# SESAME

Encourage the deployment of agricultural projects in urban & peri-urban areas through the development of innovative training

## MODULE 3 :
## TYPES OF URBAN AGRICULTURE/ PRODUCTION SYSTEMS & SHORT FOOD CHAINS

Co-funded by the Erasmus+ Programme of the European Union

IRFEDD
INSTITUT RÉGIONAL DE FORMATION À L'ENVIRONNEMENT ET AU DÉVELOPPEMENT DURABLE

IIS SERPIERI
CITTÀ METROPOLITANA DI BOLOGNA
CAMPUS VERT D'AZUR ANTIBES
AViTeM Agence des Villes et Territoires Méditerranéens Durables
eduscopi
Escola Agraria Amposta
AMB Àrea Metropolitana de Barcelona

# INDEX

# 1. Overview of types of Urban Agriculture

## 1.1. Micro-farming at home and surroundings

This type of urban agriculture occurs in almost all cities. It is normally practiced in small areas inside or outside the house (balcony, porch, terrace, kitchen, etc.) as well as around the house (in front or in the backyard).

Vegetables, herbs or medicinal plants are mainly cultivated. The small animals (rabbits, chickens, pigs, etc.) can be kept in small numbers. The investment is low. The reasons why people decide to participate in this activity vary according to the region and income. The producers are low-income families and middle- and high-income families. These people grow food, herbs and small animals both for subsistence and for leisure or environmental awareness or for interest in growing their own food. Small production surpluses can be exchanged or shared among friends and neighbors, although there may be occasional sales of products.

### 1.1.1. People involved and their motivations

Micro-farming at home and around the house (also known as home gardening) is often a part-time activity. Low-income urban families practice this form of urban agriculture to supplement their food, improve their diet or generate a small income. Food is an important part of some households' expenses; in cities, the lack of cash translates more directly into food shortages, scarcity and malnutrition (to a greater extent than in rural areas). Vulnerable groups in cities tend to have fewer informal safety nets (family and community networks) and the need to grow their own food may increase in the event of a rise in food prices.

Although practiced on a small scale, domestic food production by poor urban households can still account for 20-60% of total food consumption, as indicated by studies in East Jakarta, Indonesia (18%, Purnomohadi, 2000) and Harare, Zimbabwe (60%, Mbiba, 2000). In Cagayan de Oro (Philippines), households that practice urban agriculture eat more vegetables than households that do not practice urban agriculture and have the same or higher income level, which generally consume more meat (Potutan et al., 2000). Women tend to be involved in micro agriculture, as they can combine it more easily with domestic tasks.

Micro Agriculture can also be important for families affected by different pathologies, especially if appropriate production technologies that require little labor are used. Adequate nutrition can improve the life expectancy and quality of life of sick people.

A recent article by Kortwright and Wakefield (2011) examined the contributions and motivations for growing around the home, focusing on a low- and middle-income area in northwest Toronto, Canada. From their research, they were able to present a typology of different types of home gardens in the area and, by extension, in many other places.

Of course, many farms do not perfectly fit these typologies. For example, an aesthetic garden can have elements of a kitchen garden with plants such as the thyme. Which type predominates for each individual will be dictated by his or her circumstances. A family with young children may opt for a teaching garden to expose their children to the art of growing and learning about food. An individual who believes that cooking is a creative and relaxing part of their day will opt for a chef's garden, perhaps growing exotic or traditional vegetables.

### 1.1.2. Cultivation at home in special situations

Depending on the socio-political situation of the area, people will behave differently. An example is the resilience that Cuba developed during the "special period" when the Soviet

Union stopped providing financial support to the island at the end of the 1920s. Urban agriculture was one of the government's actions to combat widespread food insecurity. A recent study by Christine Buchmann (2009) on home gardens in Cuba describes the many functions they had at that time. The study shows that medicinal plants were the most common use of home gardens, followed by food plants, decorative plants and plants used for rituals. On the other hand, an interesting gender difference was noted: men usually cultivated more food, while women cultivated medicinal and ornamental plants.

The Gaza Strip provides an example of a place where food insecurity has been alleviated to some extent by urban agriculture. With 97% of the population living in urban areas or refugee camps, land for cultivation is a very scarce resource. The United Nations Food and Agriculture Organization (UN-FAO) is carrying out a project that combines organic farming and vertical farming to increase nutritional standards. The first results show an increase in the food security of the farms (FAO, 2012). Since 2014, RUAF has been working in Gaza together with OXFAM Italy, local governments, civil society, research and private sector stakeholders to help urban producers establish value-added micro-enterprises and strengthen market-oriented forms of urban agriculture (www.ruaf.org).

### 1.1.3. How it's done

Depending on the availability of space, people will cultivate in one way or another. For people living in isolated houses, cultivating and planting on the ground is the usual practice. In some parts of Europe, there is a trend towards more ornamental production. This has been occurring over the last few decades. The cultivation of an edible landscape continues to be important in old socialist countries (Simon-Roja et al., 2015). In North America, there is a strong movement towards the introduction of food plants in spaces that were previously entirely ornamental. In addition, containers can be used for decorative purposes or to isolate certain crops from diseases or pathogens.

If there is no land available, there are other cultivation options. Balcony cultivation is a popular way of growing vegetables, fruits and herbs. It is also possible to use the space efficiently by using vertical and wall growing techniques.

Some interesting new developments have been developed on how to grow in limited space and maximize yields. In Kenya, cultivation using bags filled with soil, compost and some rocks is used in areas where space is scarce, such as lowland areas. This allows for intensive cultivation; 30 to 40 spinach or cabbage plants or 20 tomato plants can grow in one bag (Pascal and Mwende, 2009) (https://www.youtube.com/watch?v=oTGAV6YCojQ).

### 1.1.4. Products and degree of commercialization

The most common crops grown in micro-agriculture are vegetables, medicinal and cooking herbs according to family or dietary preferences. In addition, we can also find small-scale animal production of birds, rabbits, pigeons, and bees. The production of ornamental plants and flowers is also common, while the recycling of domestic organic waste through composting often complements farming practices. As indicated above, the degree of commercialization of this type of urban agriculture is limited and only occurs occasionally. Investment in micro-agriculture is generally low (low-cost technologies are used).

### 1.1.5. Commercial transition

Starting with a few plants on the ground, some cases try to take the cultivation to a more commercial level, turning the farms into small family businesses. The definition of business

gardens (FBG) is applied when more attention is paid to the production and marketing of products.

### 1.1.6. Main assistance needs

Although investment costs are generally low, the availability and access to quality fertilizers/plants, small tools and gardening equipment (for example, for the use of wastewater or rainwater harvesting) are important production factors in micro agriculture. As the economic performance of micro-farming is generally low, the provision of micro-credits for investment is not a feasible strategy. Instead, the provision of free fertilizers, compost, feed or equipment free of charge to low-income farms can be part of a micro-farming development strategy. Moreover, with climate change bringing higher temperatures, water conservation is becoming increasingly critical. The automatic watering towers can be a very useful addition for producers, especially in the balconies.

New developments are being developed on how gardeners can obtain washes. One trend in the last decade has been the establishment of keyhole libraries. They function like traditional libraries, with key exchange in place of books and online resources. They often succeed in recovering the traditional heritage and variety of a region. In some cities there are also lending libraries of gardening tools.

Accessing land for cultivation can be a big problem for some people. A good example is the YIMBY (Yes in My Backyard) program in Toronto, Canada. The premise behind the program is simple. You'd like to grow your own food, but you don't have the space to do it? Do you have a yard that you would like to use? The YIMBY program links people who want to grow their own food but don't have access to land, with people willing to share their yard. The program supports producers and landowners in developing clear and effective land sharing agreements. This program fosters growth while making the community more inclusive and welcoming.

Some cities help producers. City of Mexico (Mexico) promotes rainwater harvesting and storage systems, construction of wells and establishment of localized watering systems that make efficient use of water ( for example, drip irrigation) to stimulate production and reduce the demand for drinking water. The municipality of Cape Town (South Africa) provides a start-up kit to those who want to start growing crops, consisting of a set of tools, compost and seeds. The start-up kit is complemented by training and skill building services.

### 1.1.7. Training and exchange of experiences

Urban micro-producers depend mostly on informal social structures (informal network of producers, neighbors or family members) to obtain access to information and training. Agricultural extension services do not usually serve the home garden. There is a need to exchange information to take advantage of the full potential of the crops around the houses. This could include:

*Promotion of the exchange from producers to producers*

Producers can learn a lot from their peers, who produce in the same circumstances and have the same production objectives. However, many times producers do not know each other, they are generally not able to establish adequate contacts or do not have the means, this type of exchange is not as common as it seems. Organizing meetings of urban producers to exchange information and visit each other's growing space is a very simple and effective tool that can help many producers find solutions to their own problems or apply innovations to improve their production practices.

*Agricultural extension*

Agricultural extension services are not usually aimed at people who grow their own crops at home or nearby. Havana, Cuba, is an exception, with kiosks (Tiendas de productor) where small-scale producers can buy supplies of vegetables, seeds and get advice on micro-agricultural technologies and small-scale commercial production. Advice is given on the biological control of pests and diseases, on the preparation and application of bio-fertilizers, etc. In the European context, the technical extension of urban agriculture is (still) poorly developed. Where it exists, it is often focused on community gardening initiatives and less on individual home gardening or entrepreneurial urban agriculture initiatives.

*Advising on crop selection, food preservation and food preparation*

As home consumption and food safety is one of the main objectives of micro-agriculture, important issues related to the choice of crops and the preparation and preservation of food are raised. Different types of vegetables, herbs and sprouts provide important vitamins and minerals to the urban diet. The raising of small animals and the production of olives can be an important source of protein. Rice crops can provide part of the carbohydrates needed for a person. It is important to consider appropriate cultivation options (also taking into account climate and growing conditions), crop associations and the use of rainwater or greywater to ensure harvesting throughout the year.

However, after harvesting, an important part of the yield can be lost when good packing and processing techniques are not applied. Fresh products can be preserved by applying a variety of low-cost technologies:

- Drying of the product with solar heat: it is possible to dry many herbs and to store them for a long period of time.
- Preservation by anaerobic fermentation: in an anaerobic environment (without oxygen) the vegetable juices will ferment in lactic acid causing the acidity to increase and preserving the product.
- Preservation with vinegar, sugar or salt can also extend the time of packaging of certain products ( for example, pickles).
- Sterilization and pasteurization; vegetables or fruits can be boiled and sterilized, preserving them also for a longer time (for example, jams).

## 1.2. Agriculture on roofs (in the open air or in greenhouses)

Soil agriculture has become extremely popular over the last decade. Whether it is practiced on a domestic or commercial scale, there are many benefits ranging from improved nutrition for families to economic development and job creation.

### 1.2.1. Types of people involved and their main reasons for involvement

The reasons why people choose to grow food on the land are numerous, but it can be argued that it is a response to the lack of space found in most cities. Cities have a large amount of space on the ground that can be used to provide environmental services, such as installing green roofs to enable food production and reduce building heating and cooling costs. The land offers a place where food can be grown to improve the food security of the farm, with the possibility that the surplus can be marketed.

As part of a project on climate change, RUAF has teamed up with the NGO "ENHPO" and the municipality of Kathmandu to demonstrate and promote land-based agriculture. Apart from

helping to improve the food security of households, the practice of agriculture on the land helps to manage waste and mitigate climate change (https://www.youtube.com/watch?v=n_ikGbIkS_M).

- Optimize the production space by intensifying the cultivation based on soil, developing systems of production without soil (hydroponics) and/or moving to land, building-based systems (such as gardening on the ground);
- Optimize the income from horticultural production (including transformations and direct producer-consumer relations);
- Optimize multiple urban functions of the horticultural value chains (including recreation and landscape management);
- Optimize the use of resources: improving the spatial connectivity of horticultural activities that promote the reuse of wastewater through horticultural production; better link waste management with the production, processing and marketing of food centers.

Land-based agriculture can be multifunctional in nature. It provides environmental goods and services, such as rainwater reduction, while creating a strong sense of belonging to the area and creating recreational opportunities.

The optimization of space is part of the movement known as ZFarming, which refers to all agriculture that is produced without the use of land in open spaces. In addition to cultivating on the roofs of houses, in the last decade there has been a trend of vegetable production in greenhouses located on top of buildings. Examples include Gotham Greens in New York and Chicago in the United States and Lufa Farms in Montreal, Canada. In Europe, UrbanFarmers AG has introduced in-building greenhouses in Zurich, Switzerland and La Haia, Netherlands.

In addition to maximizing profits, these companies also say they are motivated by other factors. Energy efficiency is mentioned as a primary concern of these companies and they strive to produce food in the most environmentally friendly way possible. Lufa Farms lists sustainable actions on its website:

- Not to cultivate in any new land;
- Capture rainwater;
- Recycle 100% of irrigation water and nutrients;
- Reduce energy use;
- Use green waste compost;
- Use biological controls instead of synthetic pesticides, herbicides and fungicides.

On the other hand, it should be noted that so far no independent comparison has been made of the environmental impacts of these high-tech roof systems compared to other production systems.

They also highlight that the food is consumed locally, reducing greenhouse gas emissions.

Poliflor, in Italy, specializes in green floors and roofs. The company aims to improve the thermal properties of buildings, increase the aesthetic properties of the space and contribute to the capture of environmental pollutants (www.urbangreentrain.eu).

Horticityt, also in Italy, develops horizontal and vertical horticulture. Training, research, education and international cooperation are part of their business plan. They are motivated to design and develop ideas that promote urban agriculture while benefiting from ecology (www.urbangreentrain.eu).

AMAEVA is a private French company that offers advice, design and installation of living roofs and floors. The company has distinguished itself and has made an important contribution to the industry through the creation of a training center. The topics discussed are sealing, isolation, revegetation, installation and maintenance of green covers (www.urbangreentrain.eu.pdf).

The gardens on the ground are also a way to educate the population about urban agriculture and the food system. In Toronto (Canada), Ryerson University hosts a 1000 m² rooftop garden that has become a production center, workshop and research site for many university faculties (https://www.youtube.com/watch?v=a3uxpmkWI7w).

### 1.2.2. Technologies used

In poor areas, the level of technology is of a functional nature. Cultivation containers are usually made of recycled materials. Some of the materials that can be used are PVC cans, tires, buckets and plastic bags. Often, the greenhouses are an extension of the farm, so the producer lives very close by. Food safety is an important motive, so different types of crops are usually grown. The practice can also be promoted as a social action to improve the environment and create a living space for the farm (Orsini et al., 2015).

In contrast, in richer countries, high-tech practices tend to prevail, especially with regard to water use.

