

## THE PRODUCTIVE LAB

The "productive lab" consists in a series of small-scale experiments. Its aim is to explore different aspects of urban agriculture, as well as to test various solutions according to specific local situations.

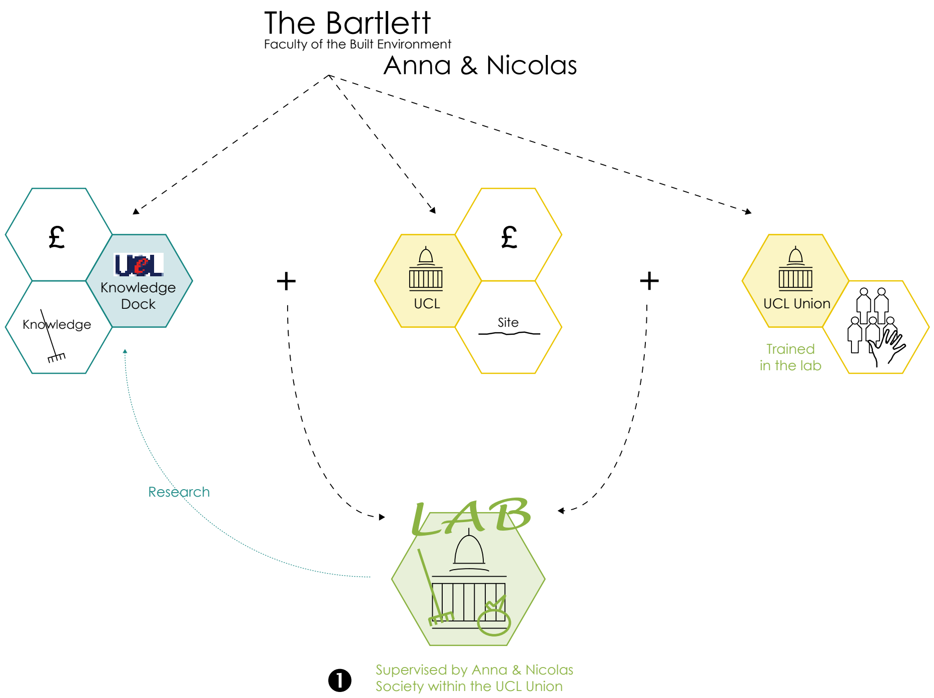
The "lab" approach allows to test how a new layer of productive city can be respectfully added to and interact with an existing built form and community. If the appropriate technical or social solutions are found, this means that they may be implemented at a larger scale.
Most of the experiments – the technical ones – are taking place in the same area of the campus, located behind the terraced houses opposite to Gordon square. This location is chosen because it is one of the most contrasted and fragmented in the campus. Indeed it contains many diverse situations regarding space, building morphology and light, which all require different types of intervention. Several farming techniques can thus be experienced and developed.

Other projects, which are more related to the existing communities of UCL, are taking place in various areas of the campus, including the students halls and the UCL Institute of Child Health.

## I. How to implement the lab?

The project is initiated by us, as students of the MSc Urban Design. ❶ We choose to collaborate with the UCL Union in order to advertise widely on the campus and recruit a team of motivated volunteers. Some students may be interested by the environmental and social dimensions of the project, others by its scientific or technical aspects. This team organises itself into a new student society.
The University is also involved in order to provide funds and allow the experiments to take place on UCL land. We assume that UCL is interested in supporting this initiative because it strengthens its reputation as a leading research centre as well as a sustainable university.

However, neither UCL nor UCLU have enough technical knowledge in the field of agriculture, nor do they probably have enough funds to fully finance such a project. A third actor is then needed as technical and financial "facilitator". This actor is found in Knowledge Dock, which is the business services arm of the University of East London. Knowledge Dock aims to help students from UEL and other London universities to develop their projects, providing funds and scientific or technical assistance.




**For further information**
Knowledgedock, http://www.knowledgedock.com/


**The Productive Lab situation map**

Technical experiments ★

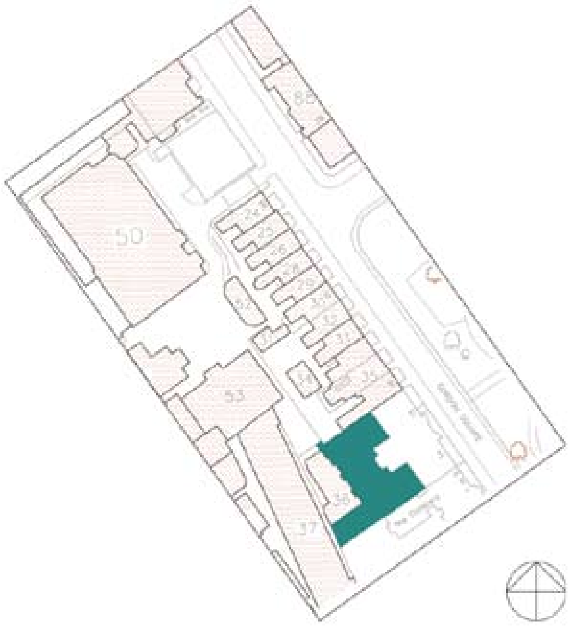
Experiments involving people ★

## II. Technical experiments

In the following section, the experiments are sorted from the cheapest and most low-key to the most expensive and high tech.

### II.1 The city vegetable garden toil and its identity

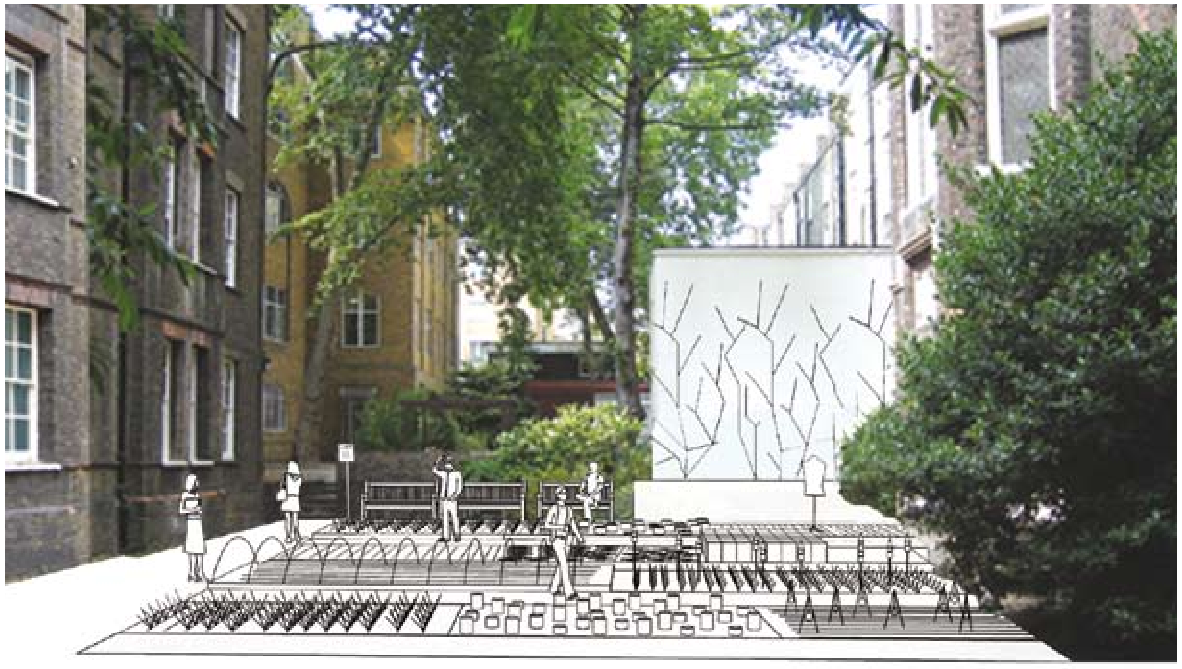
In order to achieve a maximum variety and profitability of crops' production, vegetable gardens in cities are extremely labour-intensive and entail an ongoing presence of persons.



Urban agriculture implies that vegetable gardeners have to be able to combine a wide range of technical knowledge and this is already true at the low-key scale of a simple field.

First, in order to keep a high fertility and productivity level of soil without diminishing its resources, gardeners need to precisely understand crops rotation techniques and the related cultivation cycles. 15 Then, due to the various requirements of crops gardeners need to provide the right amount of water; to straighten climbing plants; to provide the right space for the various plantation patterns; to level the crops strips; to protect certain crops from the sun; to find appropriate ways of defending the garden from birds and other animals; to prevent diseases with proper treatments; etc. ❶

For achieving these heavy tasks, gardeners can, in a way, be helped by their urban surrounding. Indeed, vegetable gardens are original opportunities to recycle all types of urban waste, in order to either protect or help the growth of the various crops. ❷ All these diverse, rigorous toils are necessary to enable the existence of urban agriculture. This gives a strong identity to cities' gardens as totally dependent and linked to human's laborious work.



**Source**
Teresa Gali-Izard, Land&Scape Series: *The same landscapes, ideas and interpretation*, (Spain: Gustavo Gili, 2005)

#### Crops rotation 15

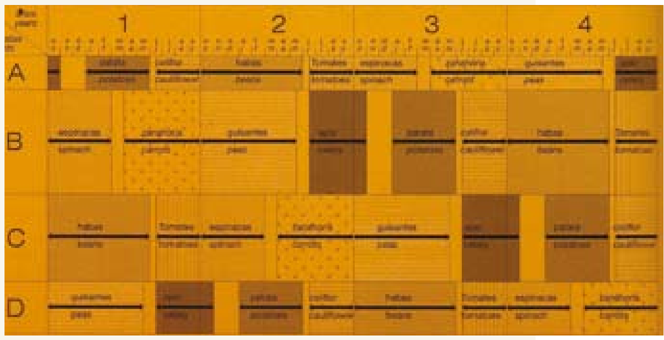
Crops rotation is a technique which enables to maintain high fertility and productivity level of soil without diminishing its resources.

Crops rotation involves combinations of different crops' family over space and time within a single plot. It requires an accurately planning of successions' order, as not every crop can follow any other one.

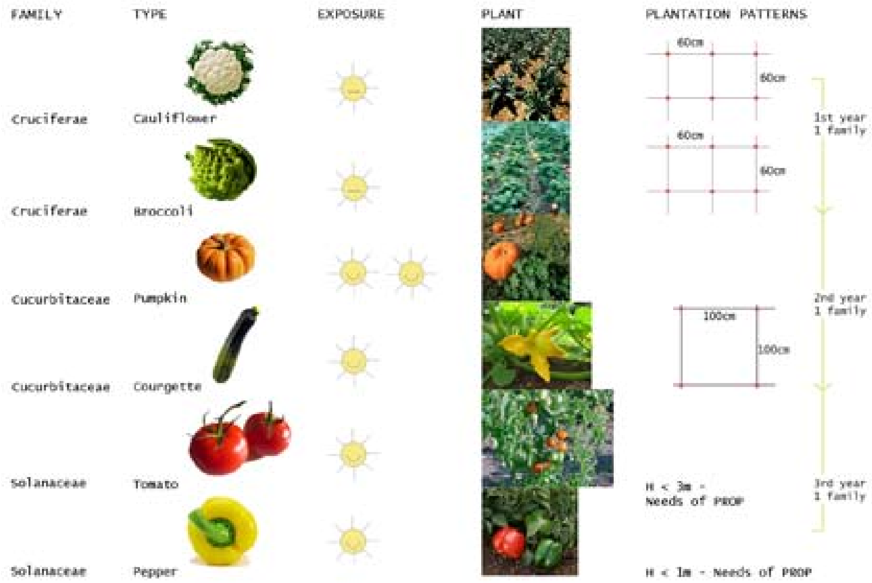
The benefits of the crops rotation strategy are various, including the following:

- It preserves soil fertility;
- It increases species' variety and consequently prevents pests to pass from crop to crop; therefore the need for chemical inputs is reduced;
- It ensures effective nutrient uptake from the soil by planning crops in accurate sequences (according to different nitrogen needs for example).

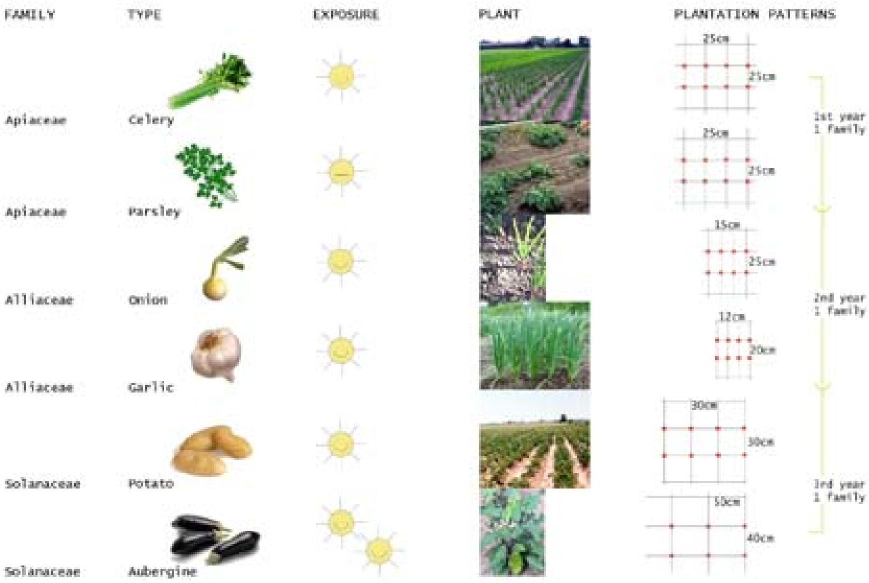
Source: Wikipedia, Crops rotation, http://en.wikipedia.org/wiki/Crop_rotation




Teresa Gali-Izard, Land&Scape Series: *The same landscapes, ideas and interpretation*, (Spain: Gustavo Gili, 2005), p. 151




30 to > 60 cm - Deep depth




0 < 30 cm - Surface depth


❶

Crop that implies different use of urban fabric

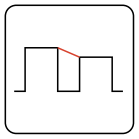

Crop that implies different use of urban fabric

❷

See Nicolas's Erith Productive City for an original way of shifting buildings according to crops rotation

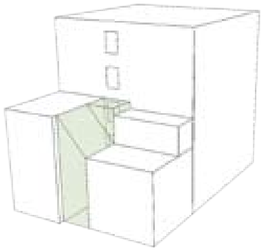
See Anna's Socio Land Lab for the potential of crops rotation on urban life

**For further information**
See http://www.organicgardening.org.uk/factsheets/gg19.php for how to plan a rotation



## II. 2 Cheap solar greenhouse

This experiment tries to make the best of a narrow, shaded disused courtyard between two low buildings.



