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How can UAG contribute to make the residential areas from 1960s and 1970s more liveable?

COST Action TU 1201
"Urban Allotment Gardens in European Cities"

Short Report of the Short Term Scientific Mission

Alnarp, Sweden, 1st April – 31st May 2015

URBAN ALLOTMENT GARDENS

How can UAG contribute to make the residential areas from 1960s and 1970s more liveable?

COST Action Urban Allotment Gardens in European Cities

Short Term Scientific Mission

Alnarp, Malmö, Sweden 1st April – 31st May

Host institution

Department of Landscape Architecture, Planning and Management - SLU (Swedish University of Agricultural Sciences)

Home Institution

Department of Agricultural Sciences – UNIBO (ALMA MATER STUDIORUM, University of Bologna)

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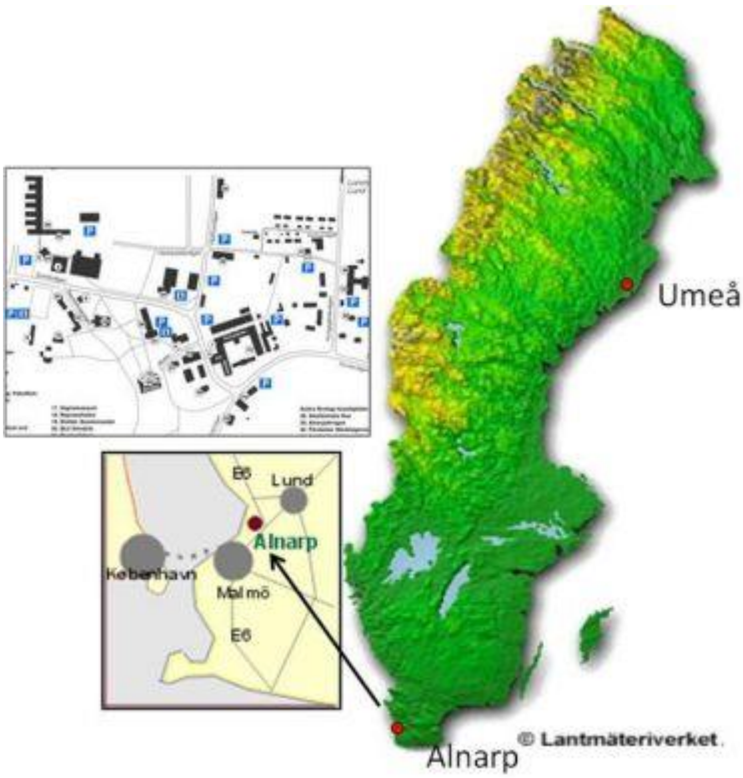
Where is Alnarp?

Source: http://kids.nationalgeographic.com



Source: www.slu.se

ABSTRACT

The presented work will discuss soilless systems cultivation trial in Alnarp, Sweden. It focuses on the production of floating systems, with the final objective to analyse food quality and production. Starting from the real production of 6 floating systems, grown under monitored conditions and filled with 2 different nutrient solutions (commercial fertilizers), it is possible to estimate the potential yield of the whole city of Malmö (Sweden), assuming that all flat surfaces could be transformed in rooftop greenhouses (RTGs). This experiment could answer two important questions: 1) how to produce safe and accessible food in a city and 2) how to design new buildings, in order to make urban agriculture a central element of them.

INTRODUCTION

✓ Urban Horticulture

Since 2007 the world's population has been predominantly urban: on May 23, 2007 for the first time in history the world's urban population exceeded the rural population, due both to the normal increasing of urban population and to the immigration from rural areas (Gianquinto and Tei, 2010). In general, people move to cities in order to improve their living condition, find better jobs and have access to goods and services not available in rural areas. Consequently, as they attract more people, cities have to provide the goods and amenities that these people need and want (FAO, 1998). The most important is occur food and ironically, nowadays the worldwide rapid urbanisation brings together a rapid increase in urban poverty and urban food insecurity.

In this context, urban and peri-urban agriculture can contribute to local economic development, alleviation of poverty and social inclusion as well as to the greening of cities and the productive reuse of urban wastes (FAO, 2008).

Urban agriculture refers specifically to enterprises located within (intra - urban) or on the fringe (peri-urban) of a town, a city or a metropolis, which grow and distribute a diversity of agriculture products - from vegetables to animal products - using human, land and water resources, products and services found in and around that urban area. Supplying the city with fresh food products such as vegetables, milk and eggs, urban agriculture is complementary to the productions coming from rural agriculture and thus improves the efficiency of the food system (Gianquinto and Tei, 2010).