Research and experimentation are important, as this is a relatively new field. Poliflor, for example, has carried out agronomic and engineering research to discover the best physiological results for the plants. They also conduct research on substrate materials to provide better thermal and sound isolation, while allowing plants to grow more efficiently.

### 1.2.3. Main potentials and challenges

In poor countries, land-based production brings nutritional advantages, as it facilitates access to clean and safe food. There is a reduction in costs. In addition, some producers will experience long-term benefits by not having to go to the market to buy food. Other social benefits may include the feeling of building community and creating educational opportunities around the crop.

From an environmental perspective, small-scale tulip cultivation offers the possibility of better waste management. In addition, it contributes to making the city more sustainable. The benefits range from improved input efficiency in the production process and a reduction of greenhouse gases because there is a high production where the market is located. Experiences in Amman, Jordan, where urban agriculture is being promoted as part of the local climate change action plan, have shown that vegetable gardens on the ground also play an important role in combating the effects of heat islands by generating cooler microclimates.

Economically, roof crops can employ people and present opportunities along the production chain (Sprecht et al., 2014 and 2015). Intensive roof-based production can also meet consumer demand for fresh and locally produced food. This can be extremely important for cities that import a large part of their vegetables and where there is a high demand for this quality of

food. Cities such as Hong Kong and Singapore, where land is scarce, recognize the potential and business opportunities that roof cultivation growth brings.

One of the possible challenges of urban agriculture are the problems of regularity of the roofs of any city. The idea that agriculture and cities are incompatible is persistent around the world. In rich areas, municipal governments with decision-making power on issues such as zoning have sometimes been slow to recognize the potential of urban agriculture over the past few decades. Sometimes policy makers don't know how to respond to a proposal such as a greenhouse on a land, they need to understand that people want to farm in cities. This is a very dynamic area that is increasingly accepted by cities around the world. An interesting example is France, where in March 2015 a national law was passed establishing that roofs must be covered with plants or solar panels, giving a strong boost to the agricultural use of roofs. There are also cities such as Hamburg (Germany) that are developing regulations on the agricultural use of roofs.

The price of food produced on the ground must reflect the fact that the food is fresh and local in order to compensate the cost of production. These types of products will not be affordable for all consumers, especially for people with low incomes. On the other hand, the quality of the fruit and of the cultivated food will be good, since if the cultivation takes place at a sufficient altitude (for example, on a plot of land on the 10th floor of Via Gandusio, Bologna, Italy) the resulting food can be free of contaminants such as heavy metals that we would normally find in vegetables grown in an urban area (Vittori Antisari et al., 2015).

Growing on land, whether in a controlled environment or not, is very different from growing in the ground. Producers will need different skills to know how to use the inputs in the best way, both economically and environmentally. There is likely to be a learning curve for rural people.

Finally, finding suitable roofs can be difficult. The roof must be located where it is possible to take advantage of the existing infrastructure (such as transport) to facilitate the commercialization of the product. In addition, the building must be structurally adequate to support the weight that the crop, the water and the people will bring. In this sense, there is also a technical challenge to develop lighter means of cultivation.

### 1.2.4. Main support needs

Many buildings can withstand the weight and pressure of a green roof that is designed solely to reduce heating and cooling costs and to reduce rainwater runoff. These soils are known as extensive green soils, where it is customary to plant plants such as sedums or similar in a medium of early and light growth. The food-producing orchards will need a heavier growing medium, as well as a thicker soil. In these cases, it is imperative to seek the advice of architects and engineers to see if the support is capable of supporting the additional load. Many buildings constructed over the last 50 years were not built to be long-lasting, so it is advisable to look for older buildings that were probably designed in a different way. A modern tool that can be useful to identify the appropriate space on the roof is Google Earth.

In poor countries, the inputs needed to grow crops are not always available. It would be useful to have centers where producers could have access to resources such as soil (growing media), fertilizers and natural fertilizers. It would also be useful to have advice on how best to grow and what containers could be used.

## 1.3. Community and institutional orchards

Around the world it is possible to find community, school and other institutional orchards. These types of orchards are usually located in areas of public land outside the city. They can be located on railroads and roads, on power lines, on the lands of community centers, churches, schools and public parks. They produce food products such as vegetables, fruits, herbs and small animals for domestic consumption, for educational purposes or as part of community development programs.

### 1.3.1. Type of people involved and their main motivations

Community gardening involves families of all income levels, both migrants and elderly, who grow food products or not, for domestic consumption, leisure or recreation, social interaction or community support. Community gardens have a long history in many parts of the world. In Europe, they began as "Victory Gardens" because of their role in the cultivation of food during World War I and World War II.

Many activities of interaction and social exchange can take place or be organized around a community orchard, from simple contact with neighboring gardeners to the sharing of tools, tasks, washes and plants, to the organization of training courses or harvest festivals. Gardeners can also share plants, including some traditional varieties. In some European countries, especially Germany and Austria, the concept of "intercultural orchards" has been successfully developed as a means to promote the social integration of ethnic and immigrant communities (Schermer, 2015). This is a way to reverse the decline in biodiversity and keep cultural traditions alive. We can summarize and affirm that preserving culture, community building and the involvement of children in agriculture can lead to social inclusion and healthier communities.

Another important role played by community orchards is the provision of food and nutrition for people with low incomes. Regardless of income levels, many other gardens will allocate part of the proceeds to food banks or social programs.

Community orchards are usually managed by the gardeners themselves or by a non-profit association that can allocate individual plots annually for a small fee. Meanwhile, the orchard can be organized collectively without individual plots. The city of Berlin, Germany, has more than 80,000 communal producers who rent plots on land where buildings were destroyed during World War II. As of 2016, Mont-real, Canada has 116 community gardens and 8200 plots serving 10,000 inhabitants; a similar number of families participate in the community gardening program in Rosario, Argentina. The high number of people involved in these cities may be due in part to the fact that the municipality actively promotes community gardening and provides advice, education and site identification.

The institutional orchards include students from primary and secondary schools, hospitalized people, prisoners, etc. The benefits include the cultivation of nutritious food for the members of these institutions, ecological education (mainly school orchards) and possible income generation, physical exercise and therapy. (mainly in hospitals and prisons).

School food orchards can improve children's understanding of natural processes such as plant growth and soil formation, as well as improve their understanding of other cultures. Growing food to supplement school lunches can improve children's access to healthy and nutritious foods that would otherwise be unaffordable. The food produced can be used for healthy cooking demonstrations. Studies have shown that children who know how to cook are more

likely to eat the recommended intake of fruits and vegetables. At a time when obesity and sedentary lifestyles are on the rise, gardening continues to be a healthy outdoor activity for children and youth. All kinds of curricular themes can be explored in horticultural settings, taking theoretical topics to a very practical level.

The presence of an orchard on a campus offers many possible motivations for students and professors. A university campus is a mini-city, where the provision of food is, at times, a political and controversial issue. Throughout North America, many campus orchards are run by food system-conscious students (https://www.youtube.com/watch?v=6FYa1L_MmnM).

### 1.3.2. Products and degree of commercialization

Community and institutional orchards are mainly dedicated to the cultivation of vegetables, fruits, flowers and herbs, although sometimes small animal units can also be found (for example, in school or prison orchards).

As mentioned above, production is mainly oriented to direct consumption (by gardeners or clients of the institutions) or is distributed in various social programs. Occasional sales of surplus produce are made to community members, local shops and markets and, to a lesser extent, there are larger institutional orchards that can function as semi-commercial enterprises.

However, there are legal barriers to the commercialization of community orchard products. In North America and the United Kingdom, many community orchards are located in city parks and regulations prohibit the sale of food grown in these areas, moreover, there should be no private profit because the land being farmed is public. In other countries, food hygiene regulations may be the reason why products from community orchards are not marketed.

### 1.3.3. Scale and location

Community and institutional orchards are generally limited to between 500 m2 and several hectares. Community gardening is mainly developed in open public spaces in the city, located within walking distance of the participants' or residents' homes in popular neighborhoods. This can include parks, land that is temporarily excluded from residential development and land near railroads and under power lines. Land tenure is either informal or by agreement with the owner (through temporary or permanent agreements on user rights). The demands of other uses of the recreational land and nature/green spaces must be weighed against the benefits of community orchards.

### 1.3.4. Applied technologies and resource requirements

In many cases, only low-cost investments are made in community and institutional orchards. Usually, there is some type of water or irrigation system. Other investments may include the construction of a storage area or a meeting place. Sometimes, more technical and intensive production methods are used ( for example, tunnel cultivation, drip irrigation and sprinkler irrigation. To maximize the learning potential, it may be desirable to attach a greenhouse to a school orchard, where plants can be planted and some winter crops can be grown. This provides an opportunity for students to be in contact with agriculture throughout the year.

Often, organic production methods are used in community orchards. In Montreal, Canada, the municipal community gardening program has a clear focus on organic production methods, only organic methods to control pests, diseases and weeds are allowed. Other cities have similar rules.

The composting of organic waste is almost always done. It is done at different scales and by different institutions. The use of compost increases the fertility of the soil (thus reducing the need for fertilizers), while improving the water retention capacity of the soil.

(For more information on composting in community orchards) http://vcgn.org/wp-content/uploads/2013/12/CompostingInCommunityGardens-GrowPittsburgh.pdf).

There are forums where experiences, advice and knowledge about cultivation methods, water management, etc. are shared. In addition, it is also possible to share culinary and food preservation experiences with the aim of increasing nutritional improvements for producers.

### 1.3.5. Main potentials

Community orchards are an important way to improve the nutrition and food security of low-income populations. In addition to supplementing the diet with nutritious and fresh produce, they can produce significant savings. In the same way, the yields of institutional orchards can be very significant. At the Pennington District Prison in Grand Rapids (USA), inmates produced more than 13,000 kg of food in 2015, much of which was donated to food banks and non-profit organizations.

Community orchards also play an important role in community building. They are part of programs focused on community organization, capacity building and social inclusion of certain vulnerable groups, such as women, immigrants and youth. Recently, community gardening projects have been seen to help newcomers integrate into city life, providing them with a basic livelihood, fostering a sense of belonging to the community. An orchard can also serve as a vehicle for the revitalization of the community, cleaning up abandoned areas while contributing to the development of the city. They are also important for offering opportunities for low-cost housing and recreation. Community orchards are a good practice ground for developing the skills of future small-scale farmers.

School orchards offer an important opportunity for ecological and nutritional education. In these learning environments, young people become familiar with good and healthy foods, especially fruits and vegetables that are critical for improving nutrition, reducing obesity and chronic diseases. These are precisely the foods that are missing from children's regular diets. School orchards programs show the benefits of exercise, mental stimulation and social interactions. Children receive hands-on education in biological and environmental sciences, mathematics, geography and social studies. School gardens help to improve the diet of students and their families (by replicating learning at home).

Hospital and prison orchards also offer therapeutic benefits. Rikers Island, in Flushing Bay, New York, is a prison that houses up to 20,000 inmates at any given time (Jiler, 2006). The GreenHouse is a horticulture project with the objectives of helping to teach horticulture to inmates, with the hope of reducing the recidivism rate. An extensive curriculum has been developed that includes topics such as soil science, botany, integrated pest management (IPM) and garden design. The food grown is largely destined for anti-famine organizations in New York. This training helps to train some former inmates to work in the field of horticulture.

### 1.3.6. Main needs of support to community farms

Four main support needs can be identified to improve the development of community orchards:

- Assistance in accessing land and improving security of use (licensing, leasing, tanking);
- Assistance in group development, leadership and establishment of external links;
- Provision of training, water, compost, quality fertilizers and small tools;
- Assisting in the establishment of storage systems.

*Guarantee the owning of the land*

Depending on the area, securing land can be difficult and sometimes impossible. Often there is no infrastructure to help people access land. Contrary to common belief, some highly urbanized areas have a surprisingly high number of vacant spaces that could be used for agriculture on a temporary or permanent basis. Many cities such as Cienfuegos (Cuba), Piura (Peru), Dar Es Salaam (Tanzania) and Rosario (Argentina) have created inventories of available land using GIS techniques, which are made available to the public. Cities such as Havana (Cuba) and Lima (Peru) have formulated municipal ordinances regulating the use of vacant municipal land by organized groups of urban farmers. In the Netherlands too, cities such as Amsterdam and Utrecht show on the city council's website the land that can be used for urban agriculture (see example of Utrecht here https://objectdesk.gemgids.nl/Publication/Site/272).

Even when vacant municipal land is destined for future use (residential or industrial areas) or located in areas unsuitable for construction (flood zones or under power lines), it can be given on a temporary basis to organizations for horticultural purposes through temporary leases. In Cape Town (South Africa), unused land around public facilities or roadsides is leased to groups of low-income farmers. However, often those interested in having land to cultivate are not aware of these opportunities, therefore information campaigns will be a very important measure.

*Group development, leadership and external linkages*

The turnover rate of participants in community gardens is very variable. Sometimes it can be high, which can indicate problems in the operation of the garden. In popular community gardens, people wait for years to obtain a plot. Community orchards often bring together people from different backgrounds and cultures. Help may be needed to create leadership and group relationships. Rules for social organization around the orchard, norms of behavior and trust among diverse members are the ingredients for success in community gardening programs.

Strong community orchard organizations are characterized by good leadership, the promotion of a flexible and participatory organizational and management structure, and the active involvement of their members.

It can also be important to establish external links with other groups and organizations, for example with neighborhood groups that can help maintain the orchard.

*Provision of training, compost, quality fertilizers and small tools*

Although horticulture up to a certain level is simple, producing high yields and consistent quality is a challenge. Improving the skills and productivity of growers requires training and information. Training on organic production techniques can be of specific interest. There may be a need for consistent training on the proper management of composting facilities. Cities

could explore the possibility of contracting the services of a horticultural advisor to support community producers (as is done in Mont-real and Rosario). This person can provide technical advice, assist in orchard design and interact with landowners.

Municipalities can play an important role in improving access to water and production inputs for producers. Access to low-cost water supply throughout the year is crucially important, as well as access to organic materials ( for example, compost) and other sources of nutrients (for example, wastewater).

The city of Bulawayo, Zimbabwe, provides treated wastewater to poor urban farmers in community orchards, while the cities of Gaza, the Palestinian Authority, and Tafila, Jordan, promote the collection and reuse of grey domestic water for home and community orchards. The municipality of Cape Town, South Africa, provides community gardening groups with basic infrastructure (fences, water tanks, tool storage and watering hoses), composted organic waste, and a little free water.

Cities can also develop agreements with non-profit organizations to jointly acquire and manage land: the city provides infrastructure and support (such as water, leases, signage, insurance and liability), while the partners manage the orchards and related programs.