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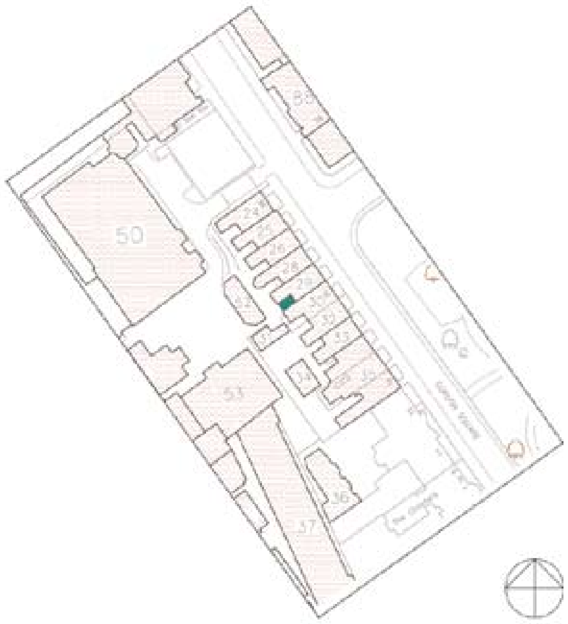
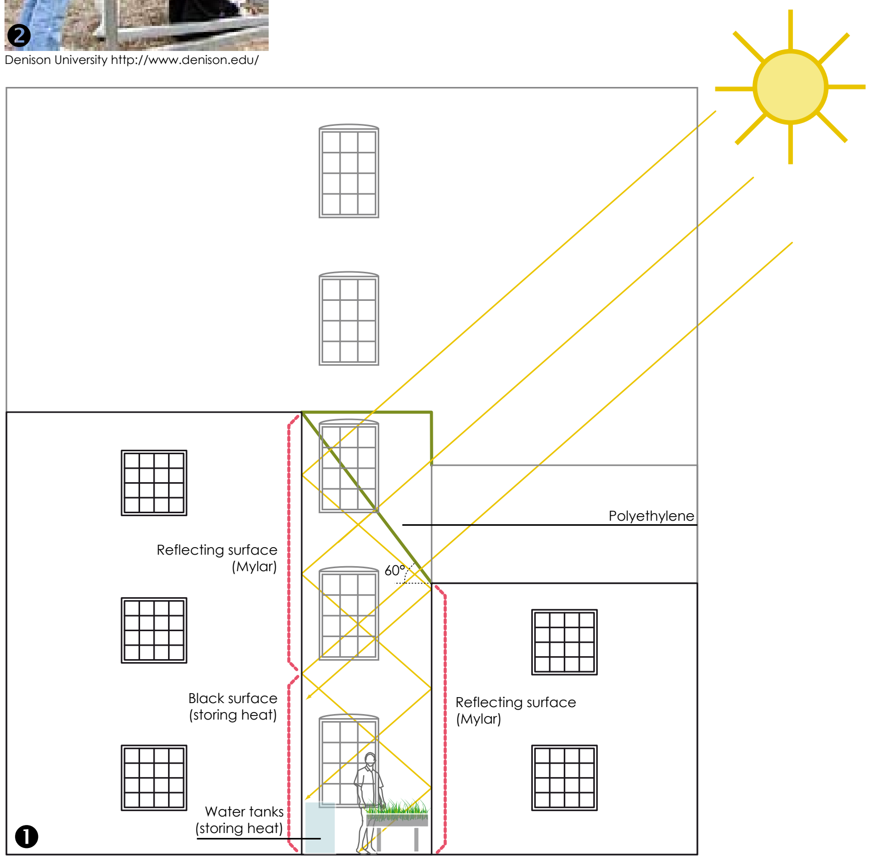
Denison University http://www.denison.edu/






❶

As the two buildings have different heights and the lowest one is on the south side of the courtyard, the principle of the solar greenhouse can be applied. The slope of the roof of a solar greenhouse is calculated so as to optimise solar penetration. It depends on the local latitude. 16 In the present case, by joining the roofs of the two low buildings, the angle is close to optimum. Yet, the space is too narrow to allow direct sunlight to reach ground level, so part of the walls is covered with a highly reflecting material such as aluminised PET film. To allow heat to be stored during the day, the lowest part of the north wall is painted in black and water tanks can be set against the wall. ❶ The structure of the greenhouse itself is very cheap and made of light metal framework ❷ covered with polyethylene sheets that allow an optimum diffusion of light.

This intervention thus permits to create at a very low price a favourable environment which, though narrow, is still suitable for hydroponic cultures. (For year-round crops the greenhouse still needs to be heated in winter, but using much less energy, cf. the "transparent greenhouse" experiment below).

### Solar greenhouses 16

By definition, a greenhouse collects solar energy. However, a new generation of greenhouse emerged in the 70s and was designed not only to collect solar energy during sunny days but also to store heat and release it at night or during cloudy periods. It is known as a solar greenhouse. While in passive solar greenhouses heat is stored and released naturally, in active solar greenhouses the heat (i.e. solar heated air or water) is stored in a storage area (usually in the ground) in order to enable a future heat redistribution whenever needed. However, in cold climates, extra heating still needs to be provided to prevent frost. Solar greenhouses are oriented to receive maximum solar heat during the winter. A typical solar greenhouse is oriented to have its long axis running from east to west. The south-facing wall is glazed and ideally sloped with an angle equal to the site latitude plus 10 or 15° in order to absorb the greatest amount of solar heat. Thus, in London (latitude 53°), the optimum slope is around 65°.
The north-facing wall is well insulated to prevent heat loss. It can be covered or painted with reflective material in order to provide a more even distribution of light. Thus, a solar greenhouse can easily be attached to a building. Heat storing materials can be used to retain solar heat. The most common method for storing solar energy is to place rocks, concrete, or water in direct line with the sunlight. Dark ceramic tile flooring can also store heat.

EnviroCept Greenhouse & Supply, http://www.greenhouses-etc.net

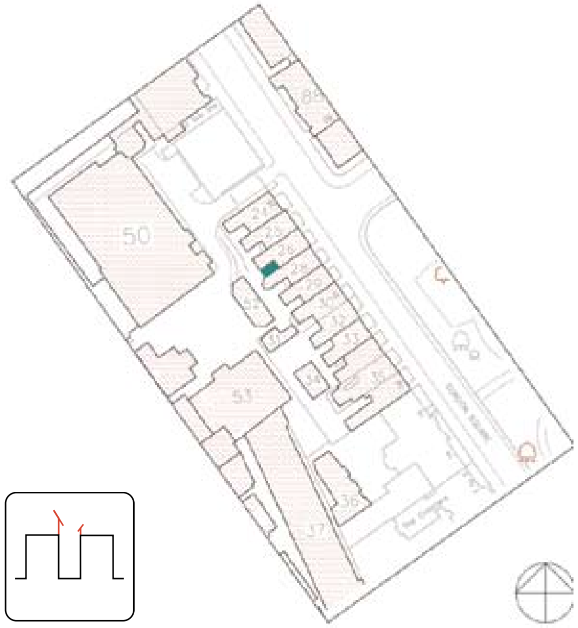
More high tech materials known as "phase-change materials" can also be used, such as paraffin or fatty acids. They are 5 to 14 times better able to store heat than water or rocks.

Source: ATTRA - National Sustainable Agriculture Information Service, Solar Greenhouses, http://www.attra.org/attra-pub/solar-gh.html



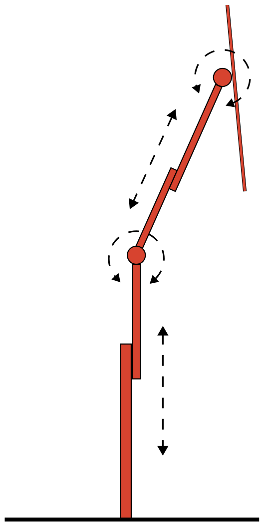
### II. 3 Bringing light

An essential question that has to be raised when implementing productive sites within a city is: "How to bring light to spaces that would otherwise be lost?"

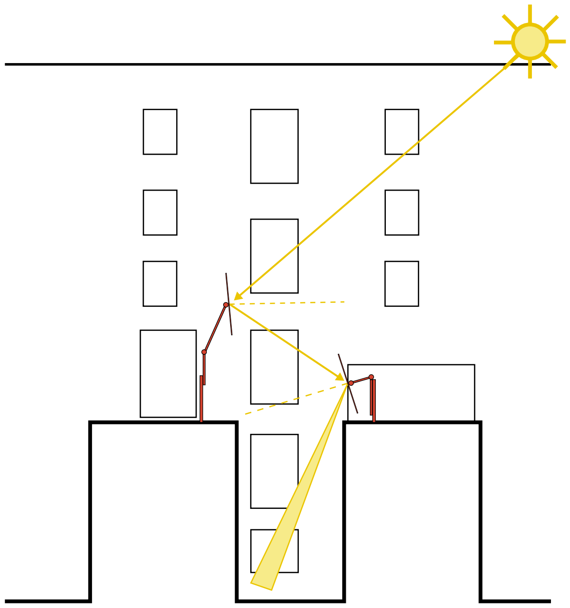


This experiment tries to make the best of a dark and empty courtyard between two buildings.
The space is unused, but being very shaded it does not allow the creation of farmable surfaces.

A system of reflectors with pivoting mirrors is imagined.



Thanks to sensors these mirrors follow the path of the sun, enabling the light to be reflected down to the ground level. ❶ Moreover, the walls of the buildings forming this court are painted in white or covered with a highly reflecting material, which enables to intensify the light. 22



Section

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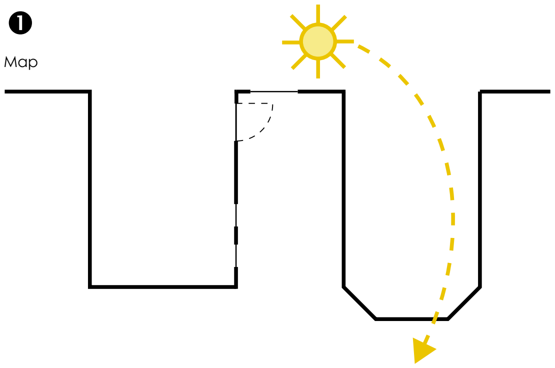
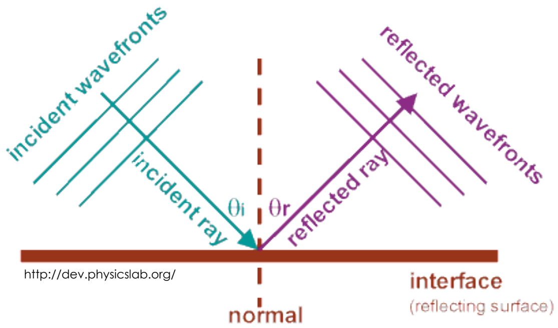
Map





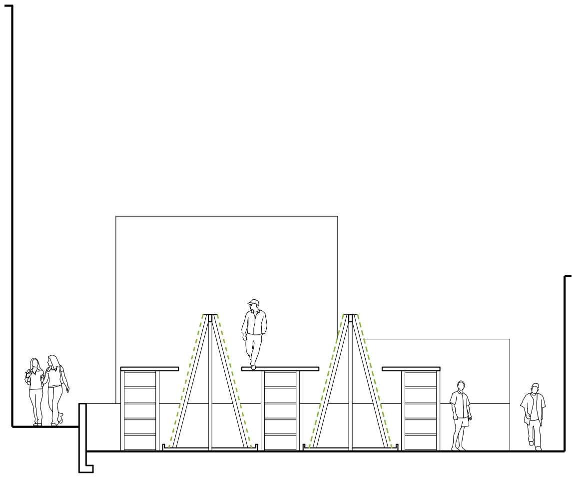


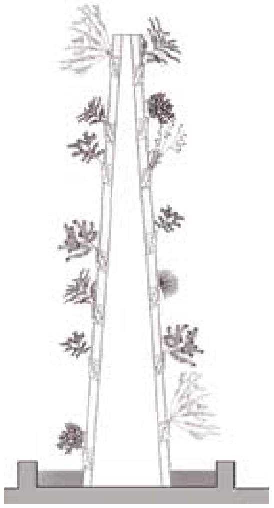
## II. 4 Vertical Fields

An important challenge of urban agriculture is how to make the most of the available space. This project experiments a technique that enables to save space and to increase production. A small garden is chosen for the experiment; its surface does not allow effective implementation of traditional farmable plots, yet its location and orientation are interesting.

A vertical garden of "plush green walls" (17) is set. These walls enable to significantly increase farmable surfaces compared to horizontal techniques.

