house, which generally only has a few square metres to offer. The cultivation techniques in the previous chapter can also be put into practice in a limited surface area. One big advantage of course is that you or your neighbours can watch over the crops. If you grow crops in someone else's courtyard the owner could keep an eye on it.

Courtyard boundaries are perfect for planting trees and shrubs. The advantages are: they give shade, they form a shield against dust and dirt carried by the wind, and they are a welcome change from a fence or expensive wall of bricks or loam.

Multi-purpose hedges are of economic use: plant fruit trees or medicinal plants. A low, dense and thorny hedge is an effective way to separate fields or beds from public areas. Plants with edible fruits might be a good idea.

Medicinal plants or herbs or other non-food plants less likely to get stolen are advisable if the plot is left unguarded.

5.5 Construction areas and wasteland

Wasteland that is actually intended for some other purpose will often do nicely for urban agriculture. These are sites that are often fairly large, from a few dozen to hundreds of square metres in size, therefore, negative marginal effects do not play much of a role.

Always bear in mind that the ground can be polluted or unfertile, especially if houses previously stood there or it is where activities of an industrial nature or traditional crafts took place. The only way to assess the soil quality and check for pollution is by ascertaining what the ground was used for previously, unless you have a costly soil survey done. A growers group with enough members may be able to afford to have a chemical soil analysis done. Naturally, if you have some cultivating experience, you could try out a few quick-growing crops that are not too demanding.

If a plot is owned by a third party, it would be very wise to arrange for access and use by means of a contract or licence. It might at times only be for a very short period, but it is always better to have a growing period that is restricted by a licence than to lose access to the plot at the will or whim of someone else.

5.6 Sloping land

Gardens located on hillsides can become satisfactorily productive if steps are taken to prevent soil loss through erosion. If preventive action is not taken, the best quality topsoil will wash into rivers or ponds leaving behind barren soil. Several techniques have been used to prevent soil erosion in areas where food is traditionally grown on hillside slopes (see Agrodok 11: Erosion control in the tropics).

More food can be produced per surface area by applying agroforestry methods than without them. Use of appropriate crop management is essential; we mention alley cropping in particular. In this agroforestry method, a mixture of fast-growing leguminous shrubs, trees and grasses are planted along hedgerows. Food crops are grown in 4 to 5 metre-wide “alleys” in between the hedgerows. The hedgerows are

pruned regularly to provide the soil with organic matter and to reduce shading of the food crops.

5.7 Peri-urban agriculture

We speak of peri-urban agriculture when crops are grown round about the town or in between the districts of a town, and the produce is sold in the town itself. This is mostly done on a commercial scale, plot-wise, with opportunities for irrigation. Figure 12 shows a typical situation, a spacious location at the border of a town on a larger area in open ground. You may have the opportunity to even sell on-the-spot to buyers, if your enterprise gets known to general customer public; as is shown in Chapter 8, figure 19.

Peri-urban agriculture requires good ownership or user agreements in order to be successful. It goes without saying that it usually implies that growers groups or community-based organisations are active here. Many policy makers of municipalities or other local governing bodies encourage peri-urban agriculture because it has more commercial potential than vegetable growing far away from the town.

Peri-urban agriculture has much potential as it can be marketed in the town itself and in most cases it is done on a commercial basis. This has to be so because the market is further away than growing crops in the direct vicinity of one's home. Transport of fresh produce requires good organisation, adequate production and the necessary investments.

Here is where the integrated methods come in. In many local situations peri-urban agriculture offers the opportunity to plant trees or to combine them with the agroforestry methods. You can also combine a fish pond with horticulture for marketing purposes, for instance. Small animals or poultry can be kept in pens above ponds or canals. This has become very famous as the *chinampas* system, which was developed and perfected in Mexico. These specific integrated methods are dealt with in Agrodok 21: On-farm fish culture. In this edition we will not take peri-urban agriculture or integrated methods any further than this, as its production technique to a great extent reflect agriculture.

6 Soil care and composting methods

Good soil is one of the most important requirements. This chapter is about how you can achieve this. Fertile natural soil is good for the plant, but is sometimes scarce. Compost is ideal for improving the soil, and anyone can make it. Check which starting materials can be found close to your home and which needs to be supplied. Are the materials of a good quality and are they healthy? Check their origin. Are they easy to process and transport? Do you expect better growth and production from soil that you have prepared yourself? Can the soil be used again and again, and can the quality be restored after harvest, or will you need to get rid of the soil after using it once? By experimenting, you can try to answer these questions based on your own circumstances, or determine what is best.

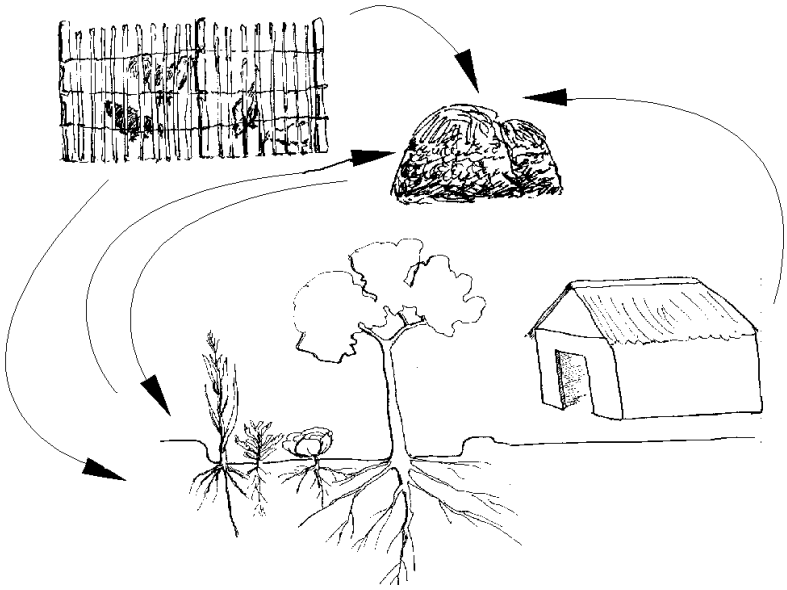

Figure 13: Managing the cycle of minerals and organic matter on backyard scale

Organic components on household level come from domestic waste from the kitchen, dung from small animals and other waste like leaves from trees and shrubs. It would be a pity to just throw these away in the street or outside your premises with other domestic waste. Instead, it is worthwhile to try and re-use the organic material in a small-scale cycle of natural raw materials and nutrients. This is symbolised in figure 13 in the cycle of the (indeed small) house, a chicken pen, plants and vegetation and-last but not least- the compost heap. Compost production, be it in a heap or in-situ in a pit (see figure 10), is highlighted primarily in this chapter, as it is an essential method for producing good quality soil.