*Assistance in the establishment of pension plans*

In Europe, community gardeners are often organized in associations. They pay small annual taxes to allocate land and to contribute to other expenses. But many community orchards depend on external support for their survival. To ensure the autonomy of the garden, it is necessary to avoid excessive dependence on external support. In this way, when external support disappears (for example after a change of government or at the end of a project), the organization of the orchard will not be so affected.

The community gardeners could decide to set up a group maintenance system to cover the costs of maintaining the orchard.

### 1.3.7. The main support needed for institutional gardens

Specific challenges and support needs for institutional and school gardens include:

- Training of institutional horticultural managers
- Training of the school's teachers and practical training curriculums
- Assisting in the design and establishment of gardens
- Summer school orchard management

*Training of institutional managers of gardens and school teachers*

Institutional managers and school teachers often have no agricultural training or experience in horticulture. It is possible that they need training. In addition to technical production skills, they may need more training in personnel management or administrative skills to help them manage the orchard effectively. School teachers will also need help in developing curriculums and training modules for their students at different levels. These curriculums should not only include subjects related to the cultivation and care of plants, but should also explore opportunities to apply mathematics, biology, science, cooking and other subjects in gardening and environmental practices. There are many good resources available for online teachers, such as https://www.lifelab.org/for-educators/schoolgardens/.

*Assistance in the design and establishment of the orchards*

Among the important aspects to be taken into account in the design and establishment of gardens are safety and access issues, while ensuring an aesthetic design. Raised beds may be needed to allow elderly hospital patients to participate more easily; sharp edges and sharp plants should be avoided.

A sensory orchard is a suitable design option for therapeutic (hospital) orchards. The type of plants and elements presented include those that are pleasant to look at, smell, touch and listen to. School orchards can be designed to maximize these elements.

*Management of school orchards during the summer season*

Often, the main problem in setting up a school orchard is the question of how to take care of the orchard during the summer vacation months, when the growth of plants and weeds is at its highest, as well as the need to take care of the orchard (watering, harvesting, etc.). Schools can be underfunded and lack human resources. Motivated teachers often already participate in other extracurricular activities. It is possible that other teachers do not want to take on this additional task without additional incentives.

Two interesting solutions are currently being tested in Ghana and Sierra Leone. In the first case, a community/training garden is combined with the school orchard. This ensures the presence and involvement of community members in the management of the orchard. The school children can do some tasks under the supervision of their teachers in agreement, of course, with the community producers who have the main responsibility for the orchard. It will also be important to reach a well-defined agreement on who has access to the orchard and when, when and how the benefits of the harvested products will be shared. It is convenient to formalize these agreements and decide how possible conflicts can be resolved.

### 1.3.8. Community orchards in the Metropolitan Area of Barcelona

The economic crisis has triggered the launch of community initiatives, linked to agro-ecological consumer cooperatives and the 15M movement. These proposals with a transformative will are triggering social dynamics of vindication of an agri-food system based on organic products and local channels, which is moving to other areas. This can have an impact on the growth of demand and the implementation of new initiatives based on agro-ecological production criteria in the metropolitan area. This further reinforces the valuable role of peri-urban agricultural areas (Institut d'Estudis Regionals i Metropolitans de Barcelona, 2016).

## 1.4. Small-scale commercial horticulture

This is probably the most common type of urban agriculture found throughout the world due to the high demand for fresh vegetables and fruits. The production of urban and peri-urban horticulture can have an advantage compared to rural horticulture because of its proximity to urban markets. Producers in the outskirts of cities often have access to better infrastructure, institutions that provide technical advice, market information and, possibly, financial support. They grow mainly for the market and their main objective is to generate income.

Cultivation practices vary. In areas with more horticultural tradition, there is a tendency to use more inputs, developing more intensive production methods, such as greenhouse cultivation.

### 1.4.1. Type of people involved and the main reason for their involvement

The group of small-scale commercial horticulture producers includes traditional small-scale peri-urban farmers and groups at risk of social exclusion ( for example, unemployed youth or migrants) who have access to land through informal channels or through anti-poverty or social inclusion projects run by local organizations (governmental or not). In a study of South African cities, Crush et al. (2010) suggested that commercial producers fall into the following categories:

- People with low incomes who produce food to survive;
- Those who grow crops to increase their income and improve their standard of living;
- Small entrepreneurs who have high incomes and have access to land and contributions.

A study in Lomé, Togo, shows the capacity of agriculture to absorb workers from other activities. From the late 1980s to the early 1990s, employment in Lomé's vegetable market multiplied (from 620 producers in 1987 to 3,000 in 1994) in response to population growth, reduced food imports and increased local unemployment. Only 6% of growers had previous agricultural experience and the vast majority of them, both men and women, were employed full time in vegetable growing (Mougeot, 2005). Several studies show that new categories of small entrepreneurs can appear in urban agriculture (e.g., young people, migrants) if financing programs are offered.

Horticultural production provides good yields, as a primary or secondary source of income. Wages and incomes in market-oriented urban agriculture are often comparable to those of unskilled construction workers or mid-level civil servants (in countries such as Tanzania or Cuba). Especially when the products of urban agriculture are in high demand or have some characteristic that differentiates them from rural production, as is the case with perishable products, such as eggs, milk, boletus, medicinal herbs, flowers and ornamental plants.

In rich countries, it is difficult to generalize about the people involved and their motivations. However, millennials (the generation born between 1980 and 2000) are becoming increasingly interested in urban agriculture. For example, in the U.S. state of Maine, farmers under the age of 35 have increased by 40%. For many, the desire to be a small-scale farmer is motivated by their values: they want to offer good, healthy, local and sustainably grown food to the community. Many of the new urban farmers are university educated and grew up in the cities.

### 1.4.2. Products and degree of commercialization

The main products elaborated in urban horticulture include fresh vegetables (lettuce, spinach, tomatoes, barley, sprouts, cabbage, mushrooms, pumpkins, etc.) and other crops (such as corn or potatoes, fruits and small plants). Generally, the types of cultivated crops vary according to the area and are influenced by culture, tradition, natural conditions and market demand. For example, in poor countries, traditional producers (mainly women) prefer short-cycle crops with regular harvests (twice a month) to ensure regular income and availability of food for home consumption. It is not possible to grow crops with a longer cycle, such as the carrot, which takes several months to grow before it can be harvested. Peri-urban farmers can usually afford to grow both short-cycle vegetables (to ensure faster yields) and long-cycle vegetables (to maximize profits and investments in infrastructure), depending on the management skills and size of the farm.

It is produced mainly for the market, although it can also contribute to family consumption. To face the market and the clients demands to the producers as much quantity as quality of the production. It may be necessary to invest in technological improvements in production and marketing. Access to credit and capital can be crucial.

Urban horticultural areas can supply the urban market more regularly than rural areas. In Nouakchott, Mauritania, urban and peri-urban producers supply the urban market for nine months of the year, while rural areas provide vegetables to the city for only three months, as farmers have better access to water and transport to urban areas. Around Beirut, Lebanon, strawberries and leafy vegetables are grown all year round.

In rich countries, the variety of crops grown can be impressive, as many growers try to find a nymph growing unusual fruits and vegetables. In addition, traditional varieties that are linked to the gastronomic past of a city or region can also influence the decision of what to grow.

### 1.4.3. Scale and location

Small-scale commercial horticulture is mainly practiced in periurban areas and open and empty spaces in the city (private, public or semi-public). The areas generally range from 500 m2 to several hectares.

In poor countries, a main objective for producers is a constant flow of income. In dry season, vegetables can be grown next to rivers (sometimes polluted) and/or with water from drainage wells, shallow groundwater or through canonades. In times of heavy rainfall, farmers often move to areas not prone to flooding. This was observed in Brazzaville and Bangui, where farmers move to higher ground when floods increase. In Bissau, farmers have access to plots of land next to the river and have to cut back on vegetable cultivation during the rainy season, which greatly affects their income (Moustier and Danso, 2006).

However, access to adequate land remains a key issue in urban horticulture production. The increasing cost of land as we move closer to urban centers must be weighed against the growing costs of transportation and refrigeration that increase with distance from the city.

Access to land for urban or peri-urban producers is often difficult and represents a major constraint to their activities. As they are not usually owners, they are obliged to lease land to others or to occupy public land in order to have land to cultivate. This uncertainty about soil tenure has a strong influence on the strategies and maintenance of soil use. Producers will select fast-growing plants (leafy vegetables) instead of perennial plants (fruit trees). They may also be forced to cultivate degraded soils, which further limits the range of crops. Food safety can also become a problem.

Land ownership insecurity can also inhibit investment in sustainable production technologies. As a result, farmers may choose inputs with strong and rapid effects, such as chemical fertilizers and pesticides, instead of improving soil through long-lasting natural fertilizers and composts.

### 1.4.4. Applied technologies and resource requirements

Horticultural crops are grown in open or covered fields (greenhouses), in small gardens or in larger fields. The sources of irrigation water include treated or untreated wastewater, local rivers and various systems for collecting rainwater. Producers can use traditional or high-tech and innovative production techniques. In areas with a horticultural tradition, there is a tendency to use more intensive production methods, including a higher consumption of inputs

and agrochemicals. In richer areas, organic production dominates the market in response to consumer demand. Some cities also ban chemical pesticides.

Some relatively new production techniques are being used more frequently in urban areas. These include horticultural production on urbanized land using various types of substrates. Other farmers have specialized in growing organic or conventional vegetables all year round.

Urban and peri-urban farming systems differ from rural systems because of their proximity to cities and space limitations, which often lead to a greater intensification of production. However, in such a competitive environment, focusing on yields can lead to unwise management in the use of resources such as water, land and chemical inputs, even threatening humans and the environment.

The risks to health and the environment come not only from an undue consumption of agricultural inputs, but also from cultivation in polluted areas or from irrigation with polluted water. In order to guarantee a safe food supply, it is necessary to adequately treat wastewater and use integrated pest control methods.

Pest and disease control is a fundamental aspect of urban horticultural production. Prevention is always better and more profitable than control. The most important prevention measures are:

- The use of resistant or tolerant varieties against pests or diseases.
- Crop rotation: the same crop should not be grown in the same part of the land every year.
- Clean seeds: the use of non-contaminated soil is an important measure for prevention.

Bio-pesticides, allowed in integrated control programs, can be used in combination with conventional pesticides. Plants such as pyrethrum, rotenone, barberry, nettle, tobacco or neem can be used. The leaves, fruits or roots of these plants can be dissolved or macerated in water and powdered on the crop. Similarly, repellents composed of concentrates of allium, peppers and gingers are often used in community gardens as an ecological pesticide. Another effective technique that can be used is the association of crops. Natural remedies are often highly effective and can cost less than the use of synthetic methods.

### 1.4.5. Main potentials

Policy makers around the world are showing a greater interest in urban gardening.

Peri-urban horticulture is encouraged because it improves food security and nutrition for both producers and the urban population. It is especially important in countries with poor transport and storage infrastructure. In Hanoi (Vietnam), 80% of the vegetables come from Hanoi province. In Brazzaville (Congo), 65% of the vegetables marketed come from local gardens and farms, while in Bissau, Dar Es Salaam (Tanzania) and Antananarivo (Madagascar) 90% of the vegetables come from peri-urban horticulture (Tixier and de Bon, 2006).

These data show that urban and peri-urban horticulture plays an important role in supplying fresh produce to city markets and is expected to continue to do so in the near future.

Policy makers also encourage small-scale horticulture because it provides jobs and income to poor households, thus contributing to local economic development. It is common to use crops that provide high value, such as vegetables with short growing cycles that allow the regular

generation of income. In the peri-urban area of Hanoi, agriculture provides more than half of the income of a township like Trung Trac. In Cagayan de Oro, Philippines, 40 out of the 100 farmers surveyed reported horticultural production as their main source of livelihood (Moustier and Danso, 2006).

Urban horticulture also contributes to maintaining open spaces and green areas in cities. These areas complement other functions such as promoting social interaction and recreation. Community supported agriculture systems (CSAs) can be found in Europe and North America. These are small-scale commercial horticulture farms, made up of one or more producers and subscribing consumers, who support the farm and agricultural practices. Consumers (or shareholders) of a CSA farm participate in the farm in a variety of ways that may include financing, decision-making, labor, knowledge and empowerment. The products of these farms go directly to the members of the CSA, who either collect their share of the production or collect their share from the farm.

### 1.4.6. Main assistance needs

Four main support needs can be identified to improve the development of small-scale commercial horticulture:

- Technical assistance to producers (business management, soil and water conservation, organic farming, safe use of wastewater);
- Assistance to farmers' organizations, quality control, certification, transport and marketing;
- Improving land security in the medium term;
- Improving access to credit.

Horticulture in urban areas will continue to adapt to specific circumstances. Specific techniques will be developed, including combinations of traditional horticultural practices and more modern and innovative practices.

The application of intensive ecological agriculture practices and permaculture involves an intensification and diversification of production through the application of ecological principles. Permaculture (http://www.neverendingfood.org/b-what-is-permaculture/) is especially relevant in the context of urban horticulture, as it is a flexible option that adapts to the conditions of the city due to the local recycling of energy and resources. The variety of production limits the risk and provides financial security. It adapts well to developing countries because external inputs (chemical fertilizers, pesticides) are limited or absent.

Improving soil fertility is always an important area. Due to compaction of the soil, overuse and cultivation of marginal lands, the fertility of urban agricultural systems is often a problem. The incorporation of organic matter, especially through the application of composted urban organic waste, should be increased.

Access to low-cost seeds and plants is of great importance for poor urban producers. This can be addressed through the promotion of local seed networks and seed libraries.

The introduction of high yielding varieties could lead to an increase in production. They are often used in conjunction with the more intensive use of agrochemicals, causing greater risks of soil and water contamination by nitrate leaching. These events may also require more water resources.

The reduction of health and environmental risks through practices based on integrated pest management (IPM), agroecology or organic farming practices are new techniques that are more socially accepted.

## 1.5. Small-scale commercial livestock

Although it is often more restricted and controversial than urban horticulture, livestock conservation in and around cities is a phenomenon as old as the cities themselves. In poor countries, urban livestock farming is practiced for a variety of reasons. Generating income and improving the food security of the farms are the main motivations. Cultural and religious reasons are also in the equation.

In wealthy countries, animal husbandry within cities is legally prohibited or restricted in many places, with some exceptions, especially the keeping of chickens. Currently, the practice is on the rise, as more and more people are questioning the current global food system. Farming is the way in which people can reaffirm their demands for food sovereignty.

### 1.5.1. Types of people involved and their main reasons for involvement in poor countries

In poor countries, small-scale livestock husbandry is very extended. In Dar Es Salaam (Tanzania), 75% of urban farmers maintain animal husbandry, while 80% of urban farmers in Dhaka (Bangladesh) are involved in animal husbandry.