Although urban agriculture does not only include the production of vegetables and fruits, the horticultural sector is undoubtedly the most important. Urban and peri - urban horticulture include all horticultural crops grown in small gardens or larger fields and on balconies or rooftops for human consumption and ornamental use, where the cropping system is usually adapted to the specific conditions (Tixier and de Bon, 2006). Thanks to the large variety of crops that can be produced, urban horticulture positively impacts food security for thousands of people living in urban areas by raising incomes and improving nutrition (FAO, 2008). 'Urban vegetable gardens' are becoming more present in cities all over the world and they present quite similar origins even in different countries. The main process related to the diffusion of vegetable gardens in urban areas is the migration of rural population into cities. In Europe this phenomenon was mainly experienced during periods of industrialisation: migrants from rural areas were often living in precarious economic conditions, marginalized and malnourished, therefore "gardens for the poor" were settled in plots of land belonging to local governments, factories or religious communities with the aim of alleviating this situation through to the cultivation of vegetables and the farming of small animals (Tei and Gianquinto, 2010).

The usefulness and diffusion of the urban vegetable gardens became even more important during two World Wars, when the socio-economic situation collapsed and food insecurity spread. As many cities were isolated from the surrounding rural areas, agricultural products could not reach the urban market and they were sold at high prices or even on the black market: for this reason, the food production in urban vegetable gardens became essential for surviving (Tei and Gianquinto, 2010). Similar processes are found today in developing countries, with a similar trend in South America, Africa and Asia (Li *et al.*, 2012; Mkwambisi *et al.*, 2011; Rodríguez-Delfín, 2012).

✓ Why Urban Horticulture is 'multifunctional'?

Agriculture, and more recently horticulture, has always played an important role in human history, conditioning food supply, development of rural areas and shaping of rural landscapes (Van Huylenbroeck, 2007). Agriculture provides many other benefits to the surrounding environment and people. These multiple benefits are grouped under the term "multifunctionality", first used at international level at the Rio Earth summit in 1992.

The OECD Declaration of the Agricultural Ministers Committee (OECD, 2001) defines multifunctionality of agriculture as follows: "beyond its primary function of producing food and fibre, agricultural activity can also shape the landscape, provide environmental benefit such as land conservation, the sustainable management of renewable natural resources and the preservation of biodiversity, and contribute to the socioeconomic viability of many rural areas. Agriculture is multifunctional when it has one or several functions in addition to its primary role of producing food and fibre". Looking at urban horticulture, most of the functions mentioned are nowadays integral part of its aim and essence. As a matter of fact, as we saw in the previous paragraph, urban agriculture was born with a food production function but soon after the Second World War its role completely changed and became "multifunctional" (Tei and Gianquinto, 2010; Bisgrove, 2010). Moreover, since rural areas all over the world are subject to a rapid urbanisation, starting again to grow plants in the urban environment is a form of giving back to the territory part of its original function. The different functions of urban horticulture can be resumed as follows, considering that this is just an attempt to give an overview on a topic that is really various and changeable.

- **Food production function**

Since the beginning of the urban gardens experiences, the food production function has always been the most important, focused mainly on providing fresh vegetables and fruit for individual use (Tei and Gianquinto, 2010). This function was not the only one because the 'urban vegetable garden' at the same time offered opportunities for recreation, distraction or expenditure of diversions and important meeting-place, yet. As time passed, these other roles almost overtook the food production function and nowadays other values such as food security and quality of produce have been added to the food production considering the importance of increasing the food availability and improving access to food

(FAO, 2008). In this context, the individual consumption is still the most common destination of produce, but some urban horticulturists also sell their produce as "Zero Km Agriculture", directly to the consumer (short distribution chain) or even through consumer's buying groups. At the same time, with some distinction between developed and developing countries, in the last 10-15 years the food production function regained importance mainly because of the increasing urban population in under-feeding and low income conditions (Ghosh, 2004).

- **Ecological-environmental function**

As in the last decades cities all over the world are becoming larger, environmental problems are increasing as well. Cities do not belong to the natural ecological systems and usually town planning does not consider environmental sustainability (Ghosh, 2004). In this context, urban agriculture contributes to the urban ecosystem by improving the micro-climate and favouring waste recycling. Moreover, thanks to the cities' greening, the conservation and valorisation of biodiversity is promoted, the water quality and availability protected and the carbon sequestration enhanced in form of additional biomass (FAO, 2007). Urban agriculture also acts on the requalification of suburban unused or degraded areas and at the same time favours the promotion of urban-rural linkage (Tei and Gianquinto, 2010). Nevertheless, it is important to keep in mind that, like rural agriculture, the urban one entails risks to health and environment, if not managed properly (FAO, 2000).