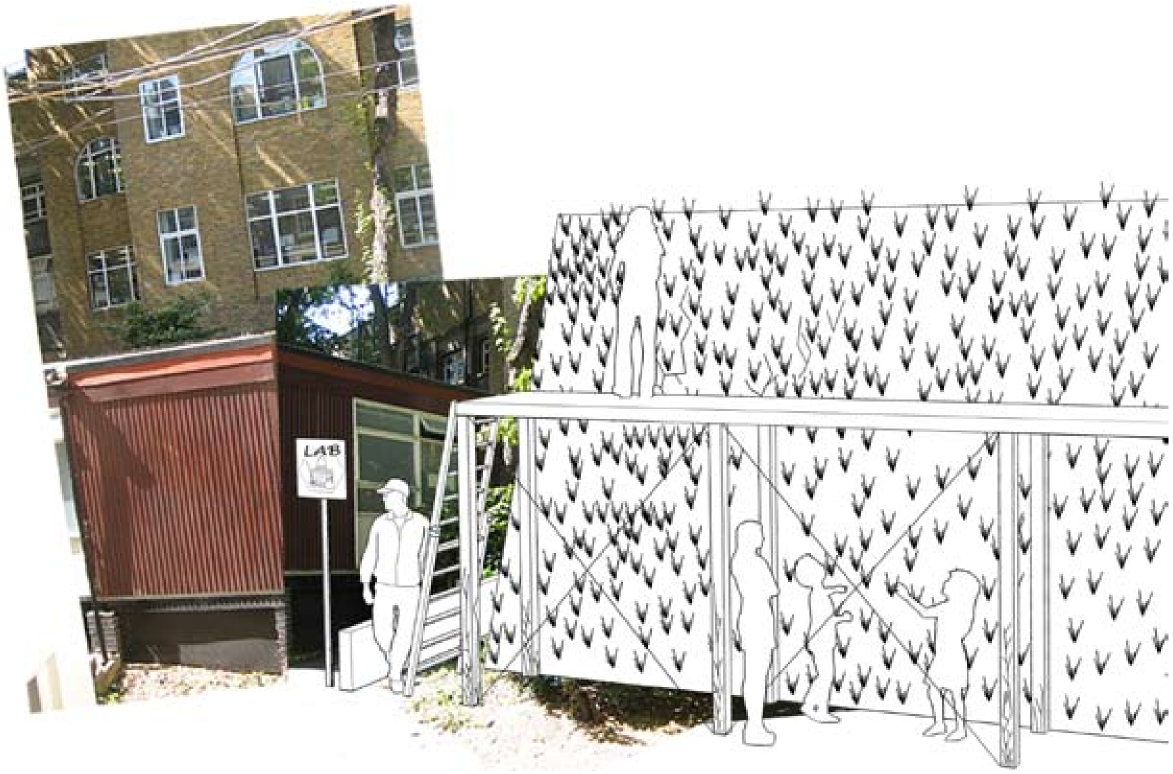
To go even further, the walls are imagined two-floors high and a light structure is installed between them in order to allow access to the crops. This structure is made of transparent materials which allow the light to reach the ground. (22)





Teresa Gali-Izard, Land&Scape Series: *The same landscapes, ideas and interpretation*, (Spain: Gustavo Gili, 2005), p 145

**For further information**
The vertical garden at the Musée du Quai Branly, http://www.frenchgardening.com/



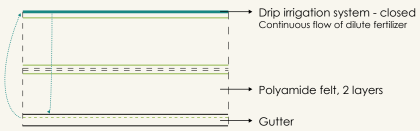

### Plush green wall (17)

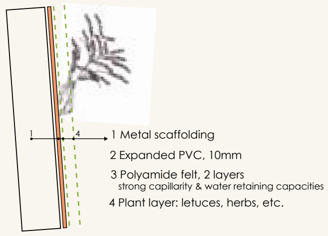
In a densely populated city, the space for agriculture has to be efficiently used in order to increase crop productivity and diversity. Patrick Blanc, botanist at the CNRS (Centre National de la Recherche Scientifique) in France, is the inventor of the "plush green wall", a vertical garden which enables plants to grow upright. There is a great variety of plants which can grow on green walls, ranging from perennials, shrubs, as well as grasses and sedges, to green vegetables as all types of lettuce or herbs needing humid soil as parsley.

The plants' roots are inserted between two layers of a one-inch-thick polyamide felt. These are stapled to plates of 10 mm thick expanded PVC fixed to a metal structure. A void separates the two layers; holes in the first plush mantle enable the insertion of the plant' roots at a density of 10 to 20 plants per square metre. The felt layers have a strong capillary and water retaining capacity. Combined with a drip irrigation system delivering a continuous flow of diluted nutrient solution, they enable the plantation of various crops. A gutter at the base of the wall collects the overflow; the excess water is sent back to the top of the wall in a closed loop.

Such organic walls have been installed at the Fondation Cartier, as well as on facades of the Musée du Quai Branly in Paris.

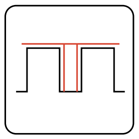
Source: Teresa Gali-Izard, Land&Scape Series: *The same landscapes, ideas and interpretation*, (Spain: Gustavo Gili, 2005)

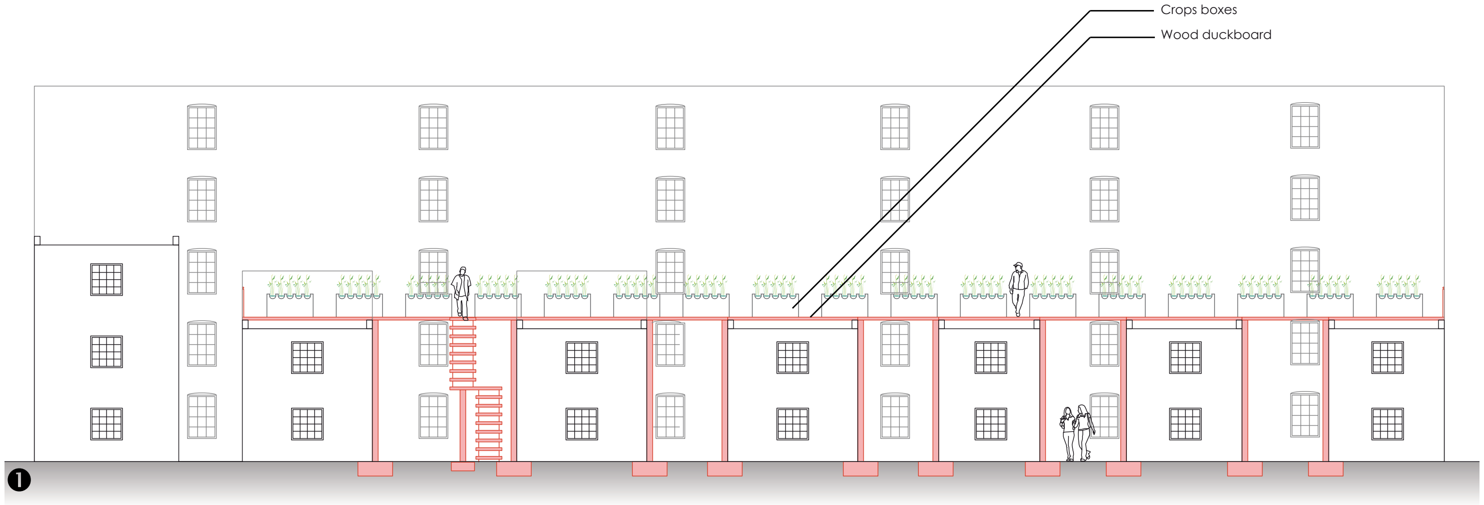


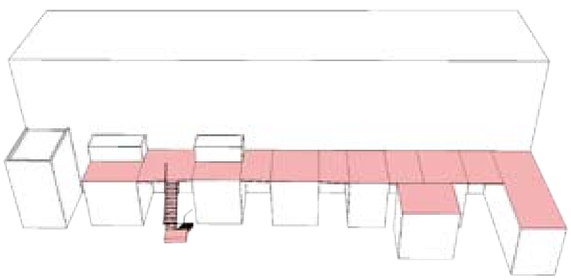
### II. 5 Creating productive surfaces

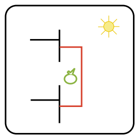
The terraced houses that constitute this part of the campus are all the same height; yet, their roofs are too high to allow easy access from the ground and are thus difficult to use for farming. Lower buildings punctuate the backyard side, but though most of them are at the same level they form a discontinuous surface.






As the space between the low buildings is poorly used, it is possible to cover it and join all the roofs with a light steel structure that allows the creation of a large continuous surface. ❶ The new structure, as well as the roofs of existing buildings, is covered with a light wood or metal duckboard which can accommodate crops boxes or racks. The duckboard is slightly higher than the original roof level of the low buildings in order not to obstruct the windows of the main buildings.





## II. 6 The productive double façade

The double façade is an increasingly popular bio-architectural device which enhances buildings' thermal inertia and thus lowers the need for heating. Basically, the air imprisoned between the two facades acts as a buffer and absorbs the fluctuations of outside temperature.

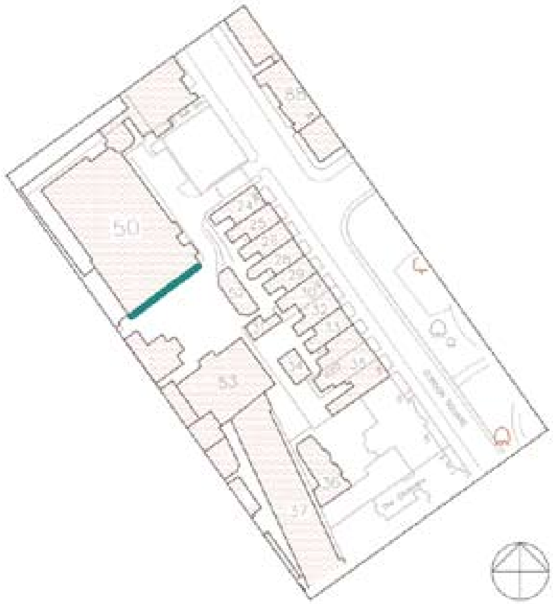
The space between the two facades can be accessible (like a veranda) but most of the time it is just lost space. This space, though narrow and vertical, could be made productive in order to increase the sustainability of the double façade system as well as its economic viability. In addition, it would also improve the external as well as the internal visual aspects of the façade, when seen from the street and from the inside.

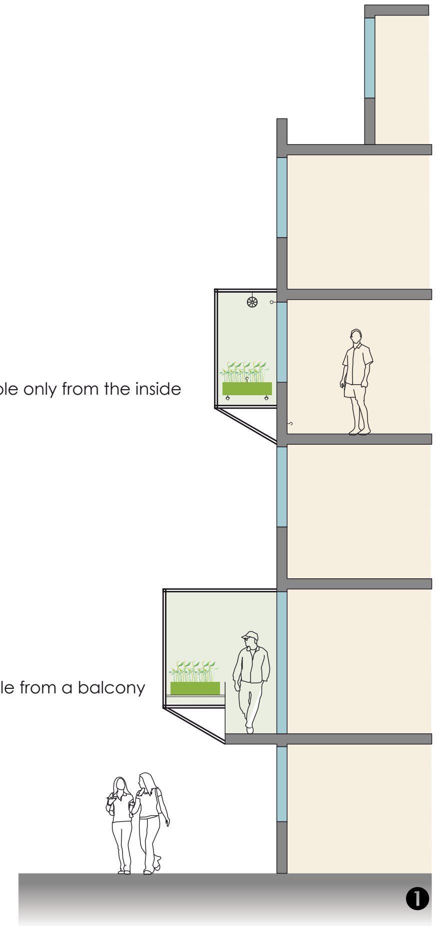
Two systems ❶ are tested in the productive lab. Both consist of light, modular glass structures that are one-storey high and accommodate hydroponic cultures. They are anchored into the façade. They can be either deployed on a part of the façade or on its whole.

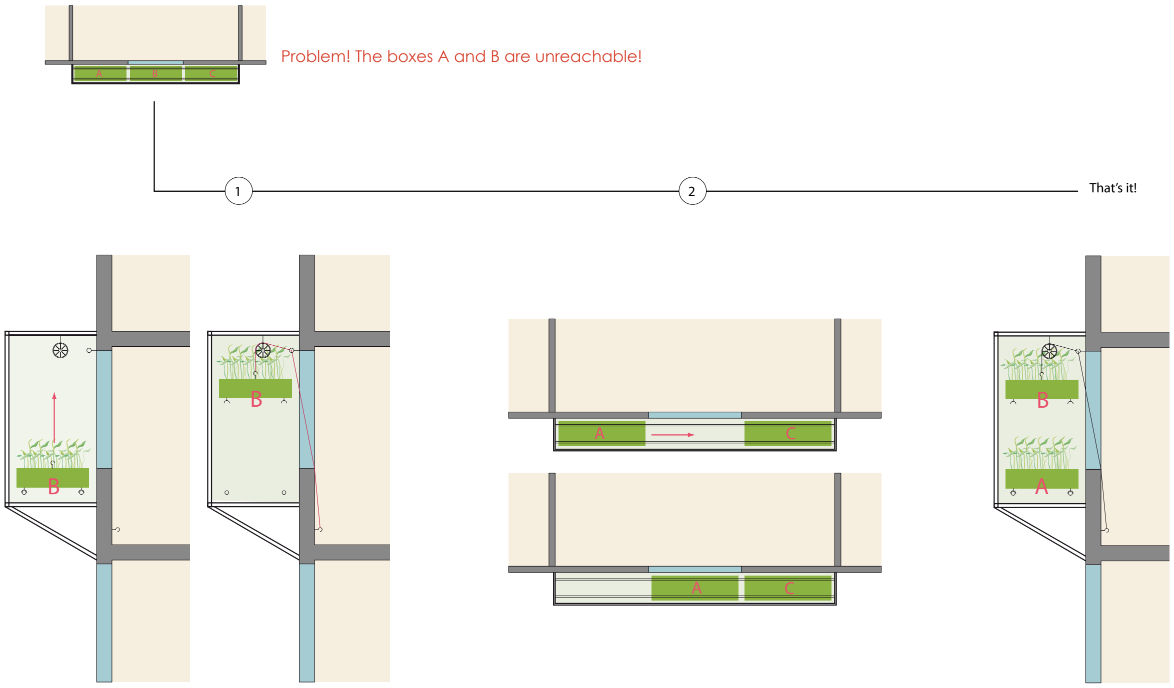
In the first system, the structure is approximately 1 metre wide. Crops are only accessible through the windows. Crops that are not directly located next to a window can be moved thanks to a "lift-and-slide" system ❷. As harvesting have to occur from within the building, this type of double façade is not suitable for all kinds of situations. Windows giving light to public or semi-public spaces such as corridors or large halls are preferred in order not to disturb private spaces.

In the second system, the structure is wider and embodies a balcony, either existing or new (an existing one is used in the case of the lab). Thus, crops are accessible from outside and harvesting can occur while people study or work inside. To make things even easier, the intermediate space between the two façades can have its own independent access.

The first system uses hydroponic aggregate cultures, as crops must be moved and therefore kept in independent boxes. In the second system, the more efficient continuous flow system is used. 18







## Hydroponics [18]

The first know reference to soilless culture dates back from Sir Francis Bacon's book Sylva Sylvarum published in 1627. Since then, hydroponics has been intensively studied by scientists. It finally got out of labs and started to be actually used in agriculture from the 1930s. The two main types of hydroponics are solution culture and medium culture. In solution culture, no solid medium is used for the roots: crops only grow in a nutrient solution. The medium culture method has a solid medium for the roots, which can be sand, gravel, rockwool, perlite, etc.

There are three main types of solution culture:
- Static solution culture: Plants are grown in containers of nutrient solution. The nutrient solution is changed either on a predefined schedule or when the concentration drops below a certain level.

- Continuous flow solution culture: The nutrient solution constantly flows past the roots. The most common version of this type of hydroponics is NFT (Nutrient Film Technique), in which the plants grow through light-proof plastic films placed over shallow, gently sloping channels. A steady flow of nutrient solution is maintained along the channel. This is one the most productive techniques, but the downside is that it is very sensitive to interruptions of the flow, due for example to power outages.