6.1 Components of soil

Soil consists of mineral soil particles, water, air and organic matter in varying stages of decay. Fungi, nematodes and all kinds of micro-organisms also contribute to determining the condition of the soil. A rule of thumb is that good soil is *airy, moist and fertile.* Sand is airy, but has no minerals and is therefore not fertile. Moreover, it retains little moisture. Clay retains much moisture and is fertile, but not airy. Loam is airy, retains water and is fairly fertile. Organic matter and humus are water retentive and are airy and fertile. Well decayed organic matter keeps the structure of a clayey soil open, and promotes the water retentiveness of a sandy soil. Adding sand or organic matter to clay soils improves the drainage.

Table 3: Different components of soil and their characteristics

Type of soil component	**Properties**			
	airiness	**moisture retentiveness**	**fertility**	**drainage**
Sand	+ +	– –	– –	+
Clay	– –	+ +	+ +	– – –
Loam	–	+	+	– –
Organic matter	+	+ +	+ +	+

Fertile soil alongside rivers is rich in minerals and contains sand for drainage and rooting volume. Loam or clay provide the nutrients.

You can increase the organic fraction of the soil by adding your own compost, decayed vegetable kitchen refuse, crop residue, dung from cattle, poultry or pets, or organic soil such as peat. One can also find good soil around trees or shrubs, where decayed leaves and twigs have formed a layer of humus.

6.2 Keeping soil in good condition: composting and mulching

Application of fresh organic matter to soil in which plants are grown should be done with caution. Hard, dry parts and stalks of the plant consist of organic matter with a relatively high carbon content. This fixes nitrogen when decomposing. Fresh, green, vegetative parts and leaves and unripe seeds contain organic matter with relatively high nitrogen content, which produces good compost. However, if this is applied to the soil in a green mass that is too dense, the heat that is given off when decaying takes place can damage the roots.

Balanced soil improvement can be achieved from the composting of fresh and decayed organic matter. Fresh organic matter, like vegetable refuse, is converted into humus by soil organisms: a quick process whereby nutrients are released. Humus consequently breaks down releasing even more nutrients. This is a lengthy process but it is extremely beneficial to soil fertility.

Decayed organic matter improves the condition of the soil:
- it retains water and improves the structure of the soil;
- it supplies nutrients: nitrogen, phosphate, potassium and sulphur;
- nutrients become available to the plant upon decomposition;
- it prevents acidification of the soil;
- it stimulates the growth of soil organisms, which in turn digest the organic parts, thus keeping the soil airy.

Protect the soil surface from direct sunlight, heat, wind and heavy rainfall, whether in pots, on beds or on small plots or on the compost pile. Therefore, we recommend keeping the soil surface between plants covered. This can be done by using either fine organic matter or mulch, fresh feathery leaves, palm nuts, coconut fronds, or with woven cereal sacks in simple layers. This coverage has several positive effects:

- weeds are reduced or eliminated by keeping sunlight off the soil surface;
- evaporation is minimised by conserving moisture in the topsoil;
- in case of heavy rainfall, the force of the raindrops is broken so that the soil becomes less impacted;
- mulching and shading conserve moisture in the top layer around seeds and seedlings.

Light mulching such as a sprinkling of fine organic matter on the soil surface after watering will reduce evaporation. Mulching and shading should allow enough sunlight to reach the plants. It is a good idea to periodically clear the mulch away and check for problems such as insect or fungal damage.

A thick layer of mulch can, however, harbour insects and encourage disease, both of which prey on tender seedlings and seeds. It can also smother and kill emerging seedlings.

If soil-borne diseases are a problem, heating the soil in small amounts will sterilise it. If the maximum daytime temperature is high enough, direct sunlight will do. Put the soil in a covered or closed pot or bag, preferably black or dark-coloured, and leave it to heat up in the sun for several days. Because heating the soil also kills beneficial micro-organisms, this should be done only when absolutely necessary – and not too often.

6.3 The virtues of good composting

If you do not want to compost in-situ, as is shown in Section 4.7, of if you have a lot of organic matter and ample space on the courtyard, then you may choose to construct a simple compost heap.

We give three main rules for making a compost heap:

- choose the right type of organic matter: use a variety of material in different stages of decay;
- ventilate: make thin layers of plant residue, alternating coarse and fine material, fresh (nitrogen-rich) and dry (nitrogen-poor);
- check the moisture content: too dry hinders decaying; too wet leads to rotting.

For complete descriptions, we once again refer to Agrodok 8: Preparation and use of compost.

A compost heap in decomposition should preferably be made within one week, which is possible to achieve from refuse from one average-sized urban household. If you do not have a constant and reasonable supply of different kinds of organic refuse, you could join up with neighbours or a group in the district, or you can collect refuse from the vegetable market and grain straw to quickly build a heap.

A compost heap should not be too moist; 50 to 60% is good. You could test it by squeezing the compost material when you should just feel the moisture in your hand, but it should not be dripping wet. The compost should glisten when moistened. If the organic matter is well metabolised, it should be odourless, black or brown in colour and it should not contain pathogens. Ready-made compost contains 30 to 50% water and more than half of it consists of particles of 2 to 10 mm in size.

Composting can also be done in a plastic bag with holes in it, in a woven basket or in a car tyre. But the end result will not be of the same quality as the compost from the methods proven in practice.

6.4 Golden rules for composting

Reduce health risks and prevent causing a nuisance

- Remove glass, plastic, metal, offal, foreign objects and batteries, immediately.

- Avoid adding too much of animal manure and do not add fresh human excreta.
- Cooked food or meat and fish on the compost heap can attract vermin.
- Do not compost directly next to the house to avoid problems with vermin and bad odours.
- Pathogenic organisms will be killed during the high temperature phase.

Encourage the composting process

- Adding some "mature" compost or "healthy" soil boosts the composting of a new heap.
- Adding earthworms with a shovel full of earth, for instance, will dramatically quicken the process.
- Grow members of the cucumber family (*Cucurbitae)* on the compost heap: they will root rapidly and this will quicken the decomposition and thus the maturing of the compost.
- Drying out of the compost by the sun's warmth can be prevented by covering it with earth or woven mats.
- Use coarse and fine organic matter to allow for the entry of oxygen. Fresh green grass and leaves clog together so that the heap will become too compact.
- A rotting smell denotes oxygen depletion, therefore the compost heap should not be too compact.
- Stamp the material of a new heap somewhat if it is too airy and not subsiding under its own weight.