- **Territorial function**

Although the territorial function is more evident for rural agriculture, also in urban areas horticulture can act in a 'territorial' sense for example through landscape protection and valorisation (Henke R., 2004): the greening of the cities gives an aesthetic value to urban horticulture that consequently improves the landscape. Another meaning of territorial can refer to social security and awareness: an urban vegetable garden settled in a suburban context can act in a sense as protection from illegal business or acts of vandalism (Gianquinto and Tei, 2010). Finally, valorisation, protection and conservation of typical vegetable products in specific territories - as agriculture already does, especially in Italy - could be a new goal to reach also in urban areas.

- **Educational-cultural function**

This function combines the importance of the divulgation of agricultural knowledge with the possibility of observation and understanding of nature and rural culture. This can be observed in urban allotment gardens where senior citizen have the possibility to "return to their rural roots" (Tei *et al.*, 2010) and at the same time in school gardens, where children can have a direct contact with nature starting from the beginning of their lives. As a matter of fact, planting on school grounds does not only provide an aesthetic environment in which students live in but also creates an educational possibility to enhance environmental awareness, for example by promoting awareness of in sustainable activities such as recycling, composting, energy saving, etc. (Akoumianaki-Ioannidou *et al.*, 2010).

- **Social function**

The term 'social' put together with the term 'agriculture' (or horticulture in this case) describes a wide range of meanings. Senni (2008) defines 'social agriculture' as the ensemble of activities that use material and immaterial agricultural resources to promote or favour therapeutic actions, rehabilitation, occupational and social inclusion of deprived people or persons in risk of social exclusion.

Therefore horticultural techniques, applied in the rural or in the urban environment, can have a wide field of application for the rehabilitation of people with addictions of various nature (alcohol, drugs), or for supporting and helping the elderly or the physically and mentally disabled (Muganu *et al.*, 2010). This is usually done by following the principles of horticultural therapy, a discipline that uses plants for rehabilitation purposes by taking advantage of the natural affinity of mankind and nature (Davis, 1995 as cited in Muganu *et al.*, 2010). Contact with nature is in general a big help for people who have experienced physical or health problems, or even problems with the law: it is easier to recognise the fruit of one's labor because nature does not judge you. There is no difference between a tomato grown by a disabled or an able-bodied person, they will either be good or not (De Angelis, 2011). Cases of application of this social function of urban horticulture are, for example, vegetable gardens in prisons, which contribute to the inmates social rehabilitation thanks to the contact with nature that helps changing attitudes and life goals, gaining a vocational and educational usefulness, together with a therapeutic value (O'Callaghan *et al.*, 2010); at the same time this activity contributes to the occupational rehabilitation offering the inmates new abilities for a future work (Ciaperoni A., 2009) since usually access to employment after release from prison is a serious issue (O'Callaghan *et al.*, 2010). Another interesting examples are the allotment gardens (gardens established for social purposes by local governmental administrations on public lands), that have several socio-cultural and economic functions particularly for senior citizens: they provide a place for meeting and overcoming loneliness, benefit their health and encourage them to use their free time to produce fresh food for themselves or for their family and friends (Tei *et al.*, 2010). Additionally, urban vegetable gardens can be important in relation to the food security condition of migrant groups in cities, also considering that food production and consumption represent daily practices and knowledge that preserve community and individual health and contribute in shaping cultural identity (Bellows *et al.*, 2010). Again, with socially deprived adolescents or drug-addicted people, activities of construction and maintenance of a vegetable garden allows them to acquire professional and vocational skills and to develop an understanding for ecological and sustainable agriculture (Steininger-Hotwagner, 2004).

✓ Simplified soilless cultivation as a solution in urban horticulture

In present times, soil sealing is globally increasing and land use changes bring humans to abandon rural areas and enlarge villages, towns and cities. In this context, planting in cities is becoming increasingly popular because of demographic growth and because it is not only a source of food but also of income. (Caldeyro-Stayano, 2004). However, farming in urban areas gives rise to some concerns like soil contamination by atmospheric pollution or by fertilisation. Consequently, within cities the main constraint to the expansion of agriculture is represented by land availability and soil fertility since often in urban areas soils are not suitable for crop production and in general access to land is scarce (Orsini *et al.*, 2010; Fecondini *et al.*, 2010). Moreover, water can constitute another problem (in the urban environment), since in some areas access to drinking water and sewerage is not easy to achieve. These considerations lead to taking into account the quality of soil and water on which plants rely, as they absorb any existing pollution (Caldeyro-Stayano, 2004).