- Aeroponics: The roots of the plants are suspended in a darkened chamber and periodically covered with a mist of nutrient solution.

The three main variations of medium culture are:
- Subirrigation: The medium generally has large air spaces, allowing ample oxygen to the roots. The container where plants grow sits in a shallow layer of nutrient solution, which is delivered to the roots by capillarity. This method requires little maintenance, only occasional refilling and replacement of the nutrient solution. Thus it is often used for display plants in buildings, but not much in agriculture.

- Flood and drain (or ebb and flow) subirrigation: At regular intervals, a simple timer causes a pump to fill the container with nutrient solution, after which the solution drains back down into a reservoir. This keeps the medium regularly flushed with nutrients and air.

- Top irrigation: Nutrient solution is periodically applied to the medium surface, for example by drip irrigation. [25]

Most commercial hydroponic cultures are found within greenhouses, because outdoor its economic profitability would be put at risk by climatic conditions (heavy winds, hail…) or pests.

## Aquaponics

An interesting recent development of hydroponics is aquaponics. Aquaponics is the combination of aquaculture and hydroponics. Plants and fish are grown together in one integrated system, forming a mini-ecosystem: the fish waste provides a food source for the growing plants and the plants provide a natural filter for the water the fish live in. Commercially, aquaponics is in its infancy but the technology evolves fast.

Sources:
Wikipedia, Hydroponics, http://en.wikipedia.org/wiki/Hydroponics
Aquaponics, http://www.aquaponics.com/

Wikipedia, hydroponic, NASA, http://en.wikipedia.org/wiki/Hydroponics

http://aquanic.org/images/photos/ill-in/hydrorot.jpg

Top irrigation, Grodan stonewool, www.hydroponics101.com

**For further information**
NASA - Farming for the future, http://www.nasa.gov/vision/earth/livingthings/biofarming.html

## II. 7 Growing in the dark

A disused and dark basement can be reclaimed in order to test different techniques of fully artificial environments. In these environments, high tech lighting is used as well as temperature, moisture and ventilation control.

One of these techniques, called "artificial ecosystem" ❶, consists in stacking vertically a large number of hydroponically-grown plants all around a single light source.

(1) The Vertical Farm project, Feeding 50,000, study conducted by Dickson Despommier, http://www.verticalfarm.com/plans-2k4.htm

It is estimated that plants require an average of 25 W/m² in order to grow in an artificially-lit environment (1). Different sustainable solutions are studied in order to provide the electrical energy required for the lighting.

- Wind power: considering that urban wind turbines can provide up to 1000 kWh per year, (26) it is estimated that a 100 m² field lit 12 hours a day would need 11 wind turbines. ❷

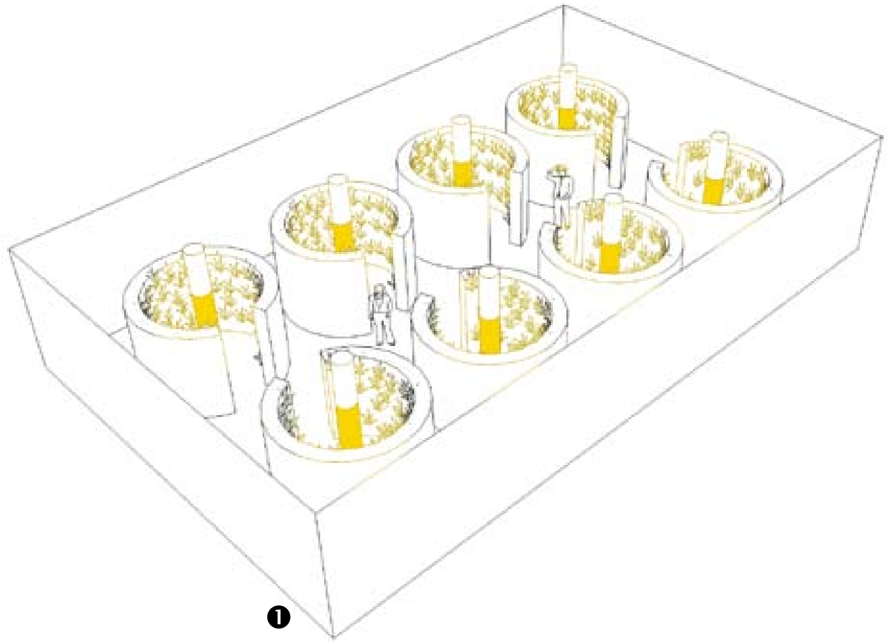
- Solar power using PVs: in London, a 10 m² panel can produce up to 850 kWh per year . (20) Thus, 100 m² of fields lit 12 hours a day require 130 m² of photovoltaic panels. ❸

However, in both cases, storing electricity depending on climatic conditions is expensive and implies great losses.

In reality, in order to provide constant lighting conditions to the plants, electricity would be topped up from or sent to the grid, according to actual climatic conditions.

Moreover, it seems difficult to find room for 11 wind turbines or 130 m² of PVs for every 100 m² of plants growing in the dark. Thus, it is unlikely that this energy-devouring experiment will go any further than the lab phase.

As a cheaper alternative, the same kind of basement can be used in order to experiment mushroom farming techniques ❹. Those require specific moisture conditions but no light at all.



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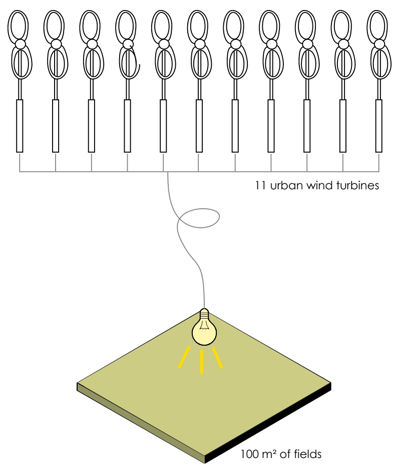
"artificial ecosystem"- closed, Les jardins suspendus, www.lesjardinssuspendus.com

"artificial ecosystem"- opened, Les jardins suspendus, www.lesjardinssuspendus.com

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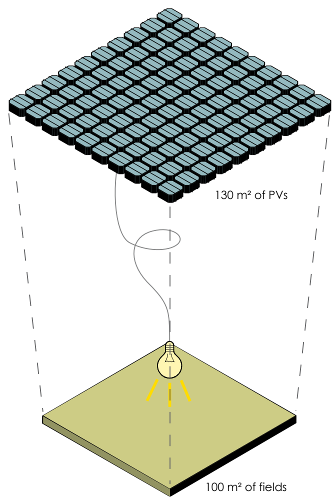


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Mushroom farms, http://prilep.club.fr/galerie2/champi/galerie.htm ❹

### The Pasona O2 urban farm in Tokyo 19

In 2005, an underground urban farm has been set up beneath a 27-floors office building in Tokyo's Otemachi business district, in a 1,000 square metre former bank vault occupying the 2nd of the 5 basement floors. This project was launched by the recruitment company Pasona when it moved its headquarters to this building. The project was conceived as a means of providing agricultural training to young people having trouble finding employment and middle-aged people in search of a second career. Through its Agriculture Internship Project in the village of Ogata, Akita Prefecture, Pasona, along with Kanto Employment Organization Inc, already offered on-the-job training on a real farm to about 100 aspiring farmers, including young people and middle-aged businessmen.

The Tokyo high-tech farm grows lettuce, tomatoes, flowers, herbs, strawberries and even rice in a terraced paddy field. It is maintained using computer-controlled artificial light and temperature management. The vegetables are grown by a pesticide-free method in which fertilizer and carbon dioxide are delivered by spraying. Hydroponics is one of the methods of cultivation used. The lettuce crops require one month to grow from seed to harvest, which is a growth rate 3-4 times faster than lettuces traditionally cultivated in outdoor farms, and the farm is capable of producing 7,000 lettuce heads daily, all year long. Crops is planned to be used as ingredients in Pasona's canteen. Technical assistance in setting up the indoor farm was provided by Professor Masamoto Takatsuji of Tokai University, who is researching such projects, which are known as "plant factories".

The organizers plan to keep the facility in Tokyo open to the public to enable businessmen and office workers to drop by and experience high-tech farming on their way home from work.
If the farm was a success after its first harvest in early summer 2005, Kanto Employment Creation Organisation together with Pasona planned to open more basement farms.

The Pasona initiative is particularly interesting in that it has been set up for educational and training purposes, which indicates that there may be high added value in farming jobs. However, this also tends to illustrate that such a high tech installation would be far from viable should its economy rely solely on the sale of crops.

Source: Web Japan, Trends in Japan, http://web-japan.org/trends/lifestyle/lif050317.html

http://www.city.chiyoda.tokyo.jp

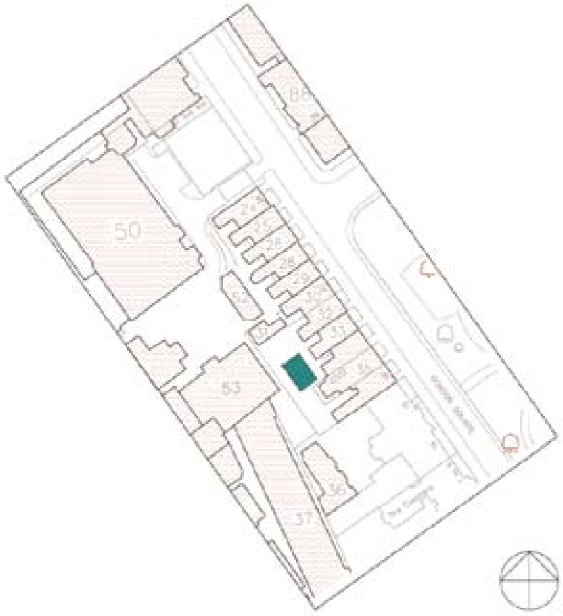
http://www.city.yokosuka.kanagawa.jp

http://www.city.yokosuka.kanagawa.jp

**For further information**
Pasta & Vinegar, Nicolas Nova's weblog, http://tecfa.unige.ch/perso/staf/nova/blog/2005/06/20/fruit-and-vegetables-grown-under-office-building/

## II. 8 Transparent greenhouse

In the middle of a large courtyard, a low modular building fractionates the space and hinders the use of the courtyard as one single field. Yet, this building is used for academic purposes and cannot be removed.



In order to make the maximum use of this otherwise lost space and leave the rest of the courtyard farmable anyway, a multi-storey greenhouse can be designed as transparent as possible: its transparency enables sunlight to reach the cultivations that it accommodates and at the same time helps to avoid casting large shadows over other parts of the courtyard.

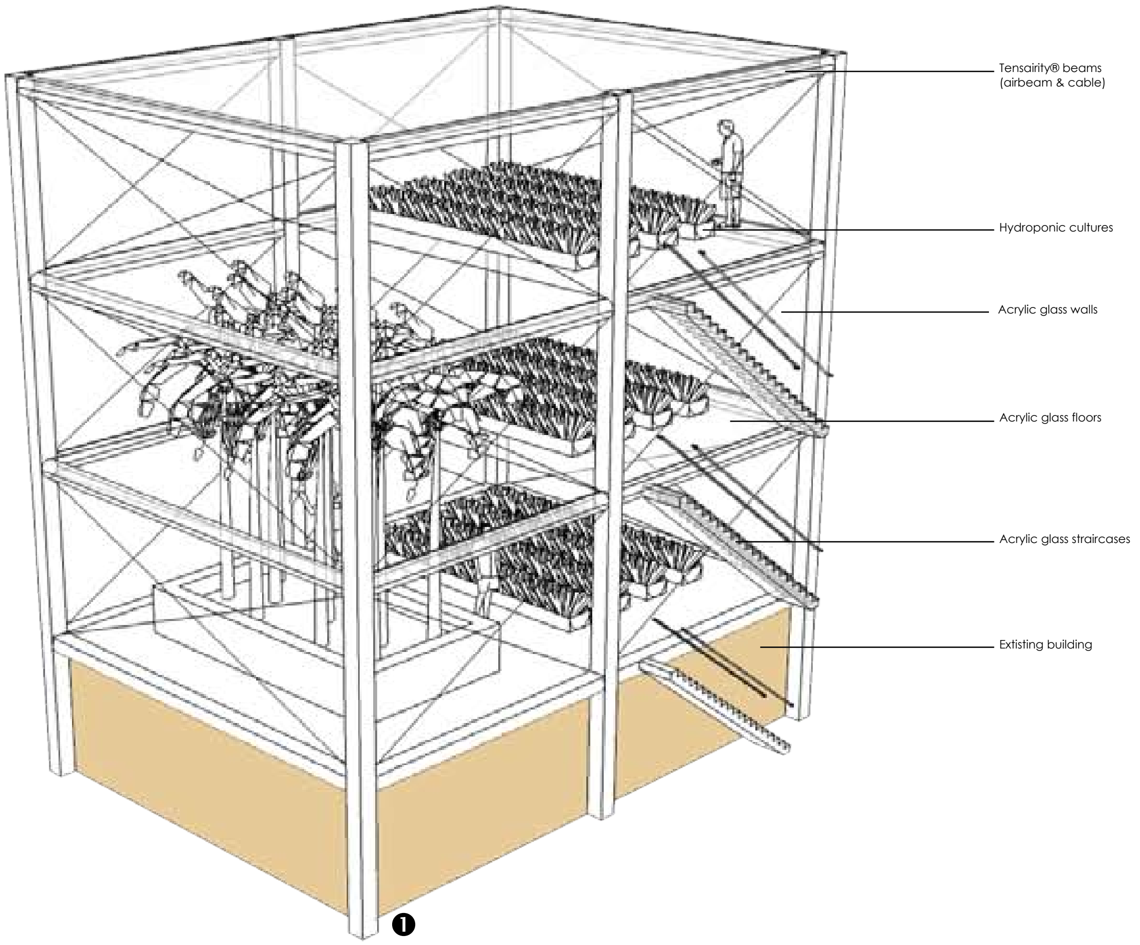
In order to reach this high level of transparency, high tech transparent materials can be used for walls and floors (such as acrylic glass) and even for some structural elements (for example, translucent tensairity® beams). 22 This greenhouse is able to reach high temperatures in summer, even allowing to grow some tropical fruits. ❶

Yet, just like any greenhouse, it needs to be heated in winter if we want to ensure year-round crops. Considering that the energy consumption of a well-designed greenhouse is approximately 7.5 kWh/m²/100degree.day (degree.day is the difference of temperature between inside and outside ❷ multiplied by the number of days of heating) (1), it requires a minimum of 135 kWh/m²/year in London in order to maintain a constant 18° inside the greenhouse.