Strive to recycle the minerals

- Organic matter that would otherwise not be used is converted into fertile soil components through composting.
- Collect organic refuse in a heap or in pits, thus preventing it from drying out or getting blown or thrown away: two significant ways by which a lot of nutrients are lost. Do not burn material usable for composting.
- Feed fresh vegetable and other organic kitchen or market waste preferably to productive animals. For example, fresh green leaf

residue for rabbits, prepared leftover food for pigs, coarse plant part for goats, waste from the vegetable market or a food stall. The fresh and nutritive waste can first be reused, then animal dung can be composted.

- Manure and urine are perfect for composting. Mix it in with other suitable organic matter, and with mineral elements of the soil, or add it in thin layers to the compost heap in small doses.

7 Water care

What is the handiest and safest way for you to get water? Is it by walking to a source and collecting water in buckets, a drum or a plastic jar? Collecting rainwater? Reusing wastewater? Drawing water from a pond, river or stream? In this chapter we present a few ideas of how different water sources can be used.

Figure 14: Irrigating by hand: most common and practical, but hard work

Is the water suitable for irrigation? The quality of water in urban areas can vary somewhat. Intensive use of public space and surface water in cities has specific effects on water quality. Here below are some suggestions to enable you to check this in your own situation. The word "source" in this chapter does not only mean wells or natural sources, but every possible origin of water.

7.1 Availability of irrigation water

How can you get water or get access to it? Make and assess an inventory of available sources of water before you start your planting. Do not forget the rain that you can expect. Ask yourself the following questions if you have to choose between different sources of water.

- *certainty* will water be available for the entire growing season?
- *quality* is the water clean, with no pathogens and not too many salts?
- *convenience* is the water source close to your plot and can the water be stored safely?

Table 4 is a very detailed and general list to help you judge the quality of different types of water.

For information on advantages and disadvantages of all types of water sources and water storage, please refer to practical literature on these topics. Below is an account on the reuse of wastewater because it is an interesting subject in the urban environment and because we have a bit more to say about it.

7.2 Reuse of wastewater and eutrophication

We make an important distinction between two types of wastewater: “grey” wastewater and “black” wastewater.

“Grey” wastewater is what we call water that has been used for household purposes, mainly for washing and rinsing and hence containing a little soap residue. This water is usually discharged from the house. Soap residue contains phosphate, a common and essential fertiliser: needed for growth of plant roots, for instance. A disadvantage of soap residue is that it can affect the surface features of the soil, plant roots and leaves. It would be best to avoid excessive use of wastewater containing natural soap or simple washing powder – without bleach.

Table 4: Potential sources of irrigation water

Sorce / origin	**Reasons for using**	**Reasons for not using (or doubtful)**
Rainwater (collecting)	relatively clean; collection possible on sites where other water sources are lacking	relatively nutrient-poor; ventilate or cover storage to avoid occurrence of mosquito larvae
Water from source or well	shallow: less clean deep: relatively clean	may be too cold for the plant for direct use; sometimes a pump is needed; if from salt-retentive soil ⇒ risk of silting
Flowing surface water	if abundantly available locally; self-cleaning potential	maybe health hazard by pathogens; difficult to check origin
Flowing surface water with industry, residential area or agriculture upstream	only if: certainty of little or no effluent being discharged upstream and if: no pollution or pathogens occur	often fairly polluted through effluent and wastewater; control on origin is sometimes difficult
Stagnant water	rather contaminated due to decomposing discharged effluent	health hazard by pathogens fairly high
Mains/piped water	clean	costly; nutrient-poor; chlorine harmful for some plants
“Grey” wastewater: suitable after simple cleaning	mostly available locally; only if complete control over source; dissolved nutrients add fertiliser value	moderate health hazard by pathogens; at least 1 cleaning phase needed; store only if ventilated
“Black” wastewater: not suitable unless thoroughly cleansed (biologically)	mostly available locally; only if complete control over source; dissolved nutrients add fertiliser value	several cleaning phases needed ⇒ only feasible on town district scale; high health risk; store only if ventilated

Soap residue and dirt can easily be skimmed off from household wastewater that has been left standing for a while. Therefore, after a minimum of effort “grey” wastewater can often be suitable for irrigation purposes.

Eutrophication is the term for uncontrolled growth of algae which is undesirable. Growth of algae is enhanced by the presence of nutrients, eg in the form of fertiliser or surface runoff - whether or not done on

purpose. And, as mentioned above, detergent residues contain large amounts of phosphates, which is a fertiliser. Treated or partially-treated domestic sewage is also a major source of nutrients. Furthermore, if stagnant sewage stays untreated, the biological eutrophication process will start by bacterial and algal activity. The process is enhanced primarily by phosphorus, leading to an increase in concentration of available nutrients. Phosphates are powerful stimulants of algal growth.

Water in which fresh leafy vegetables have been cooked contains nitrate with the mineral nitrogen. Nitrogen, mainly in the form of nitrate but also as a residue of decomposing proteins, can add to the effect of eutrophication in prolonged stagnant wastewater. Together with organic residues it can cause rotting, leading to stench.

Apart from phosphate and solid residue, “grey” wastewater also contains fat and nitrate residue. Fat can settle in drip irrigation pipes (see 7.6), and fat residue can seal off the soil. Floating fat or oil can easily be removed from standing water by skimming or by pouring off.

“Black” wastewater is dirty or very dirty household wastewater, and water that has been used for washing and bathing containing much soap residue. Water with residue from other cleaning agents also belongs in this category, just like water from toilets or latrines. This water requires to be purified more intensively to get rid of these substances as well as pathogens. This can be done by intensive ventilation in one or more stages.

To avoid health risks we do not recommend that individual households use this "black" waste water for vegetable-growing. We will not be discussing the cleaning and reuse of it further. This can only be successful if it is a central supply and takes place at district level, at the very least.

7.3 Storage of irrigation water

Where do you want to store the water? There are numerous possibilities and techniques. We would like to draw your particular attention to

collecting streaming rainwater via a solid roof, so-called rooftop water harvesting. This is potentially a very good source of irrigation water. It can be efficiently used provided that you take care of collecting, transporting and storing it. It is an ideal way to collect water in an urban area. A disadvantage is that the water can also contain dust and dirt from the air and from the roof and sometimes from trees. Use plastic or a wooden lid to cover the water to prevent mosquitoes from breeding.