The adoption of Simplified Soilless Cultivation (SSC) systems allows tackling some of these concerns and has several advantages (Orsini *et al.*, 2010; Fecondini *et al.*, 2010; Caldeyro-Stajano, 2004; Rodríguez-Delfín, 2012; Tixier and de Bon, 2006):

1. possibility of cultivation in places that have not previously been considered appropriate for food production like courtyards, small gardens, walls, balconies, and rooftops;
1. production of vegetables "without land" and in small physical spaces;
2. low-cost and simple technology which does not require any previous knowledge;
3. high efficiency in the use of water and minimisation of nutrient leakages to the environment; thanks to closed cycles;
4. closed cycles allow hight efficient use of water and minimises nutrient leakages to the environment;
5. promotion of use of recycled materials or low cost materials to build growing containers;
6. possible production of a broad range of vegetables, flowers and aromatic plants;
7. faster and vigorous growth of plants due to greater water and nutrient availability, that usually leads to higher yield than soil production;
8. no use of herbicides and limited use of pesticides is required and also there cannot be problems with nematodes since there is no soil, thus "monoculture" is possible;

9. shorter chain between harvest and consumption;

Another important contribution of soilless gardens is that they allow people to eat more vegetables without big expenses. As a matter of fact, in peri-urban and urban areas of many developing countries health matters are frequently related to a lack of micronutrients and vitamins in the diet of the population (FAO, 2008) and the low level of vegetable consumption can be due to a lack of tradition in its cultivation and use or simply to the fact that people have not enough money to purchase these products (Orsini *et al.*, 2010). Also in Italy, and in Europe in general, SSC systems can be efficiently applied in different situations in which improved health condition allows to develop a more sustainable and stable economic growth at both family and community level. According to INEA (2011) data, in Italy in 2010 vegetables and potatoes consumption represented the 10.8% of the total food expenditure, constituting the fourth most important category.

This means that people seem to care always more about health in food terms and thus the possibility to grow their own vegetables could be easily accepted and put in practice. In general, SSC systems are characterised by growing plants "without land" and this is possible in several ways. One of them has been developed and promoted since 1991 by the FAO Regional Office for Latin America and the Caribbean (FAO/RLC) as part of a food security strategy for low-resource populations in peri-urban and urban areas. Conceptually, SSC is a low input branch of soilless cultivation (or hydroponics), first developed in Latin America, which uses its general concepts but differs from High Technology Soilless Cultivation (HTSC) mainly used in the USA, Europe and Australia as follows: HTSC is oriented to the market to maximise the enterprise cost/benefit ratio using high technology and little labour and being located in rural areas. SSC's main aim is for a family to be able to feed itself and to produce a small income, therefore it is appropriate for low-resource populations.

Generally, it is located in urban or peri-urban areas, although it is also suited to rural conditions (Caldeyro-Stajano *et al.*, 2003). SSC installations can be realised with different techniques that range from the Nutrient Film Technique (NFT) to the floating system, but other methods using solid substrates can also be included in the big group of SSC that allows to grow plants in water or in containers that can be made of wood, plastic or any other recycled material and - most important - can be located in balconies, streets, courtyards and roofs. In any case, to assure soilless systems' sustainability it is important to use materials that are environmentally friendly, inexpensive and easy to find locally, and at the same time garden management should be simple (Orsini *et al.*, 2010).

✓ Simplified Floating System

Leaf vegetables, that have been used in the following experiment, are requested by consumers as fresh market and as ready – prepared fresh vegetables. Among hydroponic methods, the floating system is the easiest and cheapest way to cultivate leafy vegetables, when soil is not available or fertile. Small-scale farming, both on family and community basis, may allow achieving the goals of both, improving nutrition and reducing poverty (Orsini *et al.*, 2010).

Hydroponic systems allow a direct control of the nutrient supply, making possible the instant modification of the composition and concentration of the nutrient solution (NS) in order to reach fixed qualitative standards. Small-size leafy vegetables can be profitably grown in a floating system (Gonnella *et al.* 2001). The floating system can provide shortned growing cycles; improve quality, uniformity of growth and yield. Literature describes simplified hydroponic systems. In Orsini *et al.* (2010), the trial carried out in Peru, provided a growing system composed by a $1m^2$ wooden structure, made waterproof through the application of a plastic film, and filled with nutrient solution hosted in the floating alveolate polystyrene trays where plants were grown.

The growing substrate was rice hulls. Yield of cropped species was about 3.2 kg m^{-2} $cycle^{-1}$ (radish), 10.7 kg m^{-2} $cycle^{-1}$ (lettuce), 6.3 kg m^{-2} $cycle^{-1}$ (baby leaf lettuce), 5.4 kg m^{-2} $cycle^{-1}$ (leaf beet), 3.6 kg m^{-2} $cycle^{-1}$ (garden beet). Following this example, I conducted a similar trial in during my STSM in Alnarp. For this, I used four different vegetable species co-cultured in each of the floating system: lettuce: cv. Bionda Riccia da taglio, Blumen seeds, Milano, Italy; spinach: cv. Merlo Nero, Blumen seeds, Milano, Italy; basil: cv. Napoletano, Four sementi, Blumen group, Milano, Italy; radish: cv. Tondo Rosso; Blumen seeds, Milano, Italy.