The main motivations for participating in animal husbandry are:

- To complement the food safety of the farms;
- To have access to fresh food;
- To obtain a supplementary income;
- Traditional and religious motivations.

*Supplements food safety at the domestic level*

On low-income farms, small-scale livestock production can make a significant difference to nutrient intake. Rather than a lifestyle, it should be considered a survival strategy. Meat and milk are accessible to a sector of the population that does not have sufficient income to buy them, as they are produced at home or on land owned or leased by the farmer. Small-scale forestry can also be considered as part of the solution to other problems, such as urban waste management. Domestic waste can be used as pins.

*Greater access to fresh food*

Access to fresh food is another important reason why dairy farming is practiced in cities. The lack of adequate transport and refrigeration infrastructure makes dairy production in peri-urban areas a reasonable choice. In Addis Ababa, Ethiopia, the dairy industry is practiced on different scales to meet the demands of urban consumers. The demand for fresh milk has traditionally been an important consumer demand.

*Obtain additional income*

Due to limitations in space and capital, many producers are limited to raising small animals ( rabbits, chickens, etc).

In Quito (Ecuador) animal husbandry is an important component of urban agriculture, on the one hand laying hens for egg production and broilers for meat production, but another species of choice is the guinea pig. These small rose breeders have been part of Equator's culinary tradition for more than a thousand years, and farmers do not have to compete with large industrial producers as they would if they raised chickens. The municipal urban agriculture program, AGRUPAR, provides training on the care, breeding and processing of animals to more than 90 small farms within the city limits.

Studies on large-scale commercial urban livestock farming in Nairobi also show the generation of significant returns. The exploitation of livestock and poultry is profitable and ensures a rapid return on capital. Mireri (2002) calculated that the minimum economically viable breeding of aviram requires 300 sheep for farmers to obtain a return on their investment within 18 months. A pig farmer with 5 husbands can make a net profit of US$2,667 per year.

*Traditional and religious motivations*

It refers to certain areas where urban farmers keep animals for traditional reasons. The raising of pigs in the peri-urban area of Montevideo, Uruguay, in connection with the collection of organic and inorganic waste is an example. In some parts of the world, livestock farming is practiced for religious and traditional reasons. Muslims raise lambs for the sacrificial feast of Kurban bayrami. (www.urbangreentrain.eu).

### 1.5.2. Types of people involved and their main reasons for involvement in rich countries

In rich countries, the motivations of the people who practice urban livestock farming are very different from those of poor countries. At the end of the 19th and 20th centuries, the production of livestock was banned in the cities of North America. It was to collide with the image that many people felt a city had to project. The increase in the standard of living and the changes in the livestock industry made urban livestock production in the cities unnecessary. In addition, the development of large supermarkets in the 20th century also contributed to the decline in the practice.

In the last decades of the 20th century, the restrictions on animal husbandry in the cities were reinforced due to the fear of the possible health risks propagated by livestock farming (zoonosis). This was a response to the food safety crises.

Pallana and McClintock (2011) studied urban agriculture in Oakland, California. A low-income city with significant poverty, Oakland is an important center for urban agriculture and community food security programs, so the results should be considered as an indicator of what could happen elsewhere. Reflecting on the difficult economic circumstances of the city, it is not surprising to see that 89% of the population keeps farming to improve their nutrition.

The article delves into the most controversial aspect of keeping chickens: killing them for meat. This domestic skill would have been common at a certain time, but it is largely lost.

### 1.5.3. Different livestock production systems

The types of animals kept in urban ranching systems include all types of livestock. The choice of one animal or another can be culturally defined.

Farmers produce meat and eggs, milk, butter and cheese. They can also raise young animals for sale, for later breeding or fattening. An important by-product of urban livestock farming is the

manure, which is often used as fertilizer in urban crops, but also for the production of biogas. The production is often sold directly to consumers.

Wood production is practiced both on a small and large scale. Small-scale production tends to focus on raising smaller animals or, alternatively, on raising a few units of larger livestock (1-10 cows, 5-10 pigs or goats).

Small-scale livestock production is generally semi-intensive with little external input. Producers can collect grass or leaves from the trees, buy forage from peri urban areas or collect waste from restaurants, markets, agroindustries, breweries or grain mills for the preparation of animal feed.

### *Poultry production*

Poultry production can be divided into traditional free-range, semi-commercial, commercial and industrial systems. Free-range poultry includes chickens, ducks, turkey, pigeons, etc.

Poultry is raised for many reasons, including for consumption, gifts and ceremonies. One of the main objectives of raising chickens is to supplement farm income in terms of food and cash availability. When salaries are low, the sale of even a few eggs can be a very important contribution to family income. Farms with relatively high incomes also keep chickens, especially laying hens, because they believe that the eggs produced at home are of higher quality than those found on the market. The demand for home-raised chickens (more flavor, tougher meat) is reflected in the higher price of these animals.

Young broiler chicks are usually purchased when they are one day old and are fattened for a period of six to eight weeks. Support for vaccination schemes, input supply and marketing can be particularly useful for producers. Pines can represent up to 70% of the total cost of production, so it is important that they are produced and used efficiently. It is worth investing in good mills that minimize wastage losses. Ear production is done in an intensive way and the investments are longer term than in broilers. If the animals are confined, a balanced ration is essential to avoid nutritional stress. Sometimes artificial lighting is used to provide the hours of light needed to induce egg production.

Pigeon breeding is very popular in the Mediterranean region; for example, in the Nile delta, pigeons are common in both rural and urban areas. Pigeons can contribute substantially to diet and income. They do not compete with other animals for space and food. They are used to roaming around, but are able to find food within a radius of 15 km, thus taking advantage of the different vegetation cycles of local plants. In low-consumption systems, feeding is only necessary during the short period in which the animals become accustomed to their new home. Pigeons adapt easily to urban conditions, in fact it is common to see them in city squares and markets.

### *Pig breeding*

Pig farming is common in urban areas in many countries, except in those where the Islamic or Judaic religions are the main religion. Pig farming is well adapted to the family environment where the role of women is very important, both in the collection of domestic waste and in the care of the animals. Pig production implies an important reuse of domestic waste such as food, but waste from commercial companies and industrial activities is also useful.L'explotació porcina permet a les llars generar ingressos addicionals en els assentaments perifèrics urbans.

Most of the pork breeders are small producers who have one or two farms and raise their animals from birth to slaughter. Normally, breeding pigs (slaughtered or live) are sent to intermediaries and slaughterers or directly to consumers.

The typical problems associated with pig breeding are associated with the concern that they may spread disease, that they may be involved in car accidents and that the pigs may cause noise and public nuisance. The ways to deal with these problems are to provide the best possible housing for the animal, reduce the number of pigs so that they can survive and keep them hygienically.

### *Breeding of rabbits*

Urban rabbit farming is common in many countries, including Indonesia, Mexico, Ghana and Egypt. In some cases, the rabbits provide an essential source of high quality food (protein); in other cases, they are either kept or are "pets" for children. In the populations where the urban rabbit is kept, the animals are kept in groups on the terraces, in the gardens and even in dwellings.

### *Guinea pig breeding*

The breeding of guinea pigs is similar to that of rabbits. It can be done in urban and rural areas and guinea pigs alleviate food deficiencies in places where the production of other animals is difficult. They can feed any type of grass or plants, and a small daily amount of fresh feed per animal is sufficient. They need very little space; a small area of 1 m2 is sufficient for eight or five animals. Any material can be used, from a cardboard box to bricks.

The handling is very simple because it is not necessary to interfere in the equipment or in the preparation of the nest. After a gestation period of approximately nine weeks, an average of 2.5 animals are born per brood. The newborns are able to feed immediately and can be weaned within two weeks. Each mother can produce approximately 8 to 12 animals per year, which means approximately 100 broods with 10 mothers, corresponding to about 1 kg of live weight per week. The incidence and mortality of the diseases are very low, but, at the first suspicion of disease, as it happens with the rabbits, the animals have to be slaughtered and can be eaten if they are big enough.

### *Breeding of dairy animals*

In poor countries, goat, cow or buffalo farming is almost always linked to dairy production. If there is a demand for fresh milk, it is economically feasible to feed milk-producing cows and their young with industrial by-products and fibers. Even large commercial production units are remunerative. In India, the high demand for fresh buffalo milk leads to large commercial units of up to 500 lactating buffaloes in the cities. The milk is purchased from producers living on the outskirts of the city, who usually water the grass they produce with waste water. Dairy farmers are willing to pay high prices for these farrages and the grass is becoming a very profitable crop for small local landowners.

In poor countries, goat, cow or buffalo farming is almost always linked to dairy production. If there is a demand for fresh milk, it is economically feasible to feed milk-producing cows and their young with industrial by-products and fibers. Even large commercial production units are remunerative. In India, the high demand for fresh buffalo milk leads to large commercial units of up to 500 lactating buffaloes in the cities. The milk is purchased from producers living on the outskirts of the city, who usually water the grass they produce with waste water. Dairy farmers are willing to pay high prices for these farrages and the grass is becoming a very profitable crop for small local landowners.

In countries with a high proportion of Muslims (such as North and West Africa), rams are sacrificed on religious holidays such as Ramadan and Eid. Animals that are raised elsewhere are brought to the city for fattening. In Mali, the main food for these animals is cereal straw supplemented with industrial by-products, such as oilseeds, chestnuts, and cereal grain and meal. The pines can be expensive, since the market prices of these animals are high.

Concentrated feeds are mainly used in poultry farming units, pigs and intensive and specialized dairy farms in peri-urban areas. Concentrates are often imported or made from by-products of local grains and olives. Locally produced commercial pins are often too expensive to serve as full-ratio sources. As a result, farmers, pigs and dairy farmers in some regions end up using concentrates based on waste products, thus prioritizing economic considerations rather than nutrient consumption efficiency.

### 1.5.4. Main potentials and challenges

How and where urban ranching is practiced is important to identify benefits and problems. The acceptance of the practice by society and government plays an important role in addition to traditional and religious aspects.

*Main potentials*

We can identify in broad strokes the positive advantages of having an urban farm:

- Improve access to animal protein;
- Provide a supplementary or important source of income to participants;
- If practiced responsibly, environmental benefits can be abundant;
- Trenching local nutrient cycles and providing fertilizers for crop production;
- Keep traditions alive and produce social and religious benefits.

*Main challenges*

The potential nuisance caused to neighbors can be a problem for urban livestock. All animals generate a nuisance if they are not properly managed, but generally, the bigger the animal, the bigger the problem. Animal smells and odors are not part of everyone's idea of what a city should be like.

The spread of disease is a real issue, but sometimes greatly exaggerated. There are serious diseases related to the breeding and consumption of meat. Zoonoses are diseases that affect both humans and animals. They are more prone to spread when hygienic conditions are poor, for example, commercial forms of livestock in urban areas are particularly favorable to the multiplication of rose breeders because these systems require food packaging. The rats are carriers of viruses. Tapeworms can also be spread by pigs and humans. In many developing countries, the hygienic conditions of slaughter are not always optimal. The housing of the animals, the maintenance of hygiene and the adequate packaging of the food are typical answers to these problems.

### 1.5.5. Main assistance needs

The main needs for assistance in urban animal husbandry include technical training and assistance to farmers, especially in the prevention and reduction of health risks, improved waste management and improved husbandry practices. Improved access to feed and other sources of food, especially industrial waste or by-products, and their efficient use in livestock nutrition are important issues for technical innovation.

Other activities include:

- To improve the availability of pine trees through local resources;
- Improve the marketing of fresh meat and processed products;
- Improving access to vaccines and medicines.

Information is also needed on good practices for safe animal husbandry. The risk of transferring diseases from animals to humans (zoonosis) has increased, therefore it has to be reduced by working with producers in the management of diseases and animal waste and working on the maintenance of proper slaughter procedures, among other issues. It is also necessary to educate in good cooking practices so that it is not "dangerous" to consume the meat.

The need to invest in safer and more sustainable production systems requires, as a first step, official support and government sanction of bad practices. Some governments are slowly beginning to appreciate the potential of livestock in urban areas. However, the development of policies is not keeping pace with changes in the countryside. For example, in many parts of North America and Europe, small-scale renderers that could serve small farmers have disappeared, as regulatory changes have favored larger players in the industrial food system.

As a starting point, policy makers need to be aware of the positive impacts that this form of urban agriculture can have. When this is assured, innovative projects and programs can be developed to make animal husbandry in cities safer and more productive.

### 1.5.6. Livestock in Catalunya

The characterization of the Catalan livestock sector varies depending on whether the number of individuals per species or the quantity of meat is analyzed. Although the poultry, and specifically the chicken, is the most raised animal, the pig is by far the most produced meat, to the point that it exceeds the production of the rest of the livestock sector, representing 77% of the global production of meat (IDESCAT, 2017).

In 2014, in the Barcelona metropolitan area, there were a total of 315 livestock farms. 131 of horses, 62 of goats, 52 of sheep, 46 of hens and chickens and 24 of other types of livestock farms. Most of these farms are located in the Baix Llobregat agricultural park and the Vallès plain. In general, they are small farms (between 1 and 20 livestock units) (Àrea Metropolitana de Barcelona, 2018).

## 1.6. Urban aquaculture/aquaponics

Urban aquaculture has received renewed attention in recent decades. Aquaculture has been identified as an important economic opportunity due to declining ocean catches. Aquaponics has gained a great deal of attention and can be an elegant way to produce fish and vegetables in combination.

### 1.6.1. Types of people involved and their main reasons for involvement

*Aquaponics*

The concept of aquaponics differs significantly from the types of aquaculture that we will examine below. Aquaponics consists of combining aquaculture (fish farming) and hydroponics (the cultivation of plants without soil), growing fish and plants together in an integrated system. The fish waste is a source of organic food for the plants that grow and the plants

provide a natural filter for the water in which the fish live. The third participants are the microbes (nitrifying bacteria) and earthworm compounds that thrive in the culture media. They do the job of converting the ammonia in the fish waste first into nitrites, then into nitrates and the solids into vermicompost forming the food for the plants. (www.theaquaponicsource.com) (https://www.youtube.com/watch?v=ANpbBZu5ViE).