This energy can also be provided directly by the

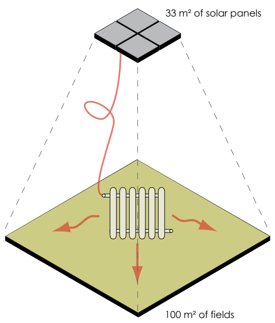
| | Average min temperature | Average max temperature |
|---|---|---|
| January | 2 | 6 |
| February | 2 | 7 |
| March | 3 | 10 |
| April | 6 | 13 |
| May | 8 | 17 |
| June | 12 | 20 |
| July | 14 | 22 |
| August | 13 | 21 |
| September | 11 | 19 |
| October | 8 | 14 |
| November | 5 | 10 |
| December | 4 | 7 |

❷ (Source: BBC Weather, http://www.bbc.co.uk/weather/world/city_guides/

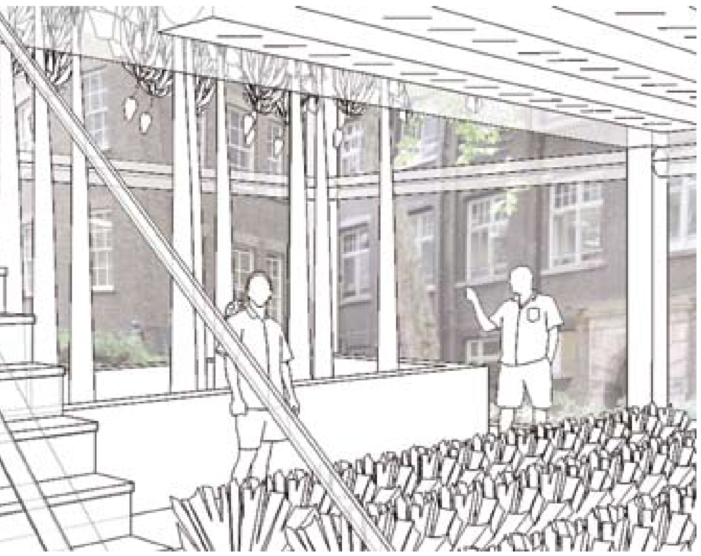



(1) Connaissez-vous la performance énergétique de vos serres, Institut Québécois du Développement de l'Horticulture Ornementale, http://www.agrireseau.qc.ca/horticulture-serre/documents/GBILODEAU.pdf

sun through solar thermal panels (1 m² of panels produces 400 kWh per year). This means that 100% of the greenhouse needs can easily be provided naturally, either in a passive way (in summer) or using active solar systems (in winter). This requires a solar thermal installation one third of the size of the greenhouse's footprint.




The size of the solar panels could even be reduced, considering that, contrary to electricity, heat is easy to store over season, for example in the form of water in an underground tank: surplus heat within the greenhouse could be captured in summer and released in winter.



## Solar energy using photovoltaic panels (20)

Photovoltaic panels convert sunlight into any form of electrical energy. However, only about 4 to 22% of the energy falling on a solar panel is converted into usable electrical energy. The efficiency is quite low because the rest of the solar light is reflected back or dissipates as heat.

Usvat Corporation Energy Department, http://www.mathematicsmagazine.com/

There are three generations of photovoltaic panels: monocrystalline panels, polycrystalline panels and amorphous silicon panels. The latter are a recent breakthrough: they are far less expensive to produce, though less efficient.

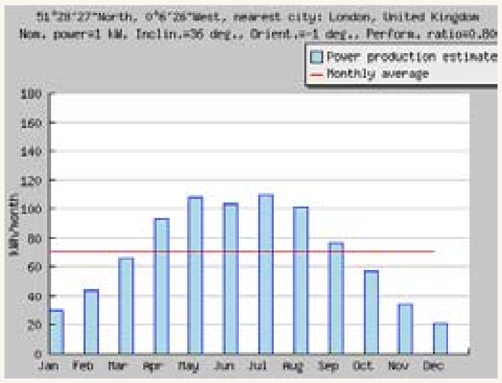
A photovoltaic panel with a peak power of 1 kWp (which corresponds approximately to 10 m² of polycrystalline modules) will produce up to 850 kWh per year if it is installed towards the south with an optimal angle of 36°. This of course fluctuates in the year according to actual sun conditions.

In 2004, 2,261 kW of photovoltaics were installed in the United Kingdom. This is a step towards sustainability, but a minor one compared to the 363,000 already installed in Germany…

Sources:
Wikipedia, Solar cell, http://en.wikipedia.org/wiki/Solar_cell
European Union, Solar Electricity Action SOLAREC, http://re.jrc.cec.eu.int/

| Month | Production per month (kWh/month) | Production per day (kWh/day) |
|---|---|---|
| Jan | 30 | 1.0 |
| Feb | 44 | 1.6 |
| Mar | 66 | 2.1 |
| Apr | 93 | 3.1 |
| May | 108 | 3.5 |
| Jun | 103 | 3.4 |
| Jul | 109 | 3.5 |
| Aug | 101 | 3.3 |
| Sep | 77 | 2.6 |
| Oct | 57 | 1.8 |
| Nov | 34 | 1.1 |
| Dec | 21 | 0.7 |
| Year | 70 | 2.3 |
| Total yearly production (kWh) | | 842 |

http://re.jrc.cec.eu.int/pvgis/pv/




**For further information**
See http://re.jrc.cec.eu.int/pvgis/pv/ for an assessment of solar energy resources in Europe
British Photovoltaic Association, http://www.greenenergy.org.uk/pvuk2/index.html

### Solar thermal energy

21

Solar energy can provide a significant part of the domestic needs in hot water (50 to 75%) and heating (15 to 25%). Such installations are more and more frequent, at least for hot water. Though we found no evidence that this has ever been done, there is no reason to think they could not be used in winter as a complementary source of heating in solar greenhouses. In order to improve their profitability the heat produced in summer could be stored underground to be released in winter.

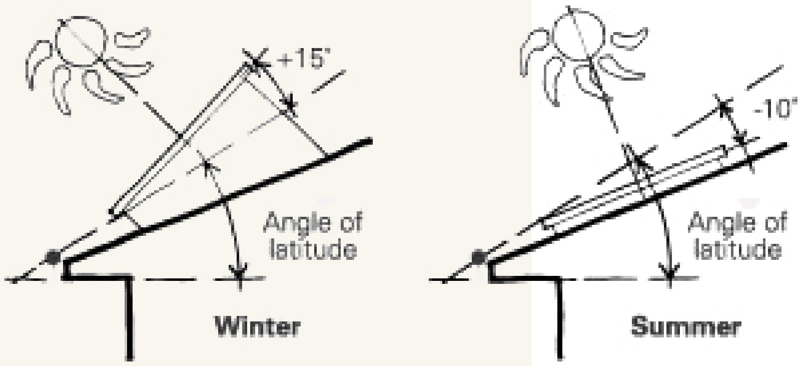
Solar thermal systems are generally composed of solar thermal collectors (panels), a fluid system to move the heat from the collector to its point of usage, and a reservoir to stock the heat for subsequent use.

Small-scale systems in the London area can be expected to provide about 400 kWh/m² per year.

Sources:

Wikipedia, Solar hot water, http://en.wikipedia.org/wiki/Solar_hot_water
Randall Thomas (ed), Sustainable Urban Design: An Environmental Approach, (London: Spon Press, 2003)

Wikipedia, http://fr.wikipedia.org/wiki/Chauffe_eau_solaire




Australian Greenhouse Office, www.greenhouse.gov.au



## New materials for urban agriculture

22

Designing farmable plots and greenhouses in a dense urban context has to face one major challenge: sunlight. Indeed, artificial lighting is extremely energy-devouring (cf. “growing in the dark” above) and natural sunlight must be favoured whenever possible. It must thus be channelled, transmitted or reflected according to situations.

To help the designer in this task, technology provides a new range of materials that reach today a very high level of efficiency:

- Aluminized biaxially-oriented polyethylene terephthalate (boPET), often better known under its commercial name Mylar, can reflect up to 99% of the light, including much of the infrared spectrum. It is already used indoor to make the most of artificial lighting in some hydroponic farms. It could be used outdoor as a wall coating redirecting light into a shaded courtyard, for example.

http://www.green-touch.ch

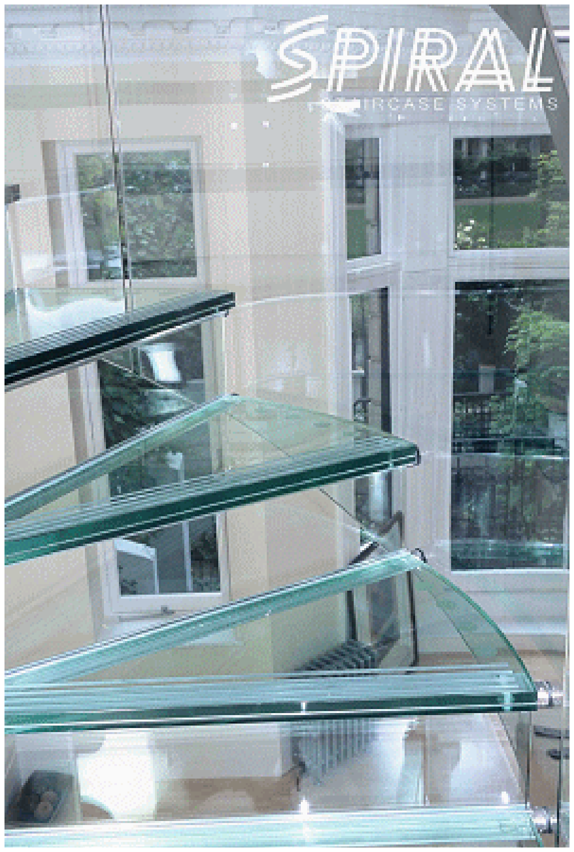
- Most glazing materials used in modern greenhouses are plastics, such as polyethylene, laminated acrylic or fibre-reinforced plastic. They allow the greatest amount of solar energy to enter while minimizing energy loss. They can transmit up to 90% of the light they receive. Their average lifespan can also enhanced by the use of UV-degradation inhibitors. Materials that diffuse light rather than transmitting it directly must be preferred because structural supports of the glazing tend to cause shadows with direct sunlight, resulting in an uneven plant growth.

- Multi-storey greenhouses could make use of materials with very good levels of transparency for their very structure. This is the case of acrylic glass, better known under its trademark Plexiglas, which can transmit up to 90% of the light. Acrylic glass is already used for floors or staircases. This might also be the case of tensairity® structures: this new technology combines the principles of tensegrity with inflatable structures.

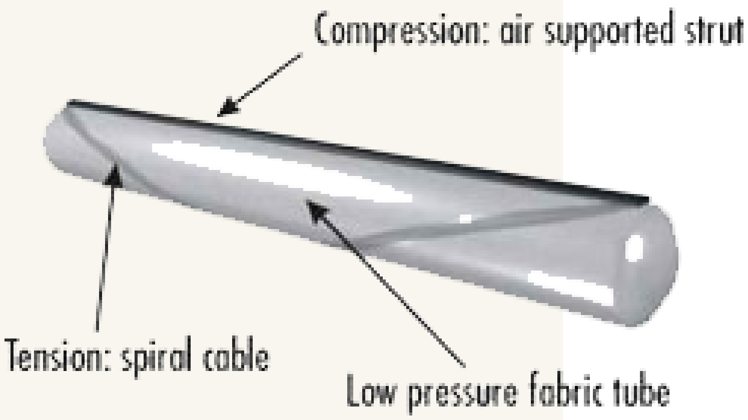
It was primarily developed in order to reduce the weight of large-span structures, but an interesting by-product is the translucency of the beams. However, they are still in a very early stage of their commercial development.

New “smart materials” could also be a future source of inspiration for designers: materials adapting to their environment, changing shape, transparency or colour following variations of temperature or sunlight or controlled by electrical or magnetic fields… The possibilities seem endless, but such materials are still only found in laboratories.

Sources:
Wikipedia, PET film (biaxially oriented), http://en.wikipedia.org/wiki/PET_film_%28biaxially_oriented%29
Wikipedia, Acrylic glass, http://en.wikipedia.org/wiki/Acrylic_glass
ATTRA - National Sustainable Agriculture Information Service, Solar Greenhouses, http://www.attra.org/attra-pub/solar-gh.html
Airlight, the revolution in construction of light weight large span structures, http://www.airlight.biz/
For further information:
Werner Sobek, Walter Haase, Patrick Teuffel, Systèmes autoadaptables in Nicolas Michelin (ed.), Nouveaux Paris, la ville et ses possibles, (Paris: Pavillon de l’Arsenal / Picard, 2005)




Spiral staircase systems, http://www.spiralstairs.co.uk



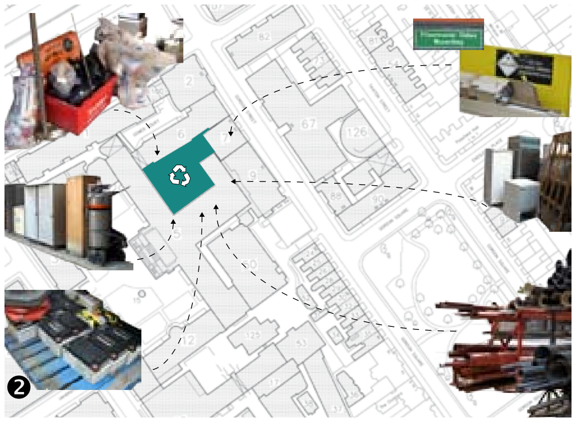

Airlight, http://www.airlight.biz

## II. 9 Composting with the turning bins system

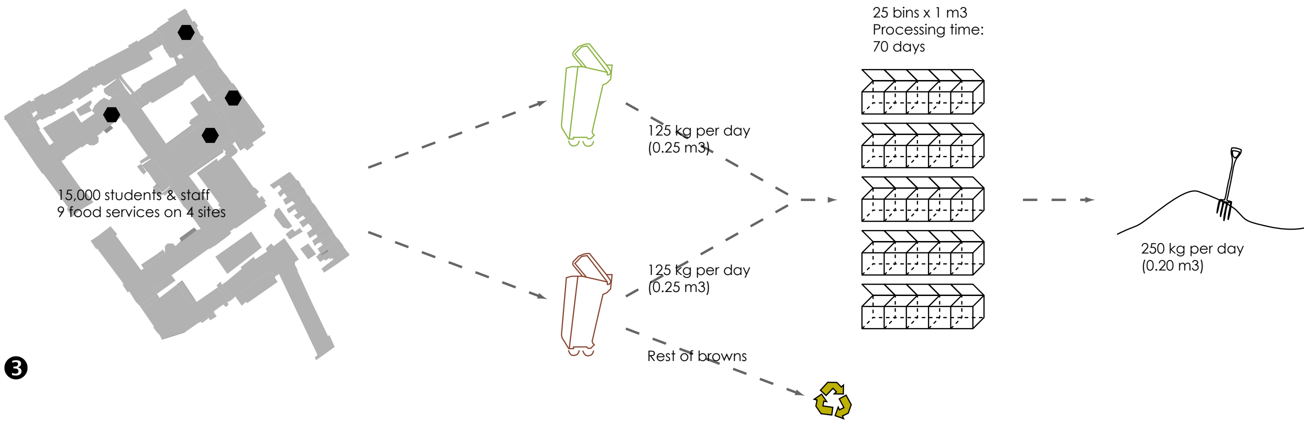
A productive campus is not only about growing food: the whole food cycle must be taken into account. Thus, a fully sustainable approach should also consider organic waste management.
Composting is a good way to loop the loop: using food leftovers and other organic wastes, it produces fertilizers which can be used to improve the soil's fertility.[23] As organic waste collection is directly dependent on people's behaviours, composting programs are also very efficient ways to increase awareness of environmental issues and make consumption habits change.