During my STSM period, I wanted to test the best nutrient solution and the best cv. For species mentioned above.

✓ Purpose of the STSM

Urban agriculture may enable producing of local food and other ecosystem services, meaning "benefits people obtain from ecosystems" (MA, 2005). Rooftop farming may enable to turning cities' vacant concrete spaces into productive farms, substantially contributing to the city food security (Orsini *et al.*, 2014). Whenever fertile soil is not available, the use of simplified soilless systems has been successfully adopted in a range of projects across the world, combining satisfactory yield with feasible implementation and maintenance. For that reason, UA would be a social, aesthetic and economic solution for "urban inhabitants". Preliminary data could be provided in a previous case study (**Fig. 1**).

The purposes of the presented STSM were the following:

- -build and test simplified soilless systems in controlled conditions;
- -using that trial to select one nutrient solution (NS) and cultivars;
- -defining processes for analysing vegetable quality production;
- -studying simplified soilless system as an aesthetic tool for buildings;
- -establish a long-term collaboration framework in the field of urban agriculture, in Malmö.

✓ Future collaboration with the host institution

Based on the positive results of this STSM, the following collaborations are foreseen:

1) July - August 2015: replication of the experiment by a SLU student
1) September – October 2015: preparation of the final report integrating the data acquired during the author's STSM and those obtained after her departure;
2) September - October 2015: implementation of study with data concerning vegetables quality and rooftop potential productivity in Malmö.

Furthermore, future collaboration will consider other research topics such as:

- Simplified soilless systems for urban vegetable cultivation;
- LCA (Life Cycle Assessment).

Figure 1. Rooftop gardens in Bologna, IT.

METHODOLOGY

Plant material

The experiment was carried out in the greenhouses of SLU (Swedish University of Agricultural Sciences), in Alnarp (55°66'N, 13°08'E, Sweden) during spring of 2015 under controlled conditions. The air temperature was set at 18°C and the day/night photoperiod was fixed on 16/8 h with high pressure sodium lamps.

Plants were sown on April 2^{nd} in alveolated plastic containers (54 holes). The selected species are: lettuce *(Lactuca sativa),* spinach *(Spinacia oleracea),* radish (*Raphanus sativus)* and basil (*Ocimum basilicum)*. They were watered every 2 days until the date of transplant (**Fig. 2**)

On April 20^{th} (18 days after sowing) the plants were transplanted round endo-sponges (∅ 40 mm; thickness: 20 mm) and moved into a greenhouse with day/night air temperature 22°/18° C, 70% RH and no artificial lights.

Plants were transplanted in the floating system on May, 13^{rd} (40 days after sowing).