In 2014, an international survey was conducted to evaluate the production and profitability of commercial aquaponic farms (Love et al., 2014). The survey shows that the industry is in its early stages, but has great potential:

- Most operations take place in controlled environments;
- The average age of the aquaponic farmers is 47 years old;
- The average year at which they started production was 2010;
- 43% used supplemental lighting;
- In the USA the average size was 0.01 ha;
- 30% of producers raised two species of fish: tilapia was the most popular variety (69%), ornamental fish (43%) and catfish (25%) were the next most popular;
- The most popular vegetables were basil (81%), vegetables (76%), tomatoes and onions (68%), kale (56%) and bok choi (51%);
- There was no pre-dominant marketing channel: the fish were sold in the markets, at the stands and by security service companies. Indirect marketing included grocery stores, restaurants, institutions and wholesalers.

*Aquaculture*

Thousands of immigrant and middle and lower middle class families in Southeast Asia and to a lesser extent in Africa and Latin America generate their food for self-consumption through water-based production systems, while feeding an even larger number of inhabitants and recycling a large part of the city's waste. Their main motive is to supplement their income and use part of the product for domestic consumption.

As consumer tastes in Europe and North America are becoming increasingly diverse and there are more and more choices of seafood and exotic fish on offer, aquaculture has become a new income-generating strategy for many producers. In North America, relatively low-cost aquaculture systems are beginning to be found in unusual places, such as domestic environments. A recent article in the Toronto Star (https://www.thestar.com/news/gta/2014/01/03/aquaponics_brings_fishfuelled_vegetables_to_toronto.html) describes a domestic aquaponic system. This is an extreme example of self-sufficiency, but it can be done at a low cost.

### 1.6.2. Products and degree of commercialization

*Aquaponics*

For home aquaponics systems, there is probably no commercialization. The motivations are for personal use. The cost of small systems is low, so the investment would not be recovered by selling fish or vegetables. For commercial operators, both fish and plants are produced with the aim of selling them. Depending on the size of the company, sales can be local or export.

There are many different types of fish that work well in aquaponic systems. The choice of fish is strongly influenced by consumer demand. The most common species are tilapia, perch and catfish. Other common types that are raised are carp, trout, salmon and Murray cod

(Sommerville et al., 2014). Chosen fish are not restricted to edible varieties. Koi and other ornamental fish are farmed in some parts of the world.

The production time is usually very fast. Typical varieties of cultivated plants include alfalfa, leafy greens, swedish chard, eggplants, sprouts, tomatoes, cabbage, broccoli, broccoli, parsley and cauliflower (Sommerville et al., 2014). The quality is high, the product is local and with adequate sowing cycles, harvesting can be distributed throughout the year.

### *Aquaculture*

We can distinguish five types of aquaculture systems:

- Fish, shrimp or seafood farming;
- Cultivation of aquatic plants for human consumption or as animal food;
- Production of fry for sale;
- Culture of fish and ornamental plants for aquariums or artificial ponds;
- Integrated systems

### *Fish and aquatic seafood*

The most popular types of fish include tilapia, catfish and different races of carp because of their high adaptability (to low quality water, especially important when using waste water), high productivity and easy hatching. Other intensive urban aquaculture systems have been used to produce high-value fish such as eels, seabass, shrimps and mussels.

### *Aquatic plants*

The usual aquatic plants cultivated for human consumption include water spinach, mimosa, water chestnuts and watercress. Most of the production takes place in flooded fields, some of which were converted to rice production to generate a larger income. Water spinach is also found floating on canals and ponds.

The aquatic plants also serve as a high-protein farm. Around Ho Chi Minh City, Vietnam, many farmers in the Binh Chanh district have combined water mimosa cultivation with fish production in separate ponds; the mimosas provide a daily income and the fish consume the grass growing alongside the mimosa.

The costs of aquatic plant production can be lower than those of fish farming, with less risk of environmental disturbance and higher potential yields. However, aquatic plant production in many areas is threatened by the change in the use of soil and by the environmental and public health impacts of applying large quantities of agrochemicals.

### *Fry production*

Some farmers specialize in the production of fry, which are sold to other producers for subsequent fattening.

### *Ornamental species*

In addition to food production, urban aquaculture in Europe, North America and other regions is used to produce ornamental species, create tourist attractions and be incorporated as part of social development and educational schemes.

*Integrated systems*

The aquatic production can be integrated with the production of chicken, poultry or pork. The fish produced by the animals are applied to the pond and eaten by the fish or used for the cultivation of the plants. In turn, mature aquatic plants can be fed.

Other integrated systems include the combined production of rice and fish in humid areas. In Tananarive, Madagascar, rice production is combined with fish production.

Aquaculture can also be integrated with horticultural production. Aquatic plants can be composted and the compost can be used to improve soil fertility. Horticultural waste ( leaves, peeled plants) can feed the fish that live in the nearby ponds.

### 1.6.3. Scale and locations

*Hydroponics*

Small hydroponic systems take up little space and can be incorporated into a house. Small units are also installed in restaurants and offices. For larger scale systems, there are many options in terms of location. The most popular options are peri-urban areas where land prices are lower. In addition, former buildings that were used for industry or manufacturing are being adapted to this type of use.

*Aquaculture*

Generally, these activities take place in peri urban areas. We see aquaculture taking place in open water reservoirs, ponds, canals, streams or reservoirs, as well as in tanks that can be placed outside or inside buildings and greenhouses. A recent example from South Africa presents a fish farm located in a shipping container. With many urban centers located in coastal areas, it is also important to note that urban aquaculture, although probably dominated by freshwater production, can also include production in saltwater and marine environments.

Urban aquaculture comprises a wide variety of systems. One way to differentiate between aquaculture systems is to distinguish between extensive, semi-intensive and intensive production systems.

Extensive aquaculture consists of cultivating water plants and stocking fish in natural or artificial reservoirs and/or urban water bodies. These extensive systems require almost no external food sources, although there may be some contribution of fish and organic farm by-products or domestic waste. However, a major restriction to aquaculture in public water bodies is the multiple uses of various groups, often with conflicting interests.

A high density of fish and a more intensive use of external food sources characterize the semi-intensive systems. Unlike aquaculture in reservoirs, urban rivers and ponds, pond aquaculture offers farmers greater control over management and allows for better monitoring, thus protecting producers from theft, predation and pollution.

Entrepreneurs in several countries are developing intensive aquaculture management in urban areas. Although it requires less land per unit of intensive production compared to extensive or semi-intensive farms, the investment costs associated with setting up these systems are relatively high. The advantage of intensively managed farms is that producers can exercise greater control over the operation of the system, better regulating factors such as water quality, food delivery and stock management. Intensive farming systems for fish production, such as tilapia or perch, are generally located in terrestrial tanks. However, due to the high

capital and operating costs of intensive systems, it is often only possible to produce high value products, such as eel or shrimp, destined for specialized or export markets.

### 1.6.4. Applied technologies and resource needs for aquaculture

We have seen that urban aquaculture covers a wide range of activities, ranging from fishing and large-scale vegetable production to intensive, high-tech production in dumps. An example of these are bioponic systems, which combine fish production with hydroponic techniques, replacing the mineral nutrients conventionally used in hydroponic vegetable production with natural nutrient inputs contained in fish effluent residues. It is an innovative food production system that combines aquaculture with hydroponic vegetable farming techniques. The system is relatively simple and, depending on the scale, may not be too expensive.

Conventionally, extensive aquaculture is characterized by its dependence on the availability of natural feed. However, in most urban and peri-urban areas, it can be assumed that the natural production of water bodies where extensive aquaculture is practiced is improved indirectly through nutrient-rich runoff and drainage.

Semi-intensive production routinely involves the application of fertilizers to improve the production of natural feed and/or the supply of additional low-protein pins. In urban environments, agricultural and food processing by-products, residues from breweries, hotels and restaurants and direct applications of wastewater are used. But the production in food systems of wastewater with insufficient water quality can threaten both production levels (contamination can significantly reduce production levels) and human health.

Intensively managed systems, whether in rural or urban environments, depend on external inputs of protein-rich feed (up to 20%). In urban areas, entrepreneurs have taken advantage of this to use by-products and waste resources (animals) to grow protein-rich feeds such as earthworms and fly larvae to supply aquaculture producers. The use of animal waste resources carries the risk of contamination, while reliance on externally supplied protein-rich feeds carries high costs and inherent financial risks.

### 1.6.5. Main potentials

Food security, employment and income generation are important and tangible benefits of urban agriculture, particularly for people in poor communities. However, the wider benefits provided to society include the reuse of waste leading to better protection of public and environmental health and the recovery of non-renewable resources.

Farmers engaged in urban agriculture have several advantages over rural producers, especially their proximity to markets. They are able to deliver fresh products on time to consumers. Consumers may prefer to buy live or locally produced fish as a guarantee of freshness, and for urban aquaculture producers it is possible to deliver live fish to the market at a small additional cost.

In Hanoi, Vietnam, 10 to 20% of the freshwater fish consumed comes from peri-urban production, while the considerable daily demand for aquatic vegetables is almost entirely met by production grown in peri-urban areas.

*Aquaculture as a potential economic sector*

Peri-urban aquaculture not only contributes to food production, but can also become an important source of income for producers and sellers. Every day between 80 and 100 tons of

aquatic plants are sold in Talat Thai, one of the two main markets in Bangkok (Thailand), with daily sales of US$44,000 and annual sales of US$15.3 million (PAPUSSA, 2006).

Urban agriculture can also provide jobs for a large number of people. Jobs are created directly as a result of planting, harvesting, maintenance and management, and indirectly, through activities such as producing and supplying fry and food, making nets and boats, and transporting and marketing harvested products. Estimates suggest that urban aquaculture around Kolkata (India) provided direct employment for 8,000 people, while employment in sectors associated with farm services was estimated at over 20,000 people.

*Contribution to aquaculture in greener cities and resource recovery*

In addition to their potential impacts on food production, job creation and economic development, aquatic production systems treat wastewater efficiently, while reusing nutrients and water and helping to create greener cities. Conventional urban wastewater treatment is often not an option for fast-growing cities in poor countries, but as long as public health issues are addressed, aquaculture systems can be an effective and economical and low-cost treatment alternative. Depending on their design and operation, urban and peri-urban fisheries receiving wastewater inputs are likely to facilitate a series of physical, chemical, biochemical and biological pollutant removal processes similar to those observed in wetlands and lagoons. By ensuring that the maximum possible benefit is derived from the recycling of appropriate water resources and nutrients contained in both solid and liquid wastes, pressure on the renewable fresh water resource and nonrenewable mineral resources will be reduced.

### 1.6.6. Support needs

Investment and support are needed to develop and increase the sustainability of urban aquaculture production systems, while regulating potential health and environmental risks. Governments should recognize the potential role of urban aquaculture in local economic development, promote and ensure access to safe land and water resources, and integrate aquaculture into urban development and planning. Producers must be helped to improve their production and management practices, while suppliers must ensure food hygiene, respecting commonly agreed food safety standards.

*Safety of water and land sources*

Aquaculture systems need access to land and sources of water that are reliable in terms of seasonal availability and quality. Water production systems should be recognized as a legitimate use of water/land and be integrated into urban development and land use planning. Multifunctional land use and zoning should be promoted, combining urban aquaculture with open green space management, recreation and flood control, while ensuring long-term land tenure for aquatic producers and promoting the safe use of wastewater. Land access terms can also restrict the long-term sustainability of aquatic production systems. In Hanoi, Vietnam, many fishermen can obtain at most a five-year lease for land leased from the commune or acquired by auction. Depending on the local situation, legal instruments must be put in place to guarantee land tenure for 10-15 years. Guaranteeing longer-term access has the advantage of allowing producers to maintain and modernize their systems, encouraging them to use more resource-conserving agricultural technologies or to develop more valuable crops and fish.

The future of aquatic plant and fish farming using urban wastewater will depend on planners being able to coordinate and develop strategies for the effective separation of industrial wastewater effluents from domestic wastewater. This is also convenient for low-income groups

of farmers and farms that can rely on vegetable crops using wastewater as the main source of water and nutrients. It also makes sense in terms of environmental protection.

There are examples such as Hanoi and Ho Chi Minh City, where industries have been relocated to industrial estates, which has allowed for more effective treatment and control of effluents.

*Innovation in the production and commercialization systems of urban agriculture*

More support is needed to improve and develop new systems and techniques for aquatic production, specifically sustainable production and the development of new product lines. Fish and ornamental plant production is among the viable and economically attractive production systems to consider. In Bangkok and Ho Chi Minh City, some producers have entered into the production of ornamental fish species. Some producers have started to grow and sell ornamental plants for home use. Other livelihood diversification strategies have been observed in Hanoi, where a rotation of aquatic plant species has been adopted, providing farmers with significantly higher incomes and some protection against seasonal price fluctuations.

Innovative urban gardening techniques being developed in North America and elsewhere are also increasingly seen as multifunctional, producing food while contributing to education and environmental protection. In Hanoi, municipal authorities have preserved large marshes and ponds within the city limits for aesthetic and flood control reasons, while remaining accessible to aquatic food producers.

Better information and education on cleaner and more sustainable production techniques could also lead to better development of aquatic production systems that are based on ecological pest control techniques as opposed to agrochemicals. Governments, research and training institutes should promote organic farming practices through training and local experimentation, and provide licenses and incentives to micro-enterprises that produce and supply organic inputs such as organic pesticides.

*Access to grants and subsidies*

Indoor aquaculture produces fish of the highest quality, because the farming environment is maintained in very good conditions. This maintenance involves considerable costs, including electricity, heat, equipment and real estate. Governments can help the aquaculture industry by facilitating access to low-cost electricity, water heat (waste heat from cogeneration plants) and equipment and real estate (abandoned buildings).

## 1.7. Small specialized production systems

Along with horticultural production, animal husbandry and aquaculture, there is a wide variety of highly specialized small-scale production systems, including the production of boletus, domestic plants, flowers, medicinal and aromatic plants and even honey production. All these products are oriented to a specific market niche or consumer demand. Specialized production systems can be small-scale and managed by individuals and families or by large corporate production companies.

### 1.7.1. Products and degree of commercialization

The destination of specialized products are urban niche markets. These include, among others, boletus, beverages (wine, beer), plants in turrets, flowers, herbs, medicinal and aromatic plants and tree seedlings.

Traditions have a strong influence on the demand for these types of products. In many countries, the main demand for flowers occurs on Mother's Day, St. Valentine's Day and during the Christmas period. In Vietnam, the celebration of Tet is an opportunity to offer two ornamental trees: kumquats with ripe fruit and flowering peach. Another example is the wine produced in the Netherlands, as demand increases, the production of locally grown wine in the Netherlands could become a new specialized urban and peri-urban product. The case study of De Haagse Stads Wijngaards Urban Green Train in the Haia shows the potential of this industry (www.urbangreentrain.eu).

Other niche markets include the wedding and/or funeral industry (flowers); exclusive restaurants selling locally sourced food and specialty shops (mushrooms or herbs).