On the UCL campus, new bins for the collection of "greens" and "browns" are placed within food services, but also within the main administrative services and academic departments, considering that many students and staff buy takeaway food and eat it at their workplace. Everyone is responsible to sort between greens, browns and non-compostable waste. Of course, proper information and advice are provided by posters, leaflets, etc. The collection of green and brown bins is then handled by UCL cleaning and maintenance staff, which is already in charge of handling all other wastes.

At the stage of the productive lab, the system is limited to the central area of the campus in order to allow manual collection using wheel bins ❶. Organic waste is brought to, stored and processed in a large courtyard situated in the centre of the campus, just behind the main refectory's kitchen. This is an ideal situation to optimise collection distances. Moreover, it is visible from the main refectory, which improves students' and staff's awareness of the experiment. Last, this is the place where all recyclable materials are already stored after being collected anywhere on the campus and before removal by specialised companies. ❷ In a way, this place is already dedicated to recycling.



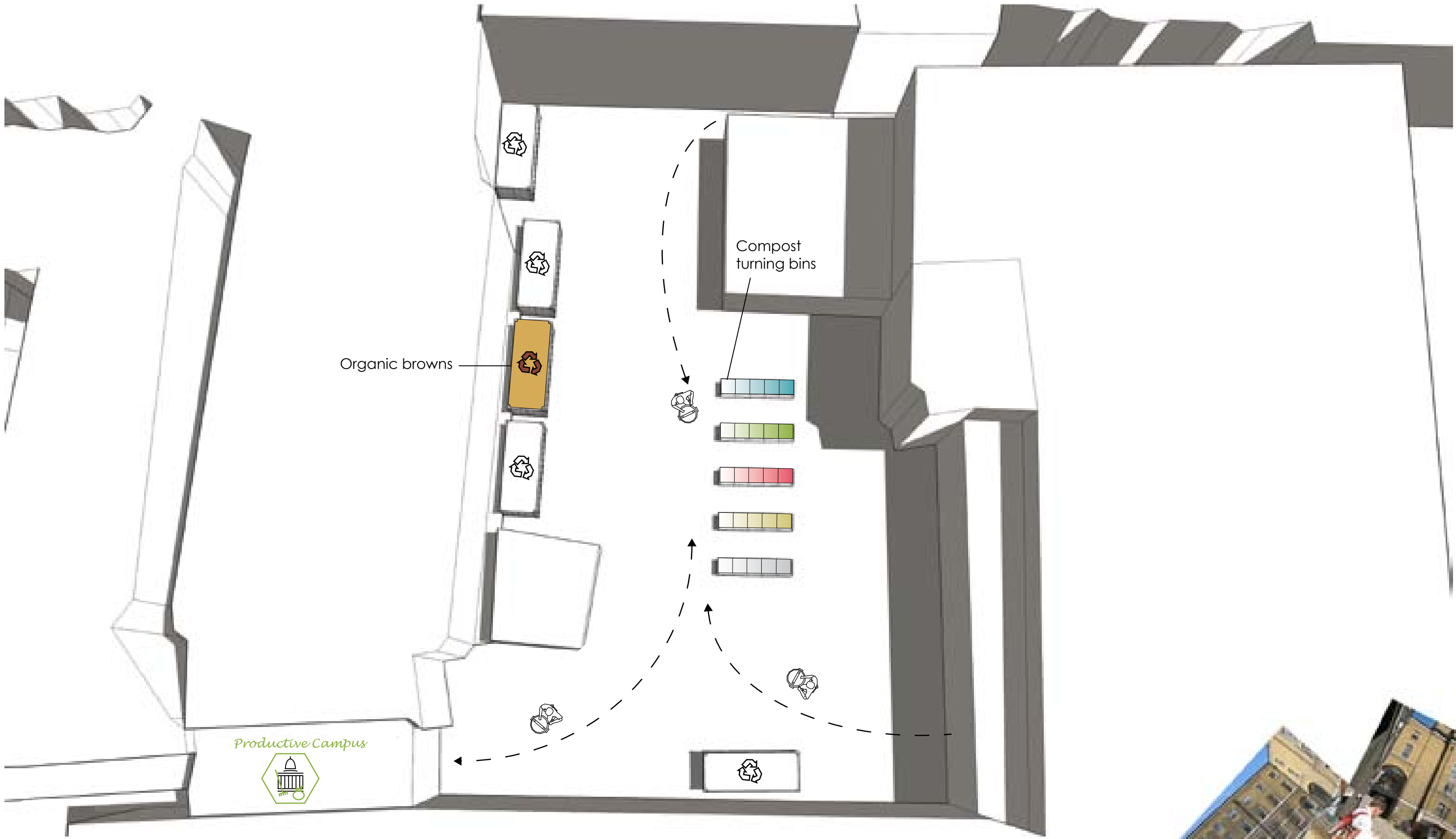
As a cheap way to test the efficiency and acceptability of a composting program on UCL campus, a very simple technique is used in the first place: organic waste is processed in 5 rows of 5 turning bins ❸. Each bin is large enough to store the organic waste collected in two days time. After two weeks, the first bins of each of the 5 rows is full and each bin's content is manually moved into the next bin in the row using a garden fork, allowing aeration of the composting materials. Fresh compost is then harvested from the last bins of each row. This task is performed by volunteer students of the productive lab society. After harvesting, the compost is used on campus within the productive lab.

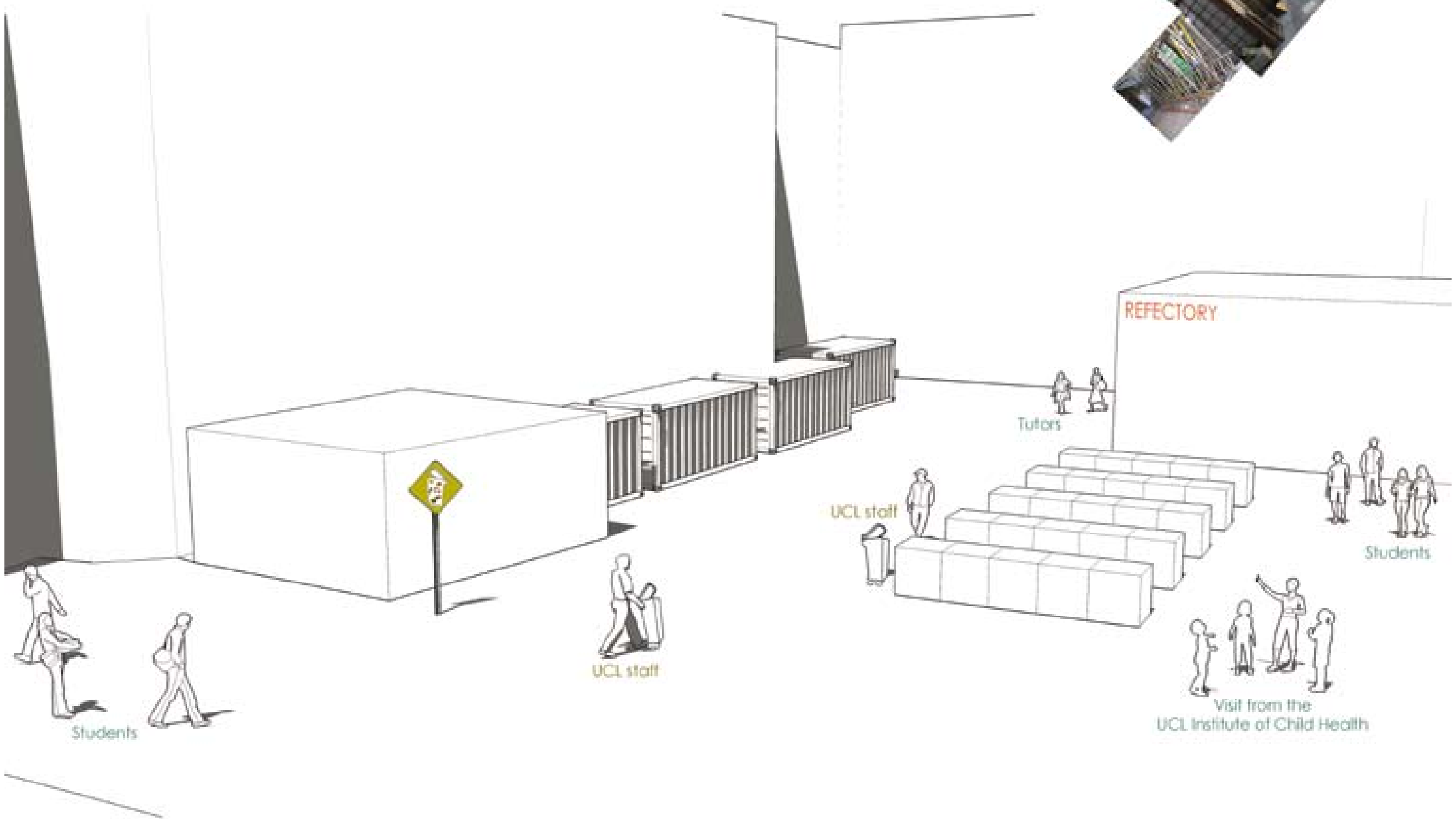




The remaining compost can be sold to students or staff who garden at home. Professional farmers within the Greater London area might also be interested.

This low key composting system will be replaced by a more high tech and efficient system able to cope with large quantities of waste in the productive campus stage.


Compost
turning bins
Organic browns
Productive Campus


REFECTORY
Tutors
UCL staff
Students
UCL staff
Students
Visit from the
UCL Institute of Child Health

## What is composting? 23

Composting is the controlled decomposition of organic remains in order to produce a substance (called compost) that is excellent for enriching soils.

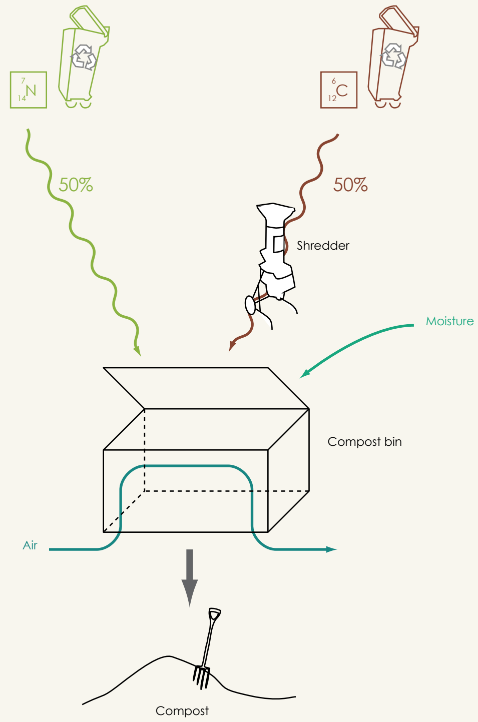
There are many different techniques of composting, some of them very easy to put into practice at a domestic scale and others more suitable for large-scale or industrial uses.

There are many composting agents at work in a compost pile, such as fungi, slugs, earthworms, etc. The main ones are bacteria. Composting bacteria are aerobic, which means that they require air in order to fulfil their function. Without air, anaerobic bacteria take over: the resulting decomposition process tend to give away a strong putrefaction odour. If there is enough air passing through the compost pile, the composting process should be odourless.

In broad terms, there are two major kinds of food that composting agents need:

- "Browns" are dry materials such as straw, dry brown weeds, autumn leaves, wood chips, sawdust or even cut up cardboard. They often need to be moistened before they are put into a compost pile. They are mainly a source of carbon.

- "Greens" are fresh and moist materials such as green weeds, fruit and vegetable scraps, green leaves, coffee grounds and tea bags, etc. Greens contain mainly nitrogen.


Meat, fish and cheese or milk products can also be used for composting, but as they are very attractive to pests (especially rodent pests which might carry diseases) they are usually banned. They might be used in highly controlled and engineered composting systems.

Designing a good composting system is a matter of providing the proper environmental conditions for its ecosystem. Two parameters are particularly important in this regard: moisture content and carbon to nitrogen (C/N) ratio. A good mix of browns and greens is thus the best nutritional balance for the microorganisms involved. This mix also helps out with the aeration and amount of water in the pile. Browns, for instance, tend to be bulky and promote good aeration. Greens, on the other hand, are typically high in moisture, and balance out the dry nature of the browns.

One last factor is heat: there is no minimal temperature condition to composting, but hotter piles will decompose faster. Thus there is a minimum pile size (approximately 1 cubic meter) that guarantees a sufficient heat within the pile for a reasonably fast decomposition process. In winter, the process will tend to slow down or even stop, but it will start again when temperatures rise again.

Main composting techniques include:

- Windrows: They are large piles of composting materials that are piled up, occasionally turned and allowed to decompose. It requires a tilling machine and is labour-intensive as well as space-consuming. It is thus inadequate to an urban context.