Some storage methods require unavoidable investments. A cement tank is robust, but very expensive and immobile. Clean oil drums or used plastic fuel cans make simple and practical rainwater tubs. Provided there is no alternative, you could use empty synthetic barrels that were once receptacles for chemical pesticides, mineral oil or other chemically-active substances. These are identifiable by the cross or skull and crossbones on the label. Some substances can adhere to the synthetic packaging, so you should always clean these containers carefully and prudently before using them to store irrigation water. If this is not done, it can be hazardous to health.

7.4 Water requirements and water loss of plants

Water requirements of plants

Water requirements vary per plant. Requirements are easy to optimise when growing on a small scale. What is important is to know how water use can be reduced to a justifiable minimum. A drop of water can only be used once. When extending garden production to the dry season, it is particularly advisable to minimise evaporation of moisture from the soil or transpiration from the plant.

A little theory: a plant grows best when the amount of water in the soil is filled to saturation point. Storage capacity is the amount of water that the soil absorbs between saturation point and wilting point. If there is too much water in the soil the plant will “drown” because the roots will not be able to get any oxygen. Storage capacity is optimal at

saturation point, when the soil contains so much water that the roots can absorb as much water and as much oxygen as it needs. The wilting point is the point at which the soil is so dry that the leaves of the plant continue to hang – thus even during the evening and at night.

Transpiration is the process of water disappearing in the air by heat; 'sweating' by plants. Most commonly it is not visible; sometimes it shows as condensation in eg a plastic warehouse with too little ventilation. It is the direct loss of water from the leaves, stems, flowers, fruits or even roots. This water can hardly be recaptured from the air by the plants, so it is worthwhile to avoid transpiration.

Evaporation is the same process, from the soil or from a water surface. Evaporation plus transpiration together are called evapo-transpiration.

In irrigation as well as evapo-transpiration, the following generally apply:

- The more clay or loam in the soil, the more moisture it can absorb and retain.
- The higher the content of organic parts/humus/compost in the soil, the more moisture the soil can absorb and retain.
- The deeper the rooting layer, the less water evaporation from the soil: the surface is small in comparison to the root depth.
- The more the soil is covered with (preferably) organic matter, or with leaves, the less chance of direct evaporation from the surface: the soil gets less warm and there is less air movement.

Suggestions for reducing evapo-transpiration:

- Irrigate only where the roots grow. For seedlings just a little; for adult plants the whole pot, container or bed.
- Add organic matter or compost to keep the soil moist
- Plant leafy vegetables near or even next to the water source
- Irrigate preferably in the evening or at night: the plants can then make optimum use of the water for growth and development.
- Avoid giving too much water too often because you will then get superficial "lazy" roots. It is better to stimulate root growth down-

wards, thus encouraging good penetration of the soil for maximum use of water and nutrients.

- Cover the soil in order to reduce warming of the soil and to prevent evaporation from the soil. Use a mulch of dried leaves or other plant residue or cover with woven sacks.
- In the dry season provide plants with shade during the hottest part of the day by means of a sunshade made from bamboo or straw; transfer plants in pots to a shady spot.
- Protect plants from the wind by building a screen or fence of locally available material: the more airflow, the more evapo-transpiration from the plant and soil.
- Choose a suitable time: cultivation is simpler during the rainy season (wet, less warm, water available) than during the dry season (warm, dry, no water available). This is especially so when plants are grown under a cover, a roofing or a tree.

7.5 Small-scale methods for irrigation

Small-scale methods for irrigation of crops require rather a lot of labour and regular attention. But, they need little investments and starting materials. Here below are a few techniques:

Watering

By far the simplest, most effective and quickest method is to give plants water using a watering can, bucket, jug, tin or pot (see figure 14). However, as the precise and suitable quantity of watering is difficult to achieve, this method is less efficient. It is highly likely that the soil is given far more water than the plant can quickly absorb, resulting in wastage by water runoff and evaporation. Moreover, a pot or container needs good drainage to prevent fungus from attacking the roots.

Watering with too much water all at once using a bucket, for instance, results in a big “pool” around the plant and seals off the soil. This will retard plant growth. Water should be poured as close to the soil sur-

face as possible to avoid eroding the soil and to avoid the soil structure becoming too compact.

Sprinkling

A gentle and dispersed stream of water will resemble rainfall, by which means moisture naturally and evenly penetrates the soil. Pouring water through plant leaves or by using a container with small holes will disperse the force of water poured on to seeds or seedlings. Besides, if you break the force of pouring water, it will also prevent seeds and a plastic bucket, earthenware jug or gourd or a big tin can with holes in the bottom and/or the sides. Fill it with water and sway it evenly back and forth over the plants, see figure 15. These are simple to make or obtain, there is no maintenance and the material can be obtained almost anywhere.

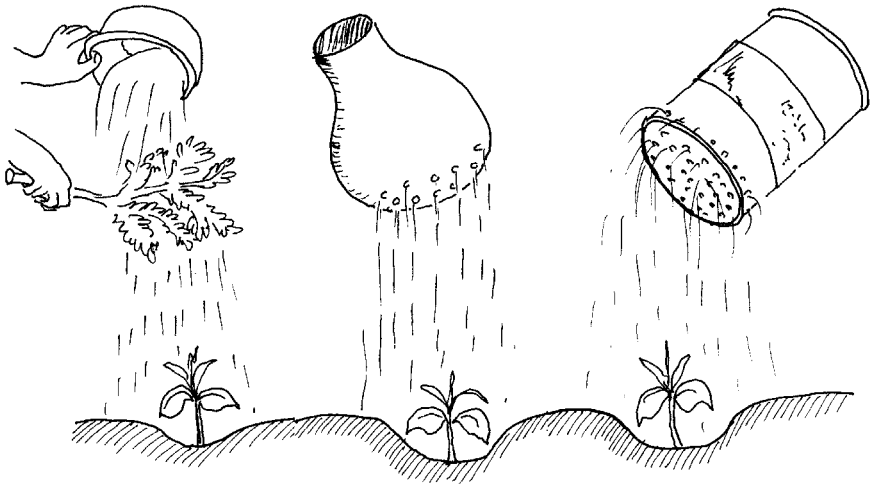

Figure 15: Different ways of watering plants manually by sprinkling

Buried jug

An earthenware jug of very porous material buried in the ground, allows water to slowly seep through its walls. Water in an upturned, wide-necked bottle placed in the ground will also slowly leak away.

The principle is very simple: water is supplied to where the plant needs it, namely, at its roots.