### 1.7.2. Types of people involved and their main reasons for involvement

*Poor countries*

Specialist producers generally come from the lower-middle class. They have their own capital and are in a position to access and benefit from development projects. They tend to be innovative producers, are willing to take risks and often have a high level of education.

Production is market-oriented, thus generating a source of income (primary or secondary) for the producers. The production of boletus, aromatic plants and the extraction of essential oils can be profitable production systems and especially suitable for female producers.

The ornamental production of plants and/or flowers can be another profitable activity for urban agriculture. Competition is fierce and many flower shops are now run by multinationals or large companies. Research shows that workers' wages are very low. For example, in Kenya salaries range from $59 to $74, while the minimum living wage is estimated at $220 per month.

*Rich countries*

Primary producers in urban agriculture understand the importance of diversification for their business. As a result, fruits and vegetables are often used as the basis for products with added value. Examples are plentiful, such as making alfalfa pesto, fruit jams and even making sprout sauces. In order to diversify the sources of income, it is not unusual to see producers growing ornamental flowers. They obtain a high price and can help in the cultivation of vegetables. Specialized production systems, especially in urban areas, will be linked to meet the demand of consumers who want special products for their kitchen. Restaurants are also one of the main drivers of this trend.

Social and environmental reasons can also drive the people behind these businesses. The Urban Green Train studio, Rotterzwam, in the Netherlands, shows its commitment to the environment by recycling most of the materials used in its boletus production. One of their proposals is the production of high quality and nutritious local food. Socially, their boletus cultivation kits allow all those interested in this type of agriculture to participate.

### 1.7.3. Scale and locations

Specialized production is practiced in different places and at different scales. It can be found both in urban and periurban areas, in confined spaces or in buildings and granaries (boletus production). It is also found along roadsides (e.g., ornamental plant production), in public areas, in vacant farms (tree nurseries or flower production in public parks) and in larger private/public plots in peri-urban areas.

### 1.7.4. Applied technologies and resource requirements

This type of production is semi-intensive, with a strong tendency towards intensification and greater use of technology. In the case of flowers, research is focused on improved flower varieties, grown in more sophisticated controlled environments for the export market.

The products come as primary products (fresh herbs, cut flowers) or processed products (dry herbs or boletus, condiments, flower bouquets).

Investments are needed: cultivation supports for mushrooms, rusks and protective clothing for the production of bees, testers for flowers and ornamental plants, etc.

The means of cultivation of the boletus can consist of dung (especially horse), organic residues (materials such as rice bags or baskets, straw or wood), but also coffee residues. Inoculation material is also required and must be of good quality.

The production of ornamental plants also requires the availability of compost, other growing materials and soil. Flower growers in Ghana obtain their flowers and plant cuttings locally from gardeners, flower vendors and shops. Some material is also imported from neighboring countries such as Togo and Nigeria. Fifty percent of the farmers build the pots while 33% rely on hired labor to build the pots for the flowers. Cow dung is the main soil improver used by these farmers. About 63% of the farmers had permanent labor to assist in flower production, thus providing employment for others (IWMI, Ghana, 2006).

### 1.7.5. Main potentials and support needs

These types of production offer many excellent products to consumers. In some areas support is needed for the sector to reach its full potential. The EU-funded TRADEIT project supports SMEs producing traditional foodstuffs such as dairy, meat and bakeries across Europe. They commissioned a survey to find out what the barriers to innovation were. The main barriers identified were:

- Lack of time for adequate innovation;
- Difficulties in accessing funding for innovation;
- Inadequate size and cost of new processing equipment to provide product innovations;
- Problems in creating adequate distribution networks;
- The problem of awareness in innovation.

Improving the development of specialized small-scale production systems is multifaceted and can include:

- Assistance in the management, control and certification of quality, processing/packing, transport and marketing;
- Technical assistance to solve existing production problems and promote farmer innovation through farmer study groups and provide access to new technologies and market information;
- Improve access to credit and financing.

Small-scale specialized agricultural production is an important contributor to local economic development. Around St. Petersburg, Russia, more than 23 million cut flowers are produced each year. Flower production is also traditionally an important activity in Vietnam. Flowers are mostly grown in the urban areas of Haiphong, Hanoi, Ho Chi Minh City, Dalat and the provincial

towns, and thousands of producers are involved. For commercial production, roses, orchids, chrysanthemums, lilies and others are grown. It is expected that the demand for flowers will only increase with the economic growth of the country and increase the standard of living of the people. It is also expected that the production area will increase substantially if Vietnamese cut flower producers enter the export market.

In Cuba, specific programs have been established to support the production of flowers, medicinal and aromatic plants. Support is provided to producers in the form of technical assistance, processing and marketing (herb drying and seasoning preparation; preparation of branches for funerals) and local production of flavors.

Selling to a niche market requires high quality products and the ability of producers to negotiate when they come to distributors and directly to consumers. Not all producers meet these requirements. They tend to have problems in business management and the ability to organize themselves to obtain better marketing results. In many cities, there are no agricultural extension services available to urban farmers. There is a need to develop new learning methodologies. Rural methodologies, such as field schools or farm to farm exchange, are slowly being adapted for use in urban environments. These "urban producers' field schools" are developed in different stages, depending on the local circumstances and the subjects covered.

In addition to the need for technical assistance and training, the producers need access to credit and capital to start or expand their businesses. The RUAF-From Seed to Table global program (2009-2010) supported groups of urban producers in 18 cities around the world to improve their production systems and strengthen the development of the urban agriculture market chain. It is necessary to investigate the possibilities of designing a guarantee fund, a fund that would serve as a guarantee for local banks and credit cooperatives to provide economic support to urban agriculture enterprises.

In Brazil, a central government guarantee fund will be provided to a state development bank. The bank provides loans to urban agricultural enterprises. One of the questions that arises with this model is what would happen if the government stopped guaranteeing the credit. This financial set-up has offered, in most cases for the first time, urban farmers the opportunity to access formal credit. If they return their first loans and gain credibility, they will be in a better position to apply for loans in the future, beyond the specific credit line.

## 1.8. Large-scale agricultural enterprises

Large-scale farms and agribusinesses contribute to local economic development and urban food security. The main limiting factors for developing these enterprises may be the lack of technical expertise, high start-up capital and marketing risks. The main needs for assistance include assistance in farm planning and management, access to information on advanced and sustainable technologies, and access to market information and funding sources.

The opportunities offered by the city in terms of market potential and access to inputs and infrastructure (roads, airports and ports) can also trigger the development of large-scale agricultural enterprises.

### 1.8.1. Types of people involved and their main reasons for involvement

Large-scale agricultural enterprises are operated by traditional farmers or by urban investors who hire a manager and labor to work. This category of traditional farmers still shares many characteristics with rural farmers. They differ in their level of intensification, capitalization and specialization and the extent of their relationship with the city in terms of diversity of production points and sources of income (agricultural and non-agricultural). Peri-urban agricultural enterprises may also have to face the threats posed by urban sprawl or other competing interests such as nature conservation.

In poor countries, urban entrepreneurs or investors, usually civil servants, businessmen or expatriates, invest in intensive crop production, poultry, fish or fruit farms, with the main objective of generating a high return on invested capital. They rely on a salaried workforce to perform most of the tasks. They may have an agricultural background and the cases of losses and failures are numerous. They usually control the commercialization of their products through direct delivery to the stores or with links to exporting companies. Some examples of this category are the producers of green beans around Dakar (Senegal).

### 1.8.2. Products, scale and locations

Large-scale agricultural companies produce poultry, pork, dairy products, vegetables, boletus, flowers and aquaculture produced in large units. The production is totally oriented to the local, national or even international market. They are mainly located in periurban areas around the cities, in areas with good transport infrastructures, both for the supply of inputs and for the commercialization of products.

Intensive production of sheep, pigs, poultry and beef takes place in many cities. Highly productive hybrid breeds are often used in conjunction with concentrated feeding. Large-scale farming systems, such as intensive chicken production, are generally found in peri-urban areas.

In Europe, North America and countries such as China and Vietnam, there is a trend towards the use of greenhouses for monocultures of tomato, cabbage, lettuce or boletus.

As large investments are needed for this type of production, long-term soil tenure is becoming a problem for the development of large-scale agricultural enterprises. Cities can protect the agricultural use of peri-urban land through zoning or controlled urbanization.

### 1.8.3. Applied technologies and resource requirements

Large-scale agricultural enterprises are usually characterized by high investments (shelters, buildings, greenhouses), the use of more advanced technologies (mechanization of certain agricultural operations, such as irrigation or soil cultivation) and a more intensive use of industrial pesticides, medicines and agrochemicals.

Intensive production systems can cause environmental pollution of soil and groundwater associated with agrochemicals. Energy requirements for mechanization and heating of large-scale enterprises are also generally high. This, combined with the materials used for buildings, agricultural chemicals used for plant fertilization and pest management, and industrial animal food, means that these types of enterprises tend to have a much greater ecological footprint than smaller-scale production systems.

In some cases, large-scale production systems make optimal use of urban waste streams, such as organic waste and compost for boletus production. Waste heat from buildings and industrial operations can be captured and reused in greenhouse production. Increasing carbon dioxide

levels also benefits plant growth. The poached water, discharged after refrigeration, can be used for fish production.

Manpower is an important resource for these companies. This offers opportunities to many immigrants. However, working conditions are not always the best. Large-scale companies are under pressure to better protect the welfare of their workers and the environment. The fair trade movement has been instrumental in ensuring that farmers and workers are treated fairly. This certification guarantees consumers that workers have not been exploited in the production of a certain product.

At the same time, agriculture, like many industries, can be high-tech and robots are used for some tasks previously performed by workers (https://www.youtube.com/watch?v=UlaNDm88yZo).

### 1.8.4. Main potentials

Large-scale agricultural enterprises could produce a large part of the city's food needs, significantly reducing product transportation requirements. In Xina, 60% of all vegetables consumed are produced in intensive vegetable production in and around the city.

However, the economic value of urban agriculture's contribution to the urban food system has rarely been estimated. It would be very interesting to calculate how much it would cost to maintain the supply and distribution of urban food in a city at the same level without urban agriculture. Large-scale flower production units or greenhouses could also provide an interesting use of land in their own right and, if properly designed, could add visual interest to an urban landscape and attract tourists, as is the case with flower bulb production (especially tulips) in the Netherlands.

If properly managed, they can generate significant revenues. They are an important contributor to local economic development, as has been demonstrated in Beijing, Xina. Linked to the development of these businesses, there is also a great potential for the development of service-related businesses, such as special labor services like milking or harvesting, agricultural training or consultancy, animal health assistance, quality control, accounting and others.

One could try to calculate the estimated impacts on the income and employment figures of the city or region if more consumers start buying more urban agriculture products from local producers and processors (both large-scale and small-scale commercial).

### 1.8.5. Main assistance needs

The main needs for assistance to improve the development of large-scale agricultural enterprises include:

- Assistance in farm planning and management;
- Access to information on advanced technologies and technical assistance to improve sustainability and improve yield ( for example, veterinary services, animal food composition and quality, organic production;
- Access to market information;
- Sources of financing.

Sometimes, peri-urban producers lack training. Training and extension institutions in agriculture, farming and agriculture should proactively include and develop the concept of peri-urban agribusiness development in their programs. Special emphasis should be placed on

the development of innovative methods and protocols for environmentally, socially and economically sustainable production systems that make optimal use of urban waste flows and services.

Finally, access to market information and funding sources are crucial for the development of large-scale agricultural enterprises.

## 1.9. Multifunctional farms

Innovative small and large-scale farmers in cities have begun to develop creative ways to better integrate into the urban fabric. They do this by offering fresh food, training, recreational services, educational and health services, and by integrating water and landscape management with productive functions.

### 1.9.1. Types of people involved and their main reasons

Multifunctional agriculture is practiced by many different categories of farmers. The future of agriculture can be solidified by introducing functions and values beyond food production. The functions refer to aesthetic and leisure activities, nature conservation and environmental services such as the management of hydrographic reservoirs (Zasada, 2011). When any of these related activities take place, the agricultural business is effectively diversified and creates new income streams or cost reductions. They also respond to an urban demand, since the inhabitants want to spend free time in areas that can be called "agricultural" (Zasada, 2011).

Although farmers with more resources are normally involved in a multifunctional use of land, which allows them to invest in complementary services and infrastructures alongside agriculture, they do not have to be highly specialized or apply advanced technology.

Besides farmers and urban investors, institutions and cooperatives can participate in multifunctional agriculture. In China there are many examples of urban investors supporting large-scale multifunctional agricultural enterprises. These companies offer a wide variety of educational and recreational services such as children's playgrounds, walking trails, picnic areas and the possibility of growing or harvesting fruits and vegetables. Specific festivals are often organized in these multifunctional farms, such as the grape or plum festival.

In the Low Countries, there are institutions and groups of producers dedicated to the fight for the preservation of multifunctional urban parks and gardens. The urban garden parks managed by the Amsterdam urban gardeners' association provide the urban population with a space for relaxation and contact with nature. In addition, the gardens offer a space where different cultural groups in an increasingly diverse urban society can meet and learn from each other. The gardens are supported by health institutes, schools and artists' groups, who use all the gardens for their own purposes.

### 1.9.2. Products and services

Multifunctional urban agriculture refers to the importance of diversification and pluriactivity (Fleury and Ba, 2005).

*Recreational and leisure services*

Recreation and leisure are a central area of multifunctional urban agriculture. Farms are a good example and are very popular in European, North American and Chinese farms. Often these farms revolve around a crop that is grown in abundance and has limited seasons. The strawberry and the pumpkins are a good example.

The restaurants and farm shops are also extremely popular with visitors and can contribute to the experience they want to give. It is also an important way for farms to achieve added value and diversify their sources of income.

Maintaining an attractive landscape and structures for tourists is another way of producing multifunctional agriculture. For city dwellers, agriculture is considered part of the cultural landscape of an area. The production and sale of regional products and the protection of the landscape can be related to the cultural heritage of the farms. For example, the agricultural park in the south of Milà plays an important role in preserving the structure of the traditional landscape and the historical buildings of the area.

Urban agrotourism is also an opportunity; in the Xina and Bangkok, aquaculture in urban or peri-urban ponds and lakes is combined with other leisure activities such as fishing, boating and restaurants.

*Social, health and environmental services*

Social agriculture or curative agriculture describes multifunctional farms that integrate social and health care services with agricultural activity (Zasada, 2011). Farms can also offer training services.

Health services provided in multifunctional farms can consist of on-farm care and restorative activities for people with psychological or physical problems. In Camilo Aldao, a small town in Argentina, children with psychological problems, mental illnesses and personality disorders have the opportunity to work in a vegetable garden and make candy from the fruit they produce. They enjoy stimulating activities without having to travel 50 km to the nearest large city.