- Wooden bins: This is a cheap option of composting based on "back-yard" composting. It requires little attention, even if some manual tilling is sometimes necessary. The problem of cheap bins is that it may let odours out and attract pests; thus it should also be avoided in a densely built context.

- Turning systems: This system deals with larger quantities of material. It involves a series of fixed bins in which each bin would hold the composting material during one stage of the decomposition process. Each time the first bin is full, the content of each bin in the row is manually moved to the next bin, which aerates it and accelerates the composting process. Finished compost is removed from the last bin. If the quantity of waste is important, the shifting from one bin to the next can be mechanized.


Turning bins in the Parc de la Ciutadella, Barcelona

- Rotating systems: In those systems, small bins are rotated every day so to aerate the ingredients and remix them. This can accelerate the process quite dramatically.

Tumbler composter


- Passive composting: This method uses a large pile of composting material that has pipes imbedded in it to provide aeration and remove the need for tilling.

- In-vessel (engineered) systems: They are sealed; self-regulating systems that automatically regulate the various pertinent factors of composting (like temperature, moisture and oxygen levels). They also usually have bio filters to remove odours from the exhaust air. They are more compact and compost at an accelerated rate due to optimized conditions. Of course, they are more expensive.


In-Vessel system, The Earth Tub, http://www.gmt

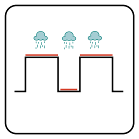
In-Vessel system, The Earth Tub, http://www.gmt

- Worm bin composting or "vermicomposting": Vermicomposting requires a special worm species that is adapted to living in decomposing organic materials rather than in the soil. With the exception of holes for drainage and ventilation, worm bins are completely enclosed, which keeps away pests. They can even be kept indoors and are well adapted to office use.

When designing a composting program, a fundamental choice must be made concerning its scale. De-centralised composting minimises transportation but requires "backyard" solutions that are less efficient and more labour-intensive, as more efficient techniques are not viable. Centralised composting makes those techniques viable (which help include in the program all organics, including meat, fish and dairy products, reducing sorting problems) but requires more transportation. A last option is off-site composting, in which the organics are sent to an external, larger composting facility, maximising transportation but increasing efficiency and economic viability.

Sources:
Compost guide, http://vegweb.com/composting/
Cornell composting website, Cornell Waste Management Institute, Cornell University, http://compost.css.cornell.edu/Composting_homepage.html

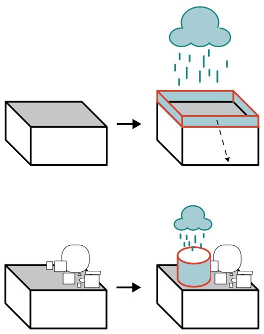
Composting can be made fun for kids

## II. 10 Saving water

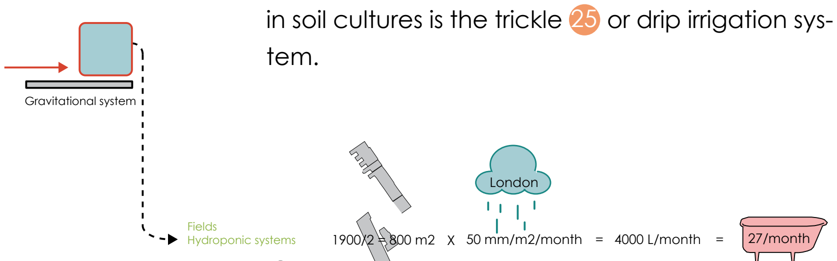
To be fully sustainable, urban agriculture has to foster a more effective use of water. The first step to do so is to collect rain water from the roofs.

Four water tanks are located on four different places on the roofs of the buildings situated all around the Lab. The roofs are all located approximately at the same height. These water tanks collect rain water falling on the roofs, store it and allow it to be distributed later to the various farmable plots or greenhouses. ❶



As they are located higher than the fields, the circulation of water uses only gravity, which allows to save the energy normally used in the supply process. The system implemented in the Lab enables to collect 4,000 litres of water per month, ❷ which is sufficient to water 100 to 200 m² of crops. (24) A coefficient of effectiveness of 0.5 has been applied, considering that half of the water falling on the roofs only may be actually collected.

An effective irrigation system is also to be considered. In hydroponic cultures, (18) the use of water is already optimised. Another system used widely in soil cultures is the trickle (25) or drip irrigation system.




❷

❶

See Anna's Socio Land Lab for urban green roofs adapted for agriculture

### How much water is needed for irrigation? (24)

The calculation of water used for irrigation in the Lab is based on the average yearly use of water for agriculture in the USA (1), which is approximately 750L/m² per year.

Considering that drip irrigation systems can cut water use by 30 to 70% (2), it has been estimated that between 250 and 500 L/m² of water were needed each year to irrigate crops. This figure only aims to give a general order of magnitude; the actual use of water varies greatly according to crops, climate and techniques used.

(1) Irrigation water use in the USA, http://ga.water.usgs.gov/edu/wuir.html
(2) BBC News, Food at risk as water drips away, http://news.bbc.co.uk/1/hi/sci/tech/396270.stm

### Drip or Trickle irrigation (25)

The drip irrigation – also known as trickle watering system – consists in introducing water slowly, directly to the roots of the plants. Through a network of tubes, pipes and emitters, the system drops the water off either on the earth surface or straight to the roots. Therefore it can be either visible or permanently or temporarily buried (Subsurface drip irrigation or SDI).

Drip irrigation enables an efficient use of water. Indeed it loses almost no water because the drops soak into the soil before they can evaporate or run off. In addition, depending on the crop's needs, the water is only applied where it is required rather than sprayed around over the entire plantation. Drip irrigation also decreases water contact with crop leaves or fruit and consequently reduces diseases associated with high levels of moisture on some plants.
Drip irrigation also enables a more efficient use of agricultural chemicals. Fertilizers and nutrients can be added in the system in order to increase productivity. Since only the crop's root zone is irrigated, chemicals are less likely to deteriorate the soil. Moreover, the system allows a limited application of insecticides when needed in order to control pests.

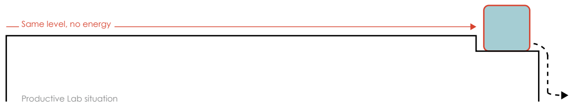
Because it helps to save water, drip irrigation is the preferred system of irrigation in areas where water supplies are restricted, such as desert regions of Africa or United States. Population growth will increase the need for water and therefore there is a true necessity for agriculture to use water efficiently.

Sources:
An introduction to drip irrigation by Clinton C. Shock, http://www.cropinfo.net/drip.htm
Wikipedia, Drip irrigation, http://en.wikipedia.org/wiki/Drip_irrigation

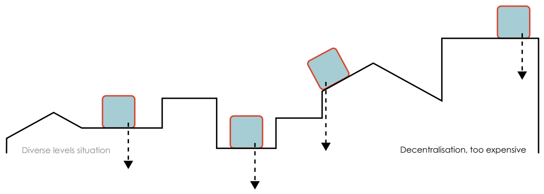


## II. 11 Water harvesting

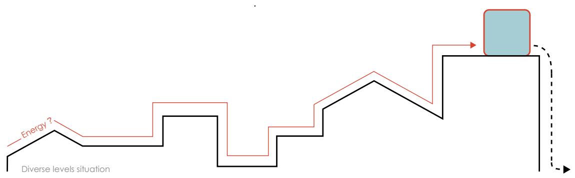
The water harvesting system designed in the Lab may not function in other configurations found in the city. As mentioned, the roofs of the buildings around the Lab are all at the same height, but different situations also have to be considered.



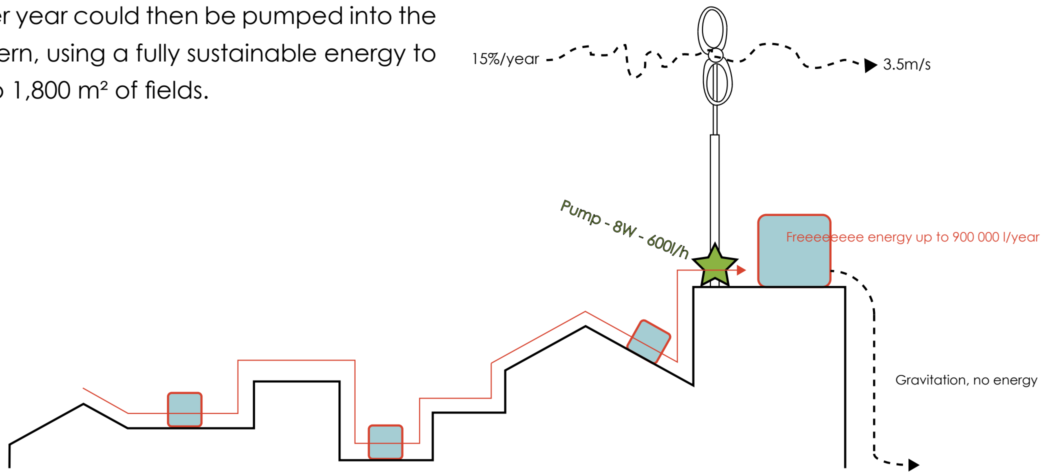

Therefore, we can wonder how to implement an effective gravitational system of water distribution in a situation where all the roofs present different heights? The easiest way to do so is to study carefully the configuration of roofs and farmable surfaces and ensure that each field or greenhouse is supplied by a roof large enough for its needs and situated higher than the crops. However, this is not always possible and would require the use of a large number of small citterns, which is not cost-effective.




Another solution is to consider a larger perimeter for water harvesting, including roofs situated at different heights, and to use a pump in order to bring the collected water to the tanks located on the highest roof. But doing so would use a lot of energy and would not really be sustainable.




Wind is a very effective source of free and renewable energy and can produce about 1,000 KWh/year in London with an appropriate system adapted to cities. 26 Considering the average London wind speed of 3.5m/s blowing 15% of the time yearly, a small urban wind turbine could supply in energy a cheap garden pump, which needs only 8W to process 800L/hour; up to 900,000 litres of water per year could then be pumped into the highest cittern, using a fully sustainable energy to water up to 1,800 m² of fields.




### Wind energy 26

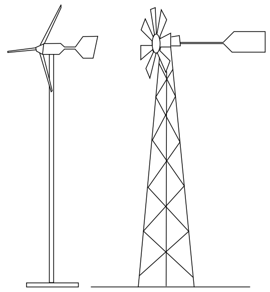
Usual wind turbines, as found in large wind farms, require specific wind conditions to provide enough energy to be profitable. The wind speed must be approximately between 3 and 9 m/s (10-30 km/h), the flow of the wind must be constant as well as its direction. The towers must be 10 to 100 m high to catch the strongest and most constant winds.

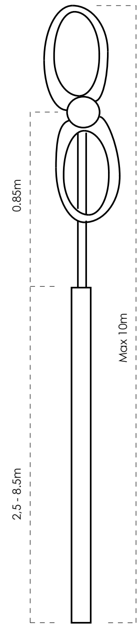
In urban locations, it is difficult to obtain such ideal conditions of wind. Winds are disturbed by the presence of buildings and it is difficult to obtain constant flows and directions.

Small scale turbines are available with a specific design that allows them to make the most of these difficult conditions. Such units are light and thus allow rapid response to wind gusts typical of urban settings. They are also easy to mount, almost like a television antenna. Moreover they make very little noise, certainly negligible compared to the ambient traffic noise.

A typical small scale urban wind turbine will provide between 0 and 3,300 W according to wind conditions. At the speed of 3.4 m/s (which is the London average), it will provide only 10 W. But with twice that speed it will go as high as 100 W. Considering an average annual wind distribution it will produce no less than 1,000 kWh each year.

Sources:
Wikipedia, Wind power, http://en.wikipedia.org/wiki/Wind_power
Randall Thomas (ed), Sustainable Urban Design: An Environmental Approach, (London: Spon Press, 2003)



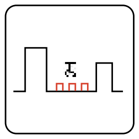



See Nicolas' Erith Productive City for an alternative use of flood for irrigation

**For further information**
Der Windwandler, http://www.windwandler.de/

## III. Experiments involving people

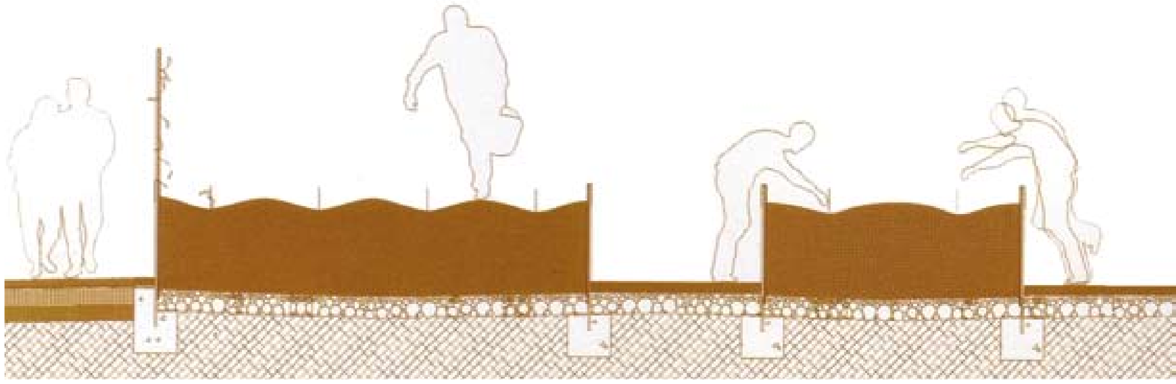
Urban agriculture is not only about growing food; as presented before, the positive aspects of implementing productive sites within a city are various, ranging from environmental or food issues to more social aspects such as reinforcing communities or helping the weakest. The following experiments are implemented during the Productive Lab phase and enable to test social interactions related to urban agriculture and its social benefits.