A porous unglazed, unfired, earthenware pot is buried in the ground – in between the plants – with its opening just above the surface. The porosity of the pot will ensure that the soil is evenly supplied with water. You will need to refill the pot regularly. The disadvantage is that the water will only be released to the same spot and the roots will only develop there, unless watering is also done directly on the soil. Therefore, sow or plant fine leafy vegetables close by. Cover the opening of the pot to reduce evaporation and to prevent attracting animals. This will also keep away larvae from harmful insects breeding in water.

Tins and tin cans

Bury empty tins from drinks or tin cans from preserves in among the soil. The tins will hold irrigation or rain water to supply the roots with water by evaporation, or act as receptacles for holding roots that grow in the water. Other advantages are:

- it is a simple way to increase the rooting depth and to air the soil;
- they are light and are ideal for roof terraces or balconies. You will have less weight to transport and the roof or balcony will have less burden to bear.

7.6 Drip irrigation

Figure 16 shows a views of a drip irrigation system, consisting mainly of a bucket on a stand and one or two flexible, perforated tubes.

The principle of drip irrigation is to provide a plant with a direct and accurate dose of water, hence to the roots. Drip irrigation is very popular for irrigating vegetables, herbs, fruit crops and newly planted trees in the (sub) tropics, but also in temperate regions. The crop gets ample water: not too much and not too little, and will then grow well. Little water is lost through evaporation, surface runoff or by weed intake.

Figure 17 Shows the same installation, but now a situation in which the tubes are actually laid out on a vegetable crop on a raised bed where it can irrigated by drip dosage.

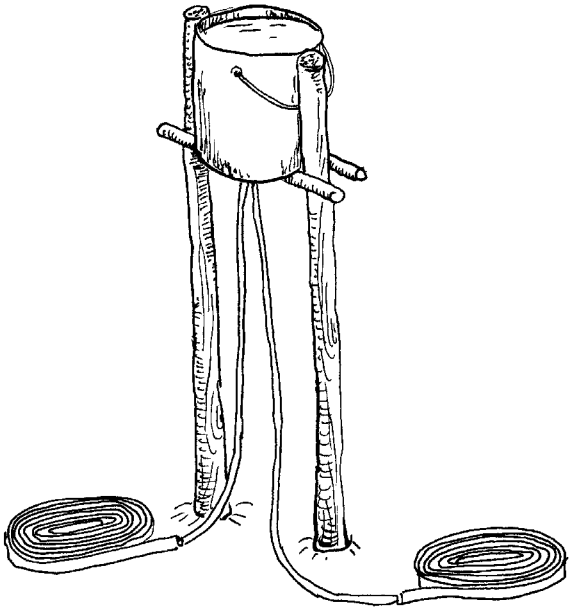

Figure 16: Drip irrigation installation on a stand

Material and time to experiment are needed to set up such a system – but when it works, the method is simple and practical. Purchasing and installation costs are best shared through a grower's group or cooperation. The technique of drip irrigation is easy to demonstrate in a school, a women's group or a community centre. An address where it is available readily is mentioned in the further reading and reference list.

The advantages of drip irrigation are:

- very little water is needed for vegetable growing
- you can regulate the dose of water to the plants by adjusting the height (pressure) of the water container or bucket, or by using clamps or taps
- it needs little labour: only the buckets need filling from time to time
- less weed growth, the crop takes up all the irrigation water virtually directly

- the material is long-lasting
- is prevented soil compaction
- drip irrigation is applicable in rows for beds and for pots

Drip irrigation also has disadvantages:
- the materials are not easy to get outside the big cities
- good and new material is expensive
- some training in use and maintenance is desirable if drip irrigation is to be used successfully
- material and growing plants can get damaged when moving a drip irrigation installation

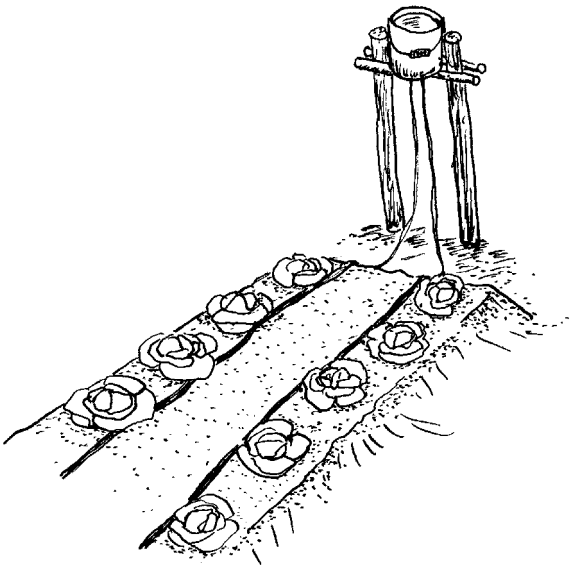

Figure 17: Drip irrigation set installed on a cultivation bed

Figure 18 shows the whole set-up of a drip irrigation system. This is for someone inexperienced in material handling too complicated to make without additional help or ready-made quick-fix system. Nevertheless the system's practicalities are shown, as it deserves introduction to more users.

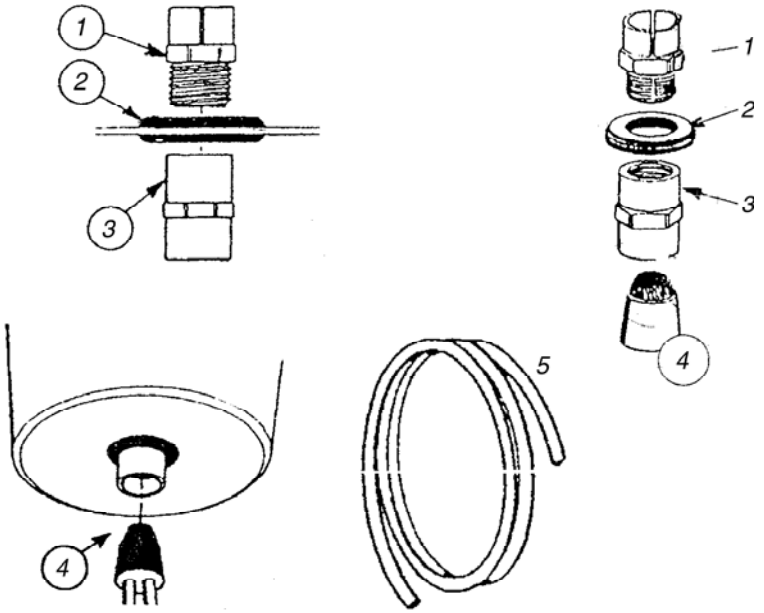

Figure 18: The materials needed for drip irrigation and their fixation

Figure 18 shows the materials needed and their fixation.
- buckets or other storage containers (see figure 16 and figure 17)
- a simple rack or stand for holding the bucket (see figure 16 and figure 17)
- a clamp holder for filter and tubing (1) inside the bucket
- a rubber ring in the clamp holder (2)
- connecting tubes or pipe-ends (3)
- a water filter for the end of the tube in the bucket (4)
- specially made perforated drip tubing (5)
- (on a robust tube end) a small outlet tap just under the bucket or
- (on a flexible tube) tubing clamps under the bucket