In other cities, health institutes and health departments provide economic support to urban farmers who offer recreational opportunities for elderly, mentally and physically disabled or psychiatric patients. In the Netherlands, farmers can benefit from government subsidies when they offer these services. But the benefits go far beyond the direct beneficiaries. Programs like this help inclusion and integration and can also generate positive economic effects (Pölling et al., 2015). (https://www.youtube.com/watch?v=yOGMJvkSbGo).

Multifunctional farms can also contribute to the provision of environmental services. This includes:

- Maintain certain green urban spaces free of construction, providing a popular attraction for people;
- Keeping the land green improves water infiltration, helping water management;
- Wooded areas can cool the area and create a microclimate;
- Maintaining the green area can help prevent flooding.

In Zurich, the multifunctional objectives of land use are related to the development of urban agriculture. The city has developed environmental objectives for agriculture that include preserving and promoting diversity and fostering agricultural knowledge for schoolchildren (Jahrl and Schmid, 2015). Currently, 50% of the land where agriculture is practiced has implemented biodiversity measures.

### 1.9.3. Main potentials and support needs

Multifunctional farms that offer pick-up services or farm meals often switch to other production methods (organic, environmentally friendly, etc.). Farmers may need advice and information on how to do this. An investment in infrastructure may be necessary to receive clients and provide the services they need. In the process of designing and maintaining their farms, they need to take care of the landscape aspects of their investments.

Multifunctional agriculture is important for local economic development and the maintenance of farmers' income in peri-urban areas. The 180 farms in the village of Beizhai, near Beijing, which participate in agro-tourism, generate approximately 65% of their annual income (between US$3,000 and US$4,400 per farm). This income is much higher than that of other nearby agricultural towns (RUAF, 2009).

Multifunctional urban agriculture plays an important role in maintaining an attractive and green peri-urban environment and providing various services to urban dwellers. Rapid urbanization has led to a sharp decrease in the amount of land available for recreation in the peri-urban area of Peking. To protect the peri-urban area, the municipality of Beijing implemented two main strategic policies, modernization and diversification of agricultural production and promotion of multifunctional agriculture (often referred to in China as recreational agriculture).

The recreational, health, educational and environmental results of agricultural production can be valued as public goods or as inputs for the production of a tourist product and would not be available without a joint agricultural production. Public support for local multifunctional agriculture is increasingly rationalized, not because of the needs of the agricultural population, but because of the public (or semi-public) goods that are delivered to society. The appreciation of local or regional agriculture for food security, landscape services, cultural heritage and environmental effects is recognized as a legitimate reason for public financial support (European Commission, 2000). The promotion of the multiple functions of urban agriculture requires:

- Integration of multifunctional green areas in development planning;
- Improving direct producer-consumer links (markets, community-based agriculture);
- Creation of markets and remuneration of public goods and services (payments for water, soil or landscape management);
- Assistance in the creation of local farmers' groups and in the creation of networks between farmers and clients (public relations campaigns, planning of recreational routes, creation of web sites, etc.);
- Assistance in the planning and management of the farms;
- Access to information on urban demand for services and sources of subsidies and funding.

*Integration of multifunctional green areas in development planning*

Municipal authorities need to understand the role that urban and peri-urban agriculture can play in maintaining the city's green spaces. These lands help in the management of areas that contain important natural resources and provide new services in terms of drainage and recreation. These multifunctional uses of land must be planned and protected both in the design of urban and peri-urban development, as is done with the urban garden parks of Rosario and Pequin.

The promotion of multifunctional agriculture stands out in Pequin's policy, as it combines food production with the provision of recreational services and ecological functions for the city. In certain areas, recreational and ecological functions can even become more important than agricultural production itself. Multifunctional agriculture becomes part of an integrated urban-rural harmonious development, in which economic development, social equity and ecology go hand in hand. To promote multifunctional agriculture, the municipal government of Peking provides various types of support, among them:

- Configuration of directions and regulations for agricultural parks;
- Allowing the use of certain land for recreational facilities;
- Offer tax subsidies for agro-tourism activities;
- Constitution of the Pequín Agritourism Association.

In order to integrate agricultural development into the urban system, a zoning plan for the peri-urban area was drawn up. The use of land in the different zones has been differentiated according to the distance from the city and the natural conditions of each zone. In the suburban areas close to the city's tourism, agricultural parks, "edible landscapes" and ecological education are preferred, while in the mountainous areas, priority is given to recreational agriculture based on farms and villages, with emphasis on the maintenance of cultural heritage and the ecological protection of natural resources.

*Interconnection between farmers and their customers*

The various examples provided show that while the production of specialized crops may be economically non viable in a specific location, agricultural activity can still be essential to create a good environment for a tourist excursion that generates local activity and income. Regional networks often help this type of development.

The Apple Hill Growers Association of California, USA, is an example of an autonomous process of agritourism development. Excursions to the farms, pastures, museums and picnic areas are offered, attracting annual day visitors to the San Francisco Badia area (2-3 hours by car). Fifty years after the original farmers formed the association, the 55 ranches now receive more than 30,000 visitors a year. Through the cooperation initiated in the early seventies, the ranchers have turned their area into an important attraction for tourists. New products and services are being added in line with visitor feedback. Over time, these local fruit producers have developed a wide variety of products, services and entertainment.

*Sources of subsidies and financing*

It is necessary to develop policy mechanisms that can pay farmers for recreational, educational or health services. One of the problems is to quantify the value of agricultural services in different local contexts.

New models are needed to finance and promote the multifunctional agricultural use of land. These may include subsidies for landscape maintenance or wastewater treatment, or tax reductions for consumers. In the United States, non-profit organizations try to preserve farmland by compensating farmers for some of the potential development value of their land. In other countries, health insurance companies may pay for social care services provided by farmers to their clients. Farmers need to be made aware of the possibilities of this support.

## 1.10. Urban forestry

### 1.10.1. Types of people involved and their main reasons for involvement

Urban forestry is practiced by many different people. We can generalize and say that there are two different types:

- The cultivation of trees to promote green spaces in urban areas, environmental management and recreation;
- The cultivation of trees for the production of animal food and food, fuel (wood) and wood for consumption or sale.

Examples of the first system include houses that plant trees for aesthetic and shade purposes, as well as environmental groups and municipalities that plant and protect urban and peri-urban forests for their environmental, social and economic benefits. Urban green spaces and specifically urban forests absorb CO2, release oxygen and help control extreme temperatures. Urban forests can provide a social space for relaxation, contact with friends and neighbors, education and training. They also contribute to economic (energy) savings, with a significant cooling effect due to direct shading and increased evapotranspiration and reduced building energy consumption. Storm water flows are reduced, as it promotes better infiltration, resulting in better water management.

The promotion of urban forestry as part of urban green infrastructure has long been practiced by cities in rich countries as part of greener urban planning. Gradually we see more cities in poor countries following this example. However, a holistic approach is needed to plan and manage urban forestry and to optimize the various social, economic and environmental benefits.

The second system (productive urban forestry) involves poor and middle-income families as well as commercial enterprises. The trees offer forest products such as wood and others such as boletus, fruits and dried fruits, herbs (medicinal), canes, seeds, nuts, leafs, etc. The production of fruits, seeds and dried fruits contributes to food security and nutrition. Perennial fruit trees include coconut, mango, apple, pear, avocado, papaya, banana, citrus, tamarind, plum and others. Deciduous trees include chestnuts, nougat, and almonds.

Wood can also be very important in urban areas. Much of Africa continues to rely heavily on fuelwood as a fuel. In times of war and conflict, city dwellers have often gone to nearby forests to illegally harvest fuelwood, as in the case of Sarajevo in Bosnia and Herzegovina during the Balkan War of the 1990s. The tree species cultivated for fuelwood production include pine, neem and eucalyptus, among others.

In poor countries, the sale of food and non-food forest products contributes to income generation. Sometimes the branches and leaves have additional market potential and are used to make furniture, support material, rugs, brooms or handicrafts. Examples include the cultivation of:

- *Pandanus, the leaves of which are treated and used to manufacture rugs, hats and baskets;*
- *Java cedar, a source of dye.*

Finally, we can find species with flowers, fruits or leaves that are used to make body oil (coconut), saps (oil palm) and perfumes, offering opportunities for a rapidly expanding export market.

In Europe, because of the growing recognition of the principles of permaculture design, there has been a growing interest in establishing food forests or edible forests in the context of creating broader urban food strategies. Examples are the edible forest of Ketelbroek in the Netherlands, which was established by a private initiative. In Spain there are initiatives for edible urban forests in Vitòria-Gasteiz and Màlaga.

### 1.10.2. Scale, location and applied technologies

Trees and woods are grown in both urban and peri urban areas, along streets and roadsides, in abandoned canyons, private gardens, parks and cemeteries. These trees are found on farms (on private or public land), forests and natural plantations.

Trees and woods can be particularly suitable for cultivation in polluted areas, on steep slopes and in areas with scarce soil and water, as they generally require less water and less soil fertility than short-term cultivation on land.

The form, design and function, as well as some technical and management aspects vary according to the type of tree and location. For example, in more mountainous areas, forests can be integrated into the management of hydrographic basins, given the need to prevent erosion and landslides, while in lowland cities, especially in arid and semi-arid areas, they help provide shelter for animals, save energy by cooling the environment and contribute to mitigating climate change.

Specific technological and management challenges for urban forestry include:

- Adequate selection of tree species;
- Adequate care of the trees in a period of climatic change;
- Inventory of the area;
- Political and legal enforcement of urban forestry.

The urban environment often presents challenges for trees, such as space for roots, poor soil quality, pollution, heat, water and light deficiencies. In order to select suitable tree species, the following characteristics are important:

- The ecophysiological properties of trees. For example, when we plant trees in the street, it is necessary to make sure that their root systems and types of crowns do not easily damage the subway infrastructure; it is also necessary to avoid trees with braided branches or large and heavy fruit that could cause problems due to fruit fall.

- Their shape and function. The trees in the parks are often selected according to their aesthetics: shape, ornamental characteristics (flowers, color of the foliage) and ability to provide shade.

- A range of tree species is needed to control diseases and insects harmful to trees. For diversity, the different tree species should be distributed throughout the city. It is important to highlight native trees, well adapted to the local climate and to support native fauna and biodiversity.

Management challenges vary according to the type of urban forestry and include ensuring adequate tree care, inventorying planting areas, quantifying and maximizing tree benefits, minimizing costs, maintaining public support and funding, and establishing tree protection regulations and policies.

Commercial fruit production in gardens requires soil fertility management, pest and disease management, and pruning. It may be necessary to set up packing and processing facilities (drying, jamming and juice production) for maximum production. Large-scale peri-urban forests are professionally managed for timber production or take advantage of their natural and recreational services.

Tree inventories and plantings may require the use of a geographic information system (GIS) to support their identification, planning and management. GIS tools can help reduce the management costs associated with urban forestry and present a more accurate picture when analyzing other attributes such as water runoff, water level, and the heights of buildings surrounding the forest.

### 1.10.3. Main potentials

As mentioned above, urban forestry has several social, economic and environmental advantages.

*Social benefits*

If well planned, urban forestry brings many social benefits. Salbitano et al. (2015) identify three functions performed by forests: prevention, therapy and recovery and restoration. The recreational value of forests, parks, gardens and other urban green spaces is particularly well documented in the western world. The level of biodiversity of green spaces and urban forests is often surprising, representing "wild" nature close to the people. The great majority of recreational uses of forests take place at a distance of no more than 1 or 2 km from urban centers. It has been shown that visual experience and active use of green spaces (walking, cycling, playing and gardening) reduce stress and mental fatigue. Through the effective use of green spaces, health care agencies can indirectly reduce costs associated with obesity, physical inactivity, and poor diet and exercise patterns (Konijnendijk and Gauthier, 2006; Salbitano et al., 2015).

Productive forestry is being promoted as part of an integrated strategy for food security, economic development and urban environmental management.

*Environmental benefits*

The environmental benefits of urban forests are related to air quality and microclimate improvement, both of which help to reduce the effect of the urban heat wave. Research in Bobo-Dioulasso (Burkina Faso) demonstrated that the promotion of intra-urban greenways showed a reduction in land surface temperature compared to areas where greener management had not occurred (Lwasa and Dubbeling, 2015). In Perth (Australia) the importance of tree top on street temperature is significant.

A reduction in tree top leads to an increase in solar radiation absorption and contributes to the heat island effect. On the other hand, the increase of vegetation, specifically forest cover, will help to alleviate the urban heat wave effect and improve the physical climate of cities by increasing humidity, lowering temperatures, introducing more pleasant smells to the city, creating air barriers, intercepting solar radiation and creating shade.

Forest resources are of great importance in water management. Many of the world's largest cities are heavily dependent on nearby forests, as this is where they obtain their drinking water. Additional protection measures are often needed to ensure quality drinking water.

Trees reduce rainwater and can help in the processing of wastewater. In addition, city forests and trees act as carbon reservoirs, releasing oxygen and trapping dust and gases from polluted air, thus improving city air quality.

In arid regions, forest shelterbelts around cities help combat desertification, while trees can also be planted on steep mountain slopes to prevent soil erosion.

#### *Economic benefits*

In addition to the direct economic benefits (food and non-food production), the indirect economic benefits of urban forestry are closely related to the environmental benefits. The calculated benefits include energy savings, improved air quality, reduced stormwater runoff and increased property values.

The active management of an urban forest involves the costs of planting, maintenance, materials and disposal. These investment costs are accounted for in the budgets of municipal agencies or user groups. Returns on investment are less easily calculated. Many products that come from urban forests are public goods. Municipal authorities invest in the city's natural capital, generating various functions and intangible benefits for residents, visitors and users.

An analysis of Chicago reveals that the city has some 157 million trees, with tops covering 21% of the urban area. Chicago's urban forest currently emanates approximately 16.9 million tons of carbon (61.9 million tons of CO2), which is valued at $349 million US dollars. In addition, these trees remove about 677,000 tons of carbon per year (US$14 million per year) and about 18,080 tons of air pollution per year (US$137 million per year). It is estimated that trees in Chicago reduce annual residential energy costs by $44 million annually. The offsetting value of trees is estimated at $51.2 billion (Nowak et al., 2013).

### Main assistance needs

Improving the development of urban forestry systems requires long-term forest tenure security and the integration of urban forestry into urban land uses and green infrastructure plans. It is necessary to develop new technologies and generate knowledge to optimize the management and provision of urban forestry goods and services.