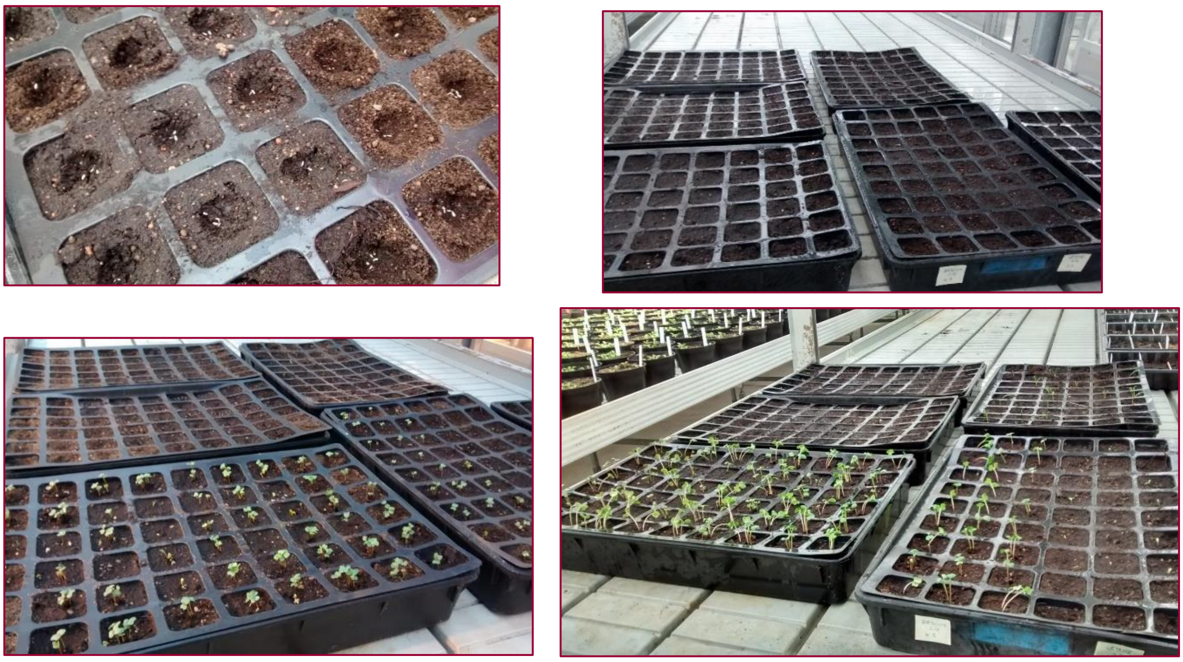


Figure 2. Seed sowing on April, 2^{nd} and growing plants in Horticum greenhouse, Alnarp

Simplified floating system

On April 27th building of floating systems started. Cultivation systems were built using recycled materials (in order to be easily replicated) following the scheme reported in **Figure 3**. Recycled pallets (120 * 80 cm), chipboards (120 * 80 cm), and six pallet rims (20 cm deep) were recovered. Firstly, the materials were sanded by hand. Chipboards and pallet rims were fixed on pallets. Afterwards, the systems were covered with nonwoven fabric, in order to make them smoother, and then with plastic film. Finally, 40 mm ∅ holes for plants were made using a cutter on the polystyrene boards, and floating systems were filled with the nutrient solution (**Fig. 4**).

Three floating systems per nutrient solution were used as replication, with two different nutrient solution. In total, six floating systems were built, each providing the simultaneous growth of the 4 selected species. Each board was divided in 4 separate groups for each crop with different plant densities (lettuce and spinach: 32 plants m^{-2}; radish and basil: 84 plants m^{-2}).

The NSs were oxygenated manually every day.

Figure 3. How to build a floating sysyem..