The simplified set-up is as follows:
- Select a good planting area and prepare it
- Construct a simple bucket rack or stand and place it at least one metre above the plants so that there is enough water pressure. The water container only requires to be filled once in a while. (See figure 16 and figure 17)

- Carefully cut a hole in the bucket just large enough for the rubber ring (2). Assemble the water outlet (1) and connect the filter plug (4) to the connecting tubes or pipe-ends attached to it (3)
- Then connect the drip lines (5) according to the directions provided

At first use (and at every re-use after storage of the tube) one should take notice of the following.

- Before closing off the end of each drip line, pour a litre or two of clean water into the bucket to wash out any dust, dirt or sand or foreign material in the lines. This is very important!
- Assemble all the parts and test the lines by filling up the bucket to see if water comes out at all the points along each drip line. If any are clogged, they can be cleared by blowing into them and then flushing the line by opening up either end to let the water escape.
- Fix a small water tap on a tube of robust material, like metal, to dose the water or to cut off the water flow, when needed.
- On a very flexible tube end of plastic or weak rubber, you could also use a clamp. This cannot be regulated like a tap: a clamp either closes or opens the tube.
- After the plot has been planted, lay the drip line next to the seedlings with the holes in the right position so that direct irrigation will take place on the soil at the base of the stem.

A few tips:

- Basically, drip irrigation consists of a perforated synthetic or rubber tubing specially made for the purpose. It must not get clogged up. Clogging of drip lines is the main problem with drip irrigation. Always strain the water through a fine cloth placed over the bucket to catch any sand, dust or dirt.
- We do not recommend perforating and using a plastic garden hose for this purpose. As the self-made holes will be irregularly, they can easily block of clog up. Even the holes of specially made drip tubing may get blocked up. Wash out the tubes regularly, and after each use before letting them to dry, with a jet of clean water, possibly under pressure.

- Sometimes one can get used drip tubing from big commercial plantations either free or for little money, because they renew their tubing regularly. Although the material is no longer new you can remove any visible damaged sections, often making it perfectly good to use.

7.7 Drainage and plant care in containers

A water-saturated soil may encourage disease problems. Much of the success of growing plants in pots or on beds depends on watering at the right time, the right place and also in the right quantity. The right drainage is linked to the soil mixture or growing medium, particularly for container culture (see Chapter 5).

Both soil and container must allow for good drainage. The drainage capacity of self-made soil in a container can be tested in a pot filled with a soil sample. Add water up to 1 cm above the top of the soil and leave for one minute. If there is still water standing on the soil surface, then the drainage needs to be improved. Most probably the addition of more compost or sand and/or fine gravel to the soil will be enough. Before planting, the soil in the container should be levelled off and wet thoroughly but not soaked.

Well-composted organic matter is the best soil amendment for opening up the structure of a clayey soil and for improving the water-holding capacity of a sandy soil. Sand or fine gravel in the top centimetre of the soil allows quick drainage. Gravel at the bottom of a perforated container has the same effect. In heavier soil, mixing in some sand as well as organic matter improves drainage. Containers must allow drainage of excess water otherwise waterlogging and damping-off of roots will occur. Holes can be made in containers of most materials except glass and fired clay, which are so brittle that they will break if holes are made in them.

Watering of seedlings demands special attention. To concentrate water on seeds, planting depressions can be made after planting the seeds. In

small containers seeds can simply be sprinkled across the soil surface, then covered with a layer of dry garden soil, pressed down firmly and gently watered. The soil must be kept moist around seeds and young seedlings because they do not have an extensive root system for gathering and storing water. If the soil dries out they will quickly die. Too much water, on the other hand, can lead to soil saturation. This can kill the seeds or seedlings and it encourages fungal attack of root and stem which can also be fatal. Watering frequency will depend on weather and soil conditions, planting methods and plant types, and must be organised to fit in with the gardener's schedule.

8 Socio-economic aspects

You may be aware of the potential of urban agriculture and want to give it a try. However, before you start you need to take into account all the aspects involved, and try to estimate the added value of urban farming for your household. Once you have outlined these aspects you can answer for your situation the questions described in Chapter 2 like: “what can I produce – and how?”

Socio-economic aspects of urban agriculture have not been focused on in previous chapters. Relevant factors and aspects that determine the chances of failure or success are presented in Appendix 2: *Checklist of benefits and costs of urban agriculture*. Many analyses have been made on benefits, costs, risks and access to inputs existing in the multifaceted field of urban agriculture.

We would like to highlight a few, focusing on:
- availability and access to land and water
- relationship between use and ownership of land
- gender sensitivity related to household food and income provision

In this chapter, we will sometimes use the word “urban farmer” indicating all men and women involved primarily in urban agriculture. Consequently, “farming” indicates “urban agriculture”.

For further reading we refer you to the reference list.

8.1 Gaining and maintaining access to land and water

A major bottleneck may lie in gaining legal access and the legal right to cultivate the land and get water. There are a variety of access arrangements in urban agriculture.

1 *Economic rent or lease*. As a farmer, you have official access to the land and pay rent as a share of income earned on the land.

2 *Usufruct rent or lease*. This means official access by which you have the right to use the land, provided that you continue to cultivate it. Examples include excess land around airports and the public facilities that would otherwise be unused.

3 *Licensed farming*. As a farmer, you have official access in return for maintenance of the land (for example, strips of land along highways, railways, or an underpass, or on municipal lots).

4 *Informal agreement*. The farmer does not have official right to the land but does have the landowner's permission for access and use.

5 *Unsanctioned farming*. This is when you farm without the landowner's consent.

Options 1, 2 and 3 are beneficial for both urban farmer and landowner as long as the tenancy laws ensure the rights of both. If you cultivate on urban land that you own, the potential prospects are good. If it is company land, the larger the space the better. Licensed, long-term agriculture on public land and vacant spaces might give you the opportunity to even plant trees. Sale of marketable crops right on the production spot is preferable as buyers can get there easily: see Fig. 8.1

Unfavourable situations can be challenged and tackled by collective, social urban agriculture organisations. Permits or leases are often arranged between local governments, large corporations or national government departments and NGOs, cooperatives or associations.