#### *Integration of urban forestry in green urban land management plans*

Long-term security of access to and use of land is a major condition for promoting sustainable tree planting and conservation. Legislation on land use and the protection of urban forest resources is particularly problematic in developing countries, where uncontrolled migration to cities, poverty and lack of control lead to drastic and illegal changes in land use and overexploitation of green resources.

Amsterdam (Netherlands) promotes urban agriculture and forestry as part of its green ecological structure, alongside sports facilities, parks and waterways. Accessibility and the promotion of multiple functions are two pillars of this policy.

Beijing, China, defines four types of urban forestry in terms of planning and spatial functions:

- Forests in the mountainous areas outside the city owned by the municipality or the central government;
- Forests located in the peri-urban areas, with the function of protecting the local agricultural fields from windstorms and drought;
- Green belts established immediately adjacent to new construction zones for growth management and environmental improvement;
- Green spaces in residential areas.

The resulting mosaic of forest systems, street trees, gardens, woodlands and recreational parks is one of the main strategies for Chinese cities to respond to the environmental and health needs of their inhabitants.

Melbourne (Australia) has launched an urban forestry strategy in response to climate change.

(https://www.youtube.com/watch?v=BplUmxFCE8A).

*Enforcement and institutional coordination*

The development of urban forestry requires long-term cross-sectoral planning. Even in a city, responsibilities for green space are often poorly defined and fragmented. In Europe, for example, the planning and management of urban parks, street trees and periurban forests has traditionally been the domain of different professionals and sometimes different departments.

A good example of management is in Johannesburg (South Africa), where a city park office was created following the principles of new public management. Johannesburg's city parks are now managed by a director and a board of directors who report to the city manager. Previously, park services were fragmented among the five councils. This led to confusion over who was responsible for different aspects, and resulted in different standards being applied across the Johannesburg region. Building more parks is now part of the office's budget (https://www.jhbcityparks.com/index.php/tree-planting).

*Elaborate appropriate legal markers*

At national and municipal level, there is still a clear need to develop or improve the existing legal frameworks. In those cases where urban forests are mentioned in legislation, it is mainly through certain explicit provisions, as part of forestry acts. Some links with urban forests are found in environmental legislation and in land use planning acts.

In most countries and cities, municipal bylaws safeguard city forests. In Vienna (Austria), an environmental protection law covers trees on both public and private land. In Zimbabwe, trees in urban areas can only be planted or cut after obtaining prior authorization from a construction manager. Much can be learned from cities such as Curitiba (Brazil) and countries such as Cuba and the United Kingdom that have managed to develop advanced forestry policies for green management and forestry.

Urban forestry in Curitiba is known beyond Brazil's national borders for its policies in favor of well-ordered urban development, a sophisticated public transport system and environmental conservation, making it a model city in Latin America. In the last 30 years, Curitiba has focused on urban planning. A master plan for orderly urban development was implemented in early 1971. The development of the master plan was supported by the IPPUC ("Instituto de Pesquisa e Planejamento Urbano de Curitiba") with ongoing discussions with the whole society (seminars). Today, the city is extending its solutions to the entire metropolitan area through

measures such as "zoning and land use". An important part of the population participates in Curitiba's environmental programs. When suitable areas are found, the department contacts local representatives and involves them in the planning process. The areas designated for planting are always public areas, usually steep slopes or riverside areas threatened by erosion or flooding. Information is also provided on the species of trees or shrubs to be planted (Konijnendijk and Gauthier, 2006).

*New technologies and knowledge generation*

New technologies and knowledge must be developed to optimize the management and delivery of urban forest goods and services. In the EUA, the Forestry Service, through special urban forestry research centers, has generated extensive knowledge about urban forests, trees and their benefits. However, knowledge and technologies also need to be developed from the ground up.

The city of Bogotà (Colombia) is training citizens to protect and take care of the trees in their neighborhood. They collect simple leaflets with information about the watering in dry season, keeping the trees free of residues and notifying the botanical service of the city of the presence of possible pests and diseases.

## 1.11. Vertical agriculture (wall, in building, with or without soil)

Vertical gardens refer to any type of construction and support structure for vertical cultivation plants, thus making efficient use of existing space for plant production.

### 1.11.1. Type of people involved and reasons for involvement

Vertical farming is a type of urban agriculture with a rapid and controversial growth. It is practiced mainly in more developed countries. In poor countries there are also more rudimentary versions. Overall, the industry is experiencing strong growth. A recent study predicts that the market will reach US$3.88 billion by 2020, with an annual growth rate of over 30%. The industry refers not only to agricultural farms, but also to all related businesses that provide services and equipment such as lighting, hydroponic component manufacturers, climate control devices, etc. At the industrial level, large corporations such as Koninklijke Philips N.V. (Netherlands) and Everlight Electronics (Taiwan) are involved.

The book published in 2008 "The Vertical Farm: Feeding the Whole World in the 20th Century" by Dickson Despommier, proposed vertical farming as a solution to feed the world. (https://www.youtube.com/watch?v=yIXYHk0A0gM&feature=youtu.be).

Advocates of the technique and industry representatives believe that vertical farming is part of the solution to feed a world population that will increase significantly. More than 50% of the world's population lives in cities and it is expected to increase. Food production in cities will help increase the supply of food to feed a growing number of people.

Environmental management is another motivating factor for people involved in vertical farming. It can be argued that urban food production will contribute to a reduction in greenhouse gases. On industrial-scale farms, water use can be significantly reduced compared to conventional greenhouse techniques. As water is likely to become the scarcest commodity in the coming decades, vertical farming may be part of the solution.

Apart from altruistic motives such as improving food safety and environmental management, most of the companies involved in this field are doing it for economic gain and to maximize their profits.

Countries like Singapore import more than 90% of their food. Vertical growth is able to provide consumers with fresh local produce. As a rich country, the price increase associated with vertical farming is affordable for consumers.

However, vertical farming is much more than large farms where vegetables are grown inside buildings. Vertical gardening follows some of the principles of large farms where plants are stacked. It is practiced on a much smaller scale and the motivations of those involved are different. For the Urban Green Train study, Le Vivant et la Ville, in France, grows on vertical structures, often on land in need of improvement or where the space makes an environmental contribution to the city. Poliflor, in Italy, installed vertical gardens to improve the aesthetics of buildings, capturing pollutants and organic compounds and adding thermal insulation to the structure.

In poor countries, vertical farming is not usually a high-tech, capital-intensive enterprise. Sack farming as it is produced in Kenya is a form of vertical farming with little space, as the plants grow side by side inside the sack.

### 1.11.2. Products, scale and location

Theoretically, it should be possible to grow any type of vegetable, but vegetables and herbs dominate the production. These plants are the most economically efficient to produce because they grow quickly and therefore have lower costs. There is also a market willing to assume the added costs of the product by paying "premium" prices. The locations vary according to these farms. Some are newly built, while in other areas, old industrial buildings are being repopulated. An example of this is the Aizu-Wakamatsu factory in Fujitsu (Japan). Part of this semiconductor factory has been converted into a vertical farming operation. There are several examples of this type of factory in Japan. (https://www.youtube.com/watch?v=RQwSZa-1hQ8&feature=youtu.be).

For smaller, lower-tech facilities, the approach must be different. Growing vertically on the ground is an example. The Urban Green Train case study offers two lines of installation: using the climbing ability of plants to produce a green curtain and creating a vertical garden with plants anchored to the substrate. A very basic but effective vertical cultivation is the sack garden. As they do not take up much space, they can be found around the garden.

### 1.11.3. Technologies undertaken

As well as vertical farming itself, there is a wide range of technologies involved. Large farms practice this type of agriculture in a controlled environment. This approach employs a combination of engineering, plant measurement and computer-managed climate control to optimize plant growth and resource use. Water recycling is paramount in these operations. Spread Co. Ltd. in Japan is one of the most technologically advanced farms in the world. They are able to recycle 98% of the water they use in the production process.

Evidently, this type of vertical agriculture requires a great deal of capital and is therefore beyond the reach of many companies. However, alternatives with more reasonable prices are beginning to be developed. The mini-structured and modular vertical cultivation (MSM-VF) is an example (Cuello and Liu, 2014). This design uses a structure as a base that supports vertical

cultivation. Complete or partial environmental control could accompany this structure, but it is not mandatory, since the structure is designed to be located in different buildings and spaces.

In the case of green walls, continuous research is needed to see the performance of the walls. Areas of interest to the green wall industry include selection, installation, cultivation, maintenance and performance monitoring. Remote control is a new trend in the sector.

The technology used in bag orchards is low cost and effective. The bag with a volume of 0.1 to 0.5 m3 is ideal for the cultivation of leafy vegetables. A stone is used to facilitate water infiltration. The bag is filled with soil and compost. Obtaining quality soil is a problem for some bag producers, as is the supply of quality water (Pascal and Mwende, 2009).

### 1.11.4. Main potentials and problems

Vertical farming, in many ways, is a new type of urban agriculture that is evolving rapidly as it tries to live up to its potential, establish entrepreneurial initiatives and open markets, while responding to people critical of the practice. On a small scale, vertical farming makes practical use of space by allowing more plants (food) to be grown. An excellent example of this is sack farming, which is a low-cost way to grow a maximum of food in a small space. This form of agriculture can have a positive impact on domestic food security. There could even be a surplus that could be sold.

It is likely that medium-scale approaches to vertical farming, such as minimally structured and modular vertical farming, will become more abundant. This space-saving technology allows people the possibility of growing a significant amount of food in a small space, which offers them the opportunity to earn more income, as well as improving food security.

Large-scale vertical farms have many supporters and detractors. Undoubtedly, vertical farming will have a very different look in the next ten years. Loessl (2014) identified some of the advantages of vertical farming that include:

- Increase in production/m2;
- Decrease in water consumption thanks to water recycling;
- Decrease in the use of pesticides;
- Elimination of agricultural runoff;
- Elimination of seasonal, regional and climatic restrictions.

These are valid advantages that justify the practice. Climate change makes conventional agriculture difficult, since weather patterns change rapidly and unpredictably. Eliminating these risks will be one of the main virtues of this type of agriculture. Water is likely to become an extremely scarce resource in many parts of the world. The use of water in a much more rationalized way would give a boost to vertical farming.

Critics point out many problems related to large-scale vertical farming. Although many resources such as water are used efficiently, the same cannot be said about energy use. These farms use a large amount of energy to illuminate the crops. Using the sun is a global public good at no cost. LED lighting, climate control, computers and the mechanization of the installation all require energy.

Social issues also need to be addressed. This technology is expensive and, therefore, the food that is produced presents a significant increase in price. This excludes people with low incomes from being able to buy these foods. It also excludes many farmers and entrepreneurs from

entering the sector. This is a problem when public funds are used to support and subsidize these operations.

Perhaps a more developed technology will be able to respond to the critics. Therefore, more research and experimentation is needed to make it a reality.

# 2. Integration of urban agriculture in agricultural enterprises

## 2.1. Urban agriculture and agroindustry

In order to define and understand the possible positions and roles of urban agriculture in the context of general agriculture and modern societies, we have to face some long-term novelties: they are like "macroeconomic laws of nature".

Throughout the historical development, from agriculture to the manufacturing industry and later to the industry and service-oriented society, some "inconvenient observations", from the point of view of agriculture, were made by scientists.

It is possible that you do not know all the economic terms that are used, here are some explanations:

Economies of scale: term that describes how unit production costs develop as production increases. For example, if unit costs decrease as production expands, we are talking about increasing economies of scale. Many modern industrial production processes follow this logic, including modern large-scale agriculture.

Advantages of specialization: economic advantages, mainly in terms of quality and unit production costs, focusing a company or a farm on a reduced number or a single type of product or service.

The advantages of clustering: popularized by Michael E. Porter, the so-called industrial clusters (agglomerations of competing industries, linked suppliers, marketers and support) offer economic advantages for the participating companies, the advantages are diverse: contact, short distances, low transaction costs, knowledge exchange, etc. These groupings strengthen the companies that participate in them in the face of external competitors. There are regional groupings that offer these benefits, for example in the horticulture, viticulture and intensive livestock production regions.

If farms want to follow the pace of other sectors of the economy and society in terms of income, workload and human welfare, labor productivity plays an important role. This term describes how much manpower is needed to achieve a certain result (for example, a certain amount of production or a certain level of income). A certain level of productivity is of crucial importance to pay fair wages to workers and create fair incomes for agricultural entrepreneurs.

The food value chain or food supply chain covers all stages of food production from agricultural inputs, encompassing the agricultural sector and including the processing, marketing and distribution sectors (see image). In some countries, the whole system is called "agro-industry", but sometimes this term is understood as synonymous with large-scale industrialized agricultural business.

## 2.2. The supply of external inputs, part of the food value chain

Studying a typical rural farm, it can be observed that it has a very complex and differentiated income supply system. In order to obtain a general overview, we can distinguish the following main actors:

- Companies specialized in machinery, chemical industry and construction of the industrial sector;

- Companies specialized in the agricultural sector, such as animal feed producers, animal and plant breeding companies and the so-called multiplier companies;
- Input trading companies, often in the form of agricultural cooperatives dedicated to the purchase of input, processing and marketing of farm members;
- Companies supplying electricity, heat, water, fuel and lubricants;
- Institutions and companies providing services and knowledge.

## 2.3. Processing and marketing

Beyond food production, there are some value chains, recently called "Bioeconomy", in addition to the "short" value chains as an alternative processing and marketing model, especially for urban farms.

There are 4 different stages within the value chains:

- Collection and packaging/grouping of primary production for commercialization;
- First processing (starting from the agricultural product);
- Finalization (second phase and subsequent industrial transformation, including the production of artisanal foods);
- Consumer distribution.

## 3. Innovation in Urban Agriculture

The various forms of innovation are especially important because urban agriculture adapts to specific urban challenges and opportunities. Innovation is continually occurring, exploring the multiple functions of urban agriculture, such as food security, income generation and environmental management.

In addition, the necessary innovation trajectories between the different types of urban agriculture, their specific location in the peri urban space and the social needs to which the initiatives aim to contribute are differentiated.

Next, there is an article that gives an overview of the most relevant aspects of innovation in urban agriculture, differentiating the types of innovations and the successful role of the actors and stakeholders in these urban agriculture innovation processes.

https://www.ruaf.org/editorial-innovations-urban-agriculture

## References

Urban Green Train Modules and Resources (IO2), Module 3: Urban Agriculture types/production Systems and short food chains

Àrea Metropolitana de Barcelona. 2018. Challenges and opportunities of short marketing channels in the metropolitan area of Barcelona.

Institut d'Estudis Regionals i Metropolitans de Barcelona. 2016. Urban and peri urban agriculture in the metropolitan area of Barcelona: Economic, social and environmental benefits. : 1–94.