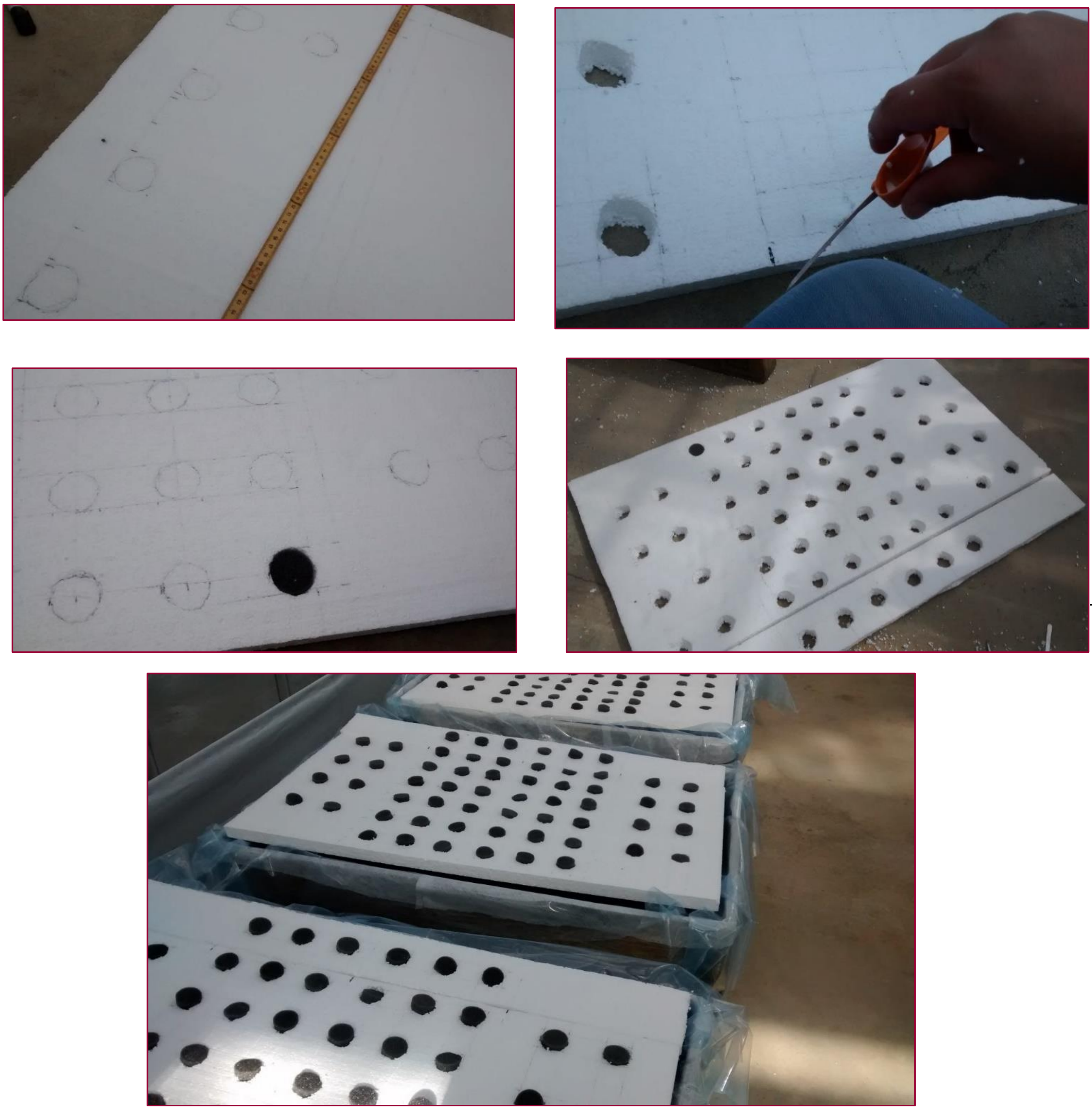


Figure 4. Preparation of polystyrene boards: 56 holes each one.

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Nutrient solution

The two basic nutrient solutions (NSs) are A) Sweden NS and B) Italian NS. NSs were chosen on the basis of the N requirement of the more demanding crop (radish). The solutions were prepared in the Department of Microbial Horticulture (**Fig. 5**). Stock solutions were prepared for dilution in 145 L. Micronutrients, macronutrients and iron were stocked in 3 different ampoules. Two different nutrient solutions were compared according to the specifications given by Orsini *et al.* (2014) (A) (KNO_3 5 mM, $Ca(NO_3)_2$ 2.43 mM, NH_4NO_3 2.5 mM, KH_2PO_4 0.6 mM, $MgSO_4*7H_20$ 1.2 mM, Fe-EDTA 0.04 mM, $MnSO_4*4H_2O$ 0.005 mM; $NaB_4O_7*10H_2O$ 0.03 mM, $CuSO_4*5H_2O$ 0.0015 mM, $ZnSO_4*7H_2O$ 0.008 mM and $(NH_4)_6Mo_7O_{24}*4H_2O$ 0.0036 mM+ H_2SO_4) Sonneveld and de Kreij (1989) (B) (KNO_3 17.5 mM, $Ca(NO_3)_2$ 13.5 mM, NH_4NO_3 2.49 mM, K_2HPO_4 3 mM, K_2SO_4 0.36 mM, $MgSO_4*7H_20$ 2 mM, Fe-EDTA 0.04 mM, $MnSO_4*4H_2O$ 0.005 mM; $NaB_4O_7*10H_2O$ 0.03 mM, $CuSO_4*5H_2O$ 0.0015 mM, $ZnSO_4*7H_2O$ 0.008 mM and $(NH_4)_6Mo_7O_{24}*4H_2O$ 0.0036 mM+ H_2PO_4).

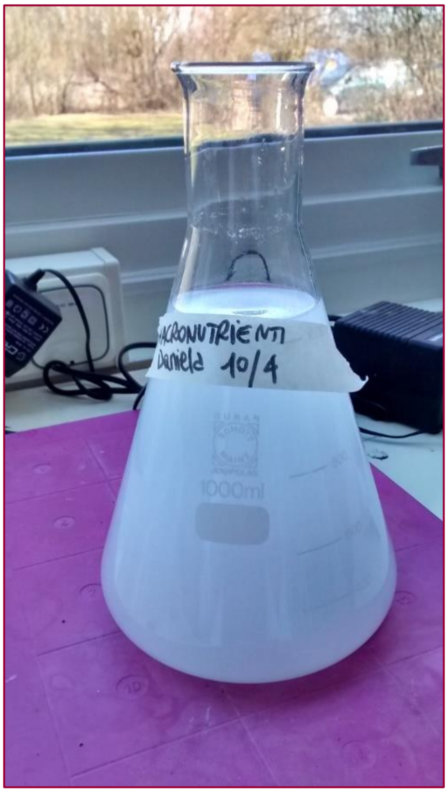

Figure 5. Nutrient solution preparation, Syra Lab., Alnarp.

pH and Electroconductivity of the nutrient solution

pH and EC of the nutrient solution were measured every day with the new high precision waterproof pH an EC meter.

Water use

Water used in the floating systems was monitored by measuring the water level with a ruler. The daily water loss was calculated as:

$$WL= (mm\ H_20 \text{ at } day_{0} - mm\ H_20 \text{ at } day_{1)}) * \text{Area of the floating system}$$

The total water used was calculated as the accumulated sum of the daily water use.