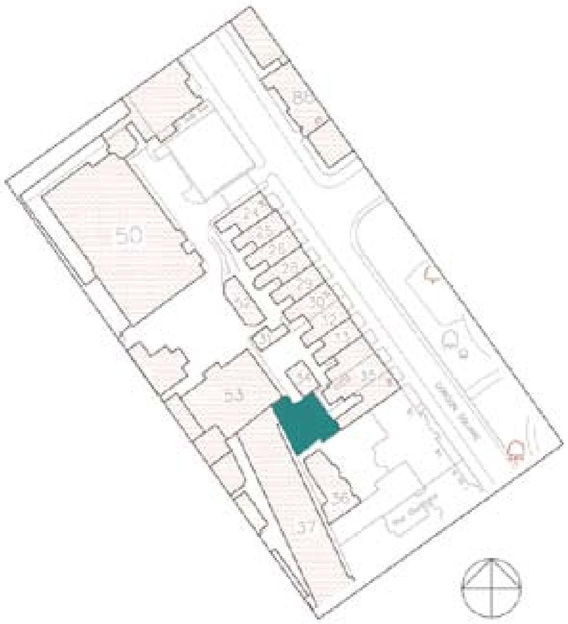
### III. 1 Accessibility

When implemented in a city, productive gardens should be accessible to the greatest number of people, including of course disabled and elder people. However gardening is physically not an easy task for everybody; therefore cultivation systems facilitating the access to crops should be provided.

The use of cultivation tables enable to provide different levels of gardens, allowing more people to easily reach the crops.



Teresa Galí-Izard, Land&Scape Series: *The same landscapes, ideas and interpretation*, (Spain: Gustavo Gili, 2005)




### III. 2 The Main Quad market

Producing food in cities makes less sense if it cannot find its way to the consumer. This relationship between producers and consumers must be as direct as possible, in order to avoid intermediates that lead to increased final prices and food miles.

In the productive lab, the quantity of food produced is modest. It is given in priority to the volunteers who give their time and efforts in order to run it. However, as high-productivity techniques are tested, there is enough food to be sold in local food services managed by the Student Union, and even to create a new market that enhances the visibility of the project.

The new market takes place in the Main Quad, the most central and symbolic space of the campus and the historic heart of the University. Every first Thursday afternoon of the month, the team of the productive lab assembles a few stands and proposes their surplus crops to the passers-by. The quality and low price of the food attracts a large public.

The market will be developed further in the next stage, the Productive Campus.

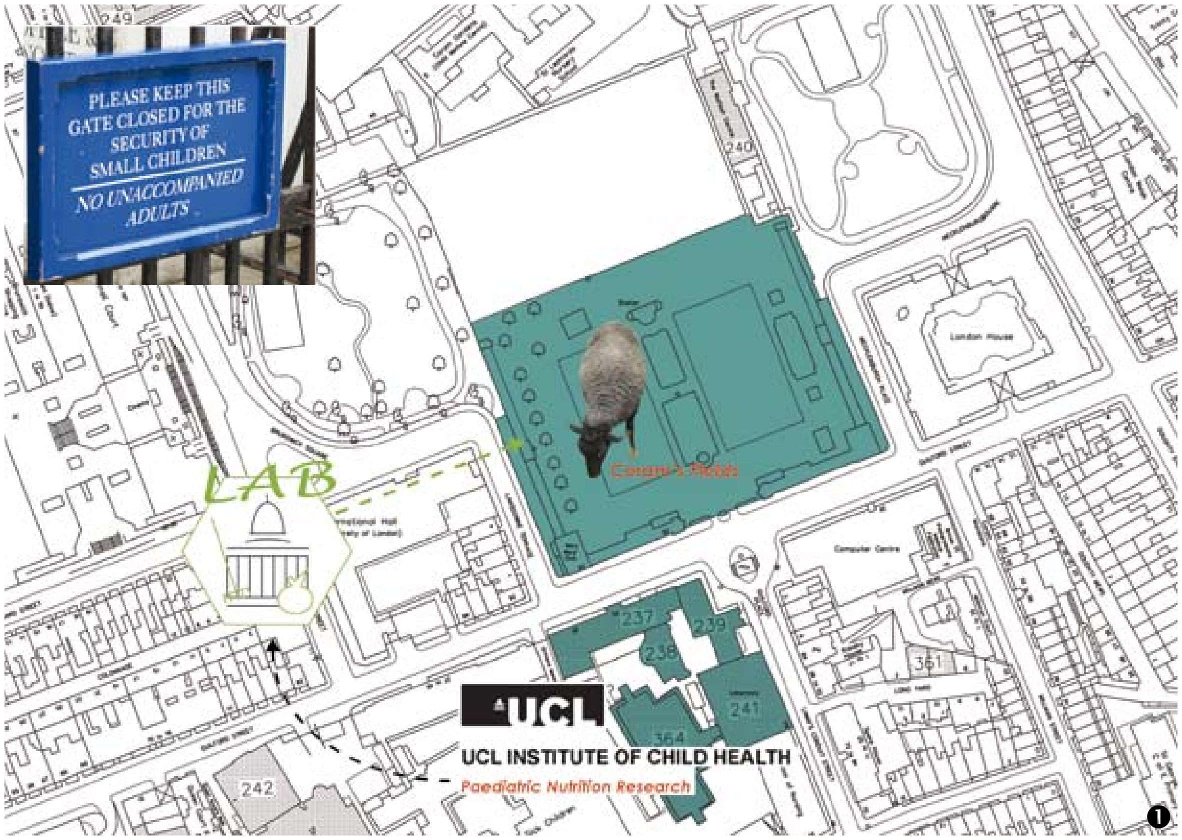
See Nicolas' Erith Productive City for the market as a city landmark

### III. 3 Educational and therapeutic garden

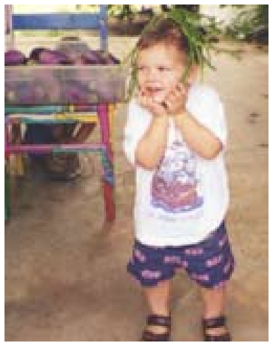
This experiment explores how the Productive Lab strategy could interact with the existing communities of UCL and enhance their relationships.

Located in central London, on Guilford Street, UCL Institute of Child Health is considered as a world-class centre for the study and the treatment of childhood diseases. Different research units and themes deal with various aspects of children illness. Among them the Nutrition Centre "*conducts research on the impact of nutrition on the health and development of infants and children in order to underpin and foster the development of both clinical and public health practice and professional training in paediatric nutrition*"

UCL, Institute of Child Health, Research Themes, http://www.ich.ucl.ac.uk/ich/html/research/biochem.html



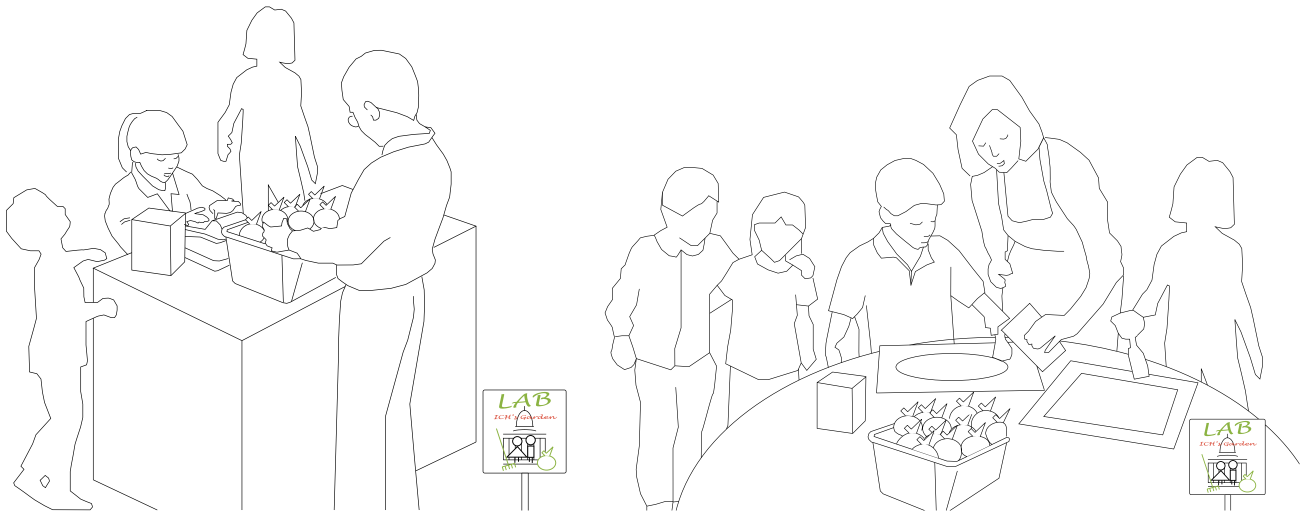

Opposite ICH, on Guilford Street, is Coram's Field, a 7 acres "children only" play area. Coram's Field features all sorts of activities for children of all ages, such as a sports area, a nursery, but also a duck pond and a small farm. ❶



With the help of the Productive Lab team, a partnership between Coram's Field and the nutrition unit of ICH is set. In addition to the diverse activities already proposed in Coram's Field, an educational and therapeutic garden is implemented.

Similarly to what is offered in various City Farms around London, 27 the therapeutic role of urban agriculture is emphasized and used in order to educate, entertain and take care of children, using various games, gardening or cooking classes. Both healthy and ill children from ICH are allowed and can mix together and make new friends.

See Anna's Socio Land Lab for an illustration of an educational garden




**Sources**
UCL Institute of Child Health, http://www.ich.ucl.ac.uk/



### The Spitalfields City Farm in Tower Hamlets 27

Located in a densely populated ward of Tower Hamlets, Spitalfields City Farm occupies a former railway goods depot, next to the lively and multi-cultural area of Brick Lane. Spreading over 1.3 acres of land owned by the borough, the farm hosts various farm animals and grows fruit and vegetable plots. The farm is part of the London City Farms and community gardens organization.

The place offers a wide range of activities and opportunities to the local community and to its 18,000 annual visitors. The farm's mission as stated on their website is: "*Spitalfields City Farm brings the countryside to the city, providing education and environmental opportunities to local communities in a relaxed and enjoyable way.*"

Following its aim to promote a better understanding of gardening and farming, Spitalfields City Farm provides various training courses for adults with learning difficulties. It also organizes school visits as well as workshops with disabled people, unemployed people and people with need for support. In addition, the farm arranges a wide choice of public events, all over the year, providing educational days focusing on animal care as well as gardening practices to promote healthy and sustainable living. With the "mobile farm" the staff is even able to provide animals for all sorts of events, such as school open days or even weddings!

Spitalfields City Farm also works to enhance strong community relationships within the people in Tower Hamlets. The «Healthy Living Project » encourages Bangladeshi women from the surrounding borough to volunteer in the garden and to attend healthy cooking sessions. Moreover these sessions enable the group - known today as the Coriander Club - to develop their English language skills.

Spitalfields City Farm is managed by a committee of fifteen people, most of them volunteers. The farm exists thanks to funds given by the borough as well as various charitable trusts, companies and public funding bodies. Pursuing similar aims, many other city farms are located in London. Most of them are part of the London city farms and community gardens organization.

Source:
Spitafields City Farm, www.spitalfieldscityfarm.org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**For further information**
Federation of City Farms and Community Gardens, http://www.farmgarden.org.uk/
Farms for school, http://www.farmsforschools.org.uk/

## II. 4 Students allotments

Just like the previous project, the following experiment tries to enhance the relationships between the existing communities of UCL.


In UCL students halls, organizational committees formed by students arrange various activities involving tenant students. Boat parties on the Thames, along with theatre and movies events are often planned. Recently, in the beginning of this summer, the International Hall committee - located on Lansdowne Terrace next to Russell Square - organized an original gardening afternoon. Students were invited to flower the garden situated in the courtyard of the Hall. ❶ Most students halls contain gardens.

A partnership between the Productive Lab group and the various students halls committees is organized. Part of the existing gardens is transformed into allotments.

A small group, yearly elected inside each hall, is in charge of organizing the various task related to the management of the allotment. The crops produced are either consumed by the students who grew them, distributed to other students or given to the hall's kitchen.

Similarly to other allotments all around UK, (28) students allotments could improve social relationships within the students community as well as help increase awareness about food origin.

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Supported by the innovative UCL Productive Lab, the Productive Hall Society invites you to their Student Hall Allotment grand opening!

Sunday September 10th 2006 the Productive Hall Society will start growing a sustainable vision of our city.

If you wish to get your hands dirty to help and beneficiate of free, fresh, home grown, healthy organic vegetables, join us for a pioneering gardening age!

From the ~~Bursar's~~ Office
Productive Hall Society



**Allotments Regeneration Initiative: the case of Lewisham in South London** 28

During the 19th century, allotment gardening was part of UK's urban environment. It even became vital during the Second World War. After WWII, the development of mass consumption and easy shopping led many people to stop growing food inside cities. Most of the allotments became then disused.

Nowadays, with the increasing interest for healthy eating or good quality food, allotments have raised a new attention and communities of city gardeners have been recreated. Recognizing the valuable contribution of these allotments in improving the quality of life in the cities, the UK government is now providing funding and an official strategy in order to assure their high-quality and long-term regeneration.

Looking at his allotment named One Tree Hill, a large inner city site of 70 plots situated in Lewisham, Ian Whiteik - member of the ARI - explains "*Fifty years ago it was completely disused, today almost all the plots are gardened to a good standard, we even had to close the waiting list; it was becoming too long…*"

In typical allotments, the rents vary from thirty to fifty pounds a year for a fifteen square meters garden, including water. The land is owned either by the council or other public organizations (rail companies, schools) or by private landlords, sometimes farms.

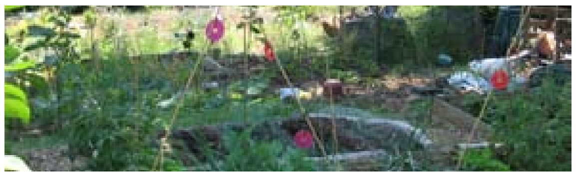
The community of tenants is usually very mixed. The awareness of food miles impact on the environment led all sorts of people to grow their own food, from families to elderly or young single people, all ethnicities included. A part of the Lewisham allotment is also accessible for disabled people.

"*Here people can act freely, as long as it doesn't contradict the interests of the allotment.*" *This gives a strong identity to the place: self-built greenhouses are mixed with diverse recycling materials and plots are full of flowers as well as vegetables.* "*But in some allotments, strict rules allow only the cultivation of eatable crops.*" says Ian.

The Lewisham allotment's organizational comity is made of several people, all volunteers. Their tasks range from assuring the provision of water; advising new gardeners; controlling that people take good care of their plot and sending them notices would not this be the case; to organizing open days for children with workshops or events for the allotment community.

After the success of One Tree Hill, Ian became a mentor of the ARI and acts today as a free consultant to help regenerating other allotments all over London. Doing so, he contributes to improving human relationship inside our modern cities, helping the environment and providing local sources of fresh food.

Sources:
The Allotments Regeneration Initiative, http://www.farmgarden.org.uk/ari/



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