Thousands of urban farmers operate in this way, for instance, even on the rubbish dumps of many cities. Under such agreements, the owner benefits from maintenance of the land and sometimes offers other goodwill benefits like employee well-being, improved relations with the community and protection from competition for the land. Public

land management becomes more efficient in places where agriculture is one of the permitted land uses. Agreements should provide both owner and farmer with security. The use of the legal system together with assistance from non-governmental organisations (NGOs), community-based organisations (CBOs) and farmers' associations is crucial to more systematic leasing or renting of land and water. The people involved must be prepared to organise cooperative skills.

Figure 19: Sale of vegetables right on the production field

8.2 Gender aspects in household provision of food and income

This chapter illustrates the extent to which urban agriculture is a "household strategy". This has important implications for programmes that attempt to promote it. Experience has often shown that the first interest group to approach for any extension or cooperative activity should be women farmers. This is perfectly illustrated in a case study in Kampala, Uganda, by Daniel Maxwell of CARE International. We challenge the reader to discover similarities and differences in their own local situation.

Urban agriculture is largely a deliberate effort of mostly urban women to provide themselves and their household with food that is not dependent on prices, cash incomes or fluctuating markets. Supplementing the income is an additional reason.

A noteworthy difference in the rationale for farming expressed by men and women, is that men are more likely to be involved in urban food production that is intended for the market, if the women occupy themselves with other activities. On average, urban agriculture is a part-time occupation for both men and women, which can be either to supplement the income of unemployed or under-employed men or, as women see it, to supply food for the family.

A division into various types of household engagement in urban agriculture can be made in the socio-economic environment. Here is an analysis from the situation in Kampala, Uganda.

1 A reasonably wealthy, small group of commercially-oriented producers for the urban market, mainly involved in poultry raising, with access to commercial credit.

2 Subsistence farmers: those whose main livelihood came from agriculture, producing basic staples for home consumption rather than for sale. They were mostly found in the more peri-urban parts of the city.

3 Farming for food security: these farmers' incomes were mainly from non-agricultural sources and thus they bought most of their food at the market. Urban agriculture was an important sideline for both income and food.

4 Those who had no choice: those who farmed because they had to; these are often women who found themselves alone with children embraced farming as a last resort or survival strategy.

In the Kampala case, the third category was by far the commonest and consisted of a vast majority of women who having gained access to some land produced food on it. They insisted that they would have exchanged farming for another job if they could have earned just as much. We can discern three main reasons why. First, food is a form of income that is less easily expropriated by other members of the household than cash. Second, in some cases women may have a source of cash income from informal businesses that rely on farming for inputs, notably preparation of food for sale. Third, farming is a task that fits in well with the domestic workload expected of women. By the way, many women held other jobs both in informal commerce and as wage earners. Development of the spare square metres around a house can make a difference, especially for household types 3 and 4.

In Kampala, men deliberately perceived farming as a marginal, culturally gender-bound activity, at least in some cases. In the division of household responsibilities, wide variation was noted in the responsibility for purchasing food and providing the money to do so. Preparation of food was still the responsibility of women, which is another reason for the above-average involvement of women in urban farming.

Women also perceived urban farming as a means of economic self-reliance. Sometimes local economic circumstances forced them to take responsibility for the provision of food for their families. In many cases, however, they had no access to the means to adequately do so. Many had little say in the allocation of their husband's income to meet household needs, let alone their own personal needs. Moreover, lack of access to an independent source of cash constituted a major ration-

ale for engaging in urban agriculture, like Fig. 8.2 shows for a situation in Indian context. This was the reason for the strong incentive for Kampala women to keep their economic activities secret, or at least marginal in appearance: all the more because ultimately it was they who mostly carried the burden of providing food to feed the family.

Figure 20: Cultivating can at the same time implicate responsibility and economic independence for women

Appendix 1: Protecting the plant

Germination problems

It can be very frustrating to see seeds fail to germinate or to watch seedlings die. If seedlings fail to emerge, the following questions should be asked:

- Was it too cold, hot, dry, or wet?
- Were the seeds past their after-ripening or dormancy period?
- Were the seeds old or mouldy and therefore no longer viable?
- Was enough time allowed for germination to occur?
- Were the seeds carried away or eaten by insects, birds, rodents?
- Were the seeds planted too deep for the seedlings to emerge? Or were they planted too near the surface, causing them to dry out?

If the evidence is unclear or indicates a problem with the seeds, a germination test could be carried out.

Protection from insects

Also discouraging is to find that plants have been severely damaged or all eaten up by cutworms. These live in the soil and chew up young stems during the night. Seedlings can be protected by placing a barrier around them, which is especially useful for people with small gardens. Use old tin cans or plastic cups with the base removed, necks of plastic bottles or bamboo stalks. These “barriers” should be pushed into the soil about 7 cm deep and stick about 7 cm above the soil surface.

Here below are some simple biological methods to control insects:

- Tobacco

Place leaves, stems and tobacco dust in a container. Add boiling water and cover it. After 3-4 hours, dilute with four parts of water and spray on the infected part of the plants. It kills all insects and therefore should preferably be applied manually and certainly used sparingly.

- Custard apple seed

Grind the seeds, mix with water and spray to keep away aphids, ants and other insects.

- Kerosene and soap

Spray with a mixture of a quarter cup soap powder, a quarter tablespoon of kerosene and one litre of water. It will combat serious insect infestation.

- Tomato

Boil stems and leaves and leave to cool. Spray for an effective, long-term way of tackling caterpillars and flies.

- Red pepper

Grind dry red pepper and sprinkle liberally on plants as a general repellent.

- Garlic, onion and red pepper

Chop and boil onions for a few minutes with garlic and red pepper. Grind and blend this mixture, dilute with water and then spray on plants.

- Ash

If termites get attracted to a plot spreading ash on the soil is an effective solution. This is especially practical for protecting a drip irrigation tube lying on the soil, as well as the wood of the bucket stand

- Wood ash water

A mixture of wood ash and water in equal parts combats fleas and beetles. Fresh – but not hot – ash spread around plant roots is effective against root maggots.

Appendix 2: Checklist of benefits and costs

This list[1] is a rough guideline primarily meant for sociologists, extension workers and agronomists. It may help them with making an appraisal of needs, motivation and potential of their target group: the urban agriculture practitioners. It will prove useful for assessing availability of inputs and the desired production target or outputs. Failure or success will largely depend on the outcome of this assessment, the subsequent discussion and the choices made by the practitioners themselves. The list is by no means complete and can be extended or shortened at wish.

Benefits checklist:

Agricultural production
- Marketed
- Non-marketed

Indirect economic benefits
- Multiplier effects
- Recreational
- Economic diversity and stability
- Avoidable disposal costs of solid waste

Social and psychological benefits
- Food security (available and affordable)
- Dietary diversity
- Personal psychological benefits
- Community cohesion and well-being
- Incorporation of gender aspects

Ecological benefits
- Hydrological functions
- Air quality
- Soil quality

Costs checklist :

Input:

Natural resources

- Land, rented or purchased
- Land, vacant of donated
- Water

Labour

- Wage for labour
- Voluntary, unemployed, and contributed labour

Capital and raw materials

- Machinery and tools
- Fertiliser and pesticides
- Seeds and plants
- Energy (fuel, oil and electricity)

Negative output:

Pollution

- Soil quality impacts
- Air quality impacts
- Water quality impacts
- Solid waste and wastewater disposal
- Hygiene and health impacts
- Nuisance (noise, bad odours, offal/waste)

[1] from: For Hunger-proof Cities – see Further reading and reference list

Further reading

Few literature sources were found to give specific technical information or descriptions of techniques relevant to urban agriculture. We did, however, find a few magazines that regularly report on the subject, much of it based on experience in Europe, Canada or the USA. Therefore, we call on readers for references and resources in countries in South and the East.

(F) - recommends an edition as worthwhile for further reading;
(R) - refers to an edition used as a source for the contents of this edition.

Magazine

- Urban Agriculture Magazine (UAM) (F)
  E-mail: ruaf@etcnl.nl

The UAM is issued by the Dutch organisation ETC as hard copy and pdf-files via the Internet. UAM is being distributed through the RUAF Regional Focal Points in Asia, Africa and Latin America. Translations into French and Spanish are available.

Books

We refer those who are interested in general aspects of urban agriculture, also in other fields than the ones described in this volume, to the following editions:

Cleveland, D., Soleri, D., **Food from Dryland Gardens.** 1995, 387 pp., Center for People, Food and Environment (CPFE), Arizona, USA. ISBN: 0-9627997-0-X.
Supported by UNICEF, this book offers both an overview of worldwide use of home gardens and a handbook of the tools and resources needed especially in low desert regions. An ecological, nutritional and social approach to small-scale household food production. (F, R)

Smit, J., et al., **Urban agriculture: food, jobs and sustainable cities.** 1996, Publication Series for Habitat II, Vol. 1. United Nations Development Programme (UNDP), New York.
Editor: The Urban Agriculture Network, Washington, DC, USA E-mail 72144.3446@compuserve.com. An extensive review of all aspects of urban agriculture worldwide. (R)

Koc, M., et al., **For Hunger-proof Cities – Sustainable Urban Food Systems**. 1999, International Development Research Centre (IDRC), Canada. ISBN: 0-88936-882-1.
This book presents urban agriculture in African, Asian, European and North-American city contexts as a system from an urban food security viewpoint and highlighting socio-economic aspects, gender and politics. Quite a few participating authors are women. Appendix 2. has been derived from this edition. (R)

Agziabher, A.G., et al., **Cities Feeding People – An Examination of Urban Agriculture in East Africa**. 1994, International Development Research Centre (IDRC), Canada. ISBN 0-88936-706-X.
This volume introduces the reader to urban agriculture case studies in Uganda, Kenya, Tanzania and Ethiopia. It contains an extended index of subjects. (R)

Bakker, N., et al., **Growing cities, growing food. Urban agriculture on the policy agenda**. 2000, Edited by DSE and a range of other national and international organisations, Feldafing, Germany. ISBN: 3-934068-25-1.
Published in the follow-up of the 1999 urban agriculture conference in Havana, by (international) organisations with an interest in urban agriculture. Presents a series of case studies from twenty towns worldwide. Available from CTA. (R)

Useful addresses

PTC+ is an international training institute, which focuses on all the links in the production chain on plant and animal commodities, (agricultural) technology, (food) technology and natural areas.

Training programmes are practice-oriented and mix theory with practical classes. PTC+ offers "open entry" programmes, "tailor-made" programmes and consultancy. Programmes are offered in the Netherlands and/or at location.

It is the policy of PTC+ to search for partnerships and co-operation programmes with national and international institutions abroad.

For more information: visit our web-site www.ptcplus.com and/or write to:
PTC+ Head Office
P.O. Box 160, 6710 BD Ede, The Netherlands
Tel.: +31 318 645700; Fax: +31 318 595869
e-mail: info@ptcplus.com

Internet

For those who have access, three major websites will lead you to a wealth of information.

- www.cityfarmer.org — Canada's office of urban agriculture (R)
- www.ruaf.org — ETC Centre for Sustainable Agriculture, Netherlands (R)
- www.echonet.org/tropicalag/aztext (F,R)

This last website is from ECHO (Educational Concerns for Hunger Organization), Florida, USA. Their site, with the beautiful name "*From Amaranth to Zai Holes*", has been growing since 1996 and

gathers a wide range of practical ideas for those who work for communities living under difficult conditions in the tropics and subtropics. It shows there are no simple answers, but there are many possibilities, methods and technologies which hold potential.

Radio

Developing Countries Farm Radio Network (DCFRN) (F,R)
Presents itself at www.farmradio.org
E-mail info@farmradio.org

With radio as the primary method of communication, DCFRN assists farming families in about 100 countries in the Caribbean, Southern and Central America, Africa, Asia and Pacific, with learning about simple proven ways to increase food supplies and nutrition and health. In English and in French.

Drip irrigation

For ordering a drip irrigation kit for the installation described in Section 7.6. you can turn to Isaya Sijali, Kenya Agricultural Research Centre. PO Box 14733, Nairobi, Kenya
Tel.: +254 2 444 029/030; Fax: +254 2 443 956
E-mail: baobab@iconnect.co.ke; Website: www. alin.or.ke

Agrodok

Special reference is made in the text of this edition to:

- Agrodok 8 : Preparation and use of compost (F,R)
- Agrodok 16 : Agroforestry (F,R)

Besides, the following are also certainly interesting for further reading:

- Agrodok 2 : Soil fertility management (F)
- Agrodok 9 : Vegetable garden in the tropics (F)
- Agrodok 26 : Marketing for small-scale producers (F)