Further analysis

Chlorophyll fluorescence

Chlorophyll fluorescence is considered to provide a good evaluation of the plant status, giving a dimension of photosynthetic efficiency (Murchie and Lawson, 2013). The peak of fluorescence is called F_m and it is reached in less than 1 second with the illumination after a dark period. Measurements after dark adaptation provide values as F_0 and F_m and their calculated difference (F_m-F_0), called F_v: the ratio F_v/F_m can be related to the maximum (or potential) quantum yield of PSII photochemistry, which normally presents value of ~ 0.83 (Murchie and Lawson, 2013). In the light period the value measurable is F'_m that is the maximum value (normally lower than F_m due to the non-photochemical quenching). Chlorophyll fluorescence will be measured at 40, 50 and 60 days after transplant (DAT) with LI-COR (PCA, Li-Cor, Lincoln, NE, USA). The measurements on maximum quantum yield (F_v/F_m) will be determined after 30 min of dark adaptation, while the actual quantum yield F_v/F_m (ΦPSII) will be measured on the youngest fully expanded leaves after 30 min of light (Moradi and Ismail 2007).

LAI

Leaf Area Index (LAI) will be estimated with LI-COR Li3100 Area-Meter (PCA, Li-Cor, Lincoln, NE, USA) at 40, 50 and 60 DAT (**Fig. 6**).

Figure 6. Tool to measure LAI, Syra Lab., Alnarp.

Morphological determination

Number of leaves

Number of leaves will be measured counting the leaves at the end of the treatments (60 DAT).

Biomass

At the end of the treatments destructive analysis will be carried out. Plants will be removed from the sponge in the floating system. Pictures of the stems and roots will be taken and analysed with a software in order to estimate the expansion of root system. Roots and stems will be divided and weighted separately with an electronic analytical scale (5 decimals).

Dry weight will be measured after putting the samples in paper bags in oven at 60°C for 72 hours.

Analysis on vegetable quality

Nitrates and Cations

For ions analysis dry matter of leaf samples were collected at 60 DAT. Plants from the different replications will be finely grinded. 0.25 g of dry matter per sample will be processed with 6 cc of HNO_3 and 2 cc H_2O_2 and put in a microwave for 40 minutes, than filtered. Subsequently, samples will be analysed with the high resolution spectrometer ARCOS ICP-OES (SPECTRO Analytical Instruments, Kleve, Germany).

FINDINGS

Since the experiment began behind schedule, it was not possible to harvest the crops (after 10, 20, 30 days) and to do tests about the quality of produce. The measures, which will be carried out after my departure, will be:

- Chlorophyll fluorescence, photosynthetic activity;
- Number of leaves and leaf area index (LAI);
- Biomass (fresh and dry weight / plant);
- Nitrate content;
- Water use.

Figure 7 shows some pictures related to the growing systems are preset; in **Table 1** are listed some data concerning the monitoring of pH, EC and water consume of each floating systems.

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Figure 7. Transpalnt, May 13th and growing plants.

date	box	pH	EC (mS)	h2o cm
	S1	6.0	3.40	17.5
	S2	6.0	3.30	17.5
	S3	6.3	3.50	17.5
	I1*	6.3	1.22	17.5
	I2	6.4	1.24	17.5
13-mag	I3	6.4	1.23	17.5
date	box	pH	EC (mS)	h2o cm
	S1	6.0	3.40	17.5
	S2	6.0	3.30	17.5
	S3	6.3	3.50	17.1
	I1	6.3	1.22	17
	I2	6.4	1.24	17.5
14-mag	I3	6.4	1.23	17.5
date	box	pH	EC (mS)	h2o cm
	S1	6.0	3.40	17.2
	S2	6.0	3.30	17.5
	S3	6.3	3.50	16.8
	I1	6.3	1.22	16.5
	I2	6.4	1.24	17.4
15-mag	I3	6.4	1.23	17.5
date	box	pH	EC (mS)	h2o cm
	S1	6.0	3.40	16.9
	S2	6.0	3.30	17.4
	S3	6.3	3.50	16.4
	I1	6.3	1.22	16
	I2	6.4	1.24	17.5
16-mag	I3	6.4	1.23	17.2
date	box	pH	EC (mS)	h2o cm
	S1	6.0	3.40	16.6
	S2	6.0	3.30	17.4
	S3	6.3	3.50	15.9
	I1	6.3	1.22	15.5
	I2	6.4	1.24	17.4
17-mag	I3	6.4	1.23	17
date	box	pH	EC (mS)	h2o cm
	S1	6.0	3.40	16.6
	S2	6.0	3.30	17.2
	S3	6.3	3.50	15.7
	I1	6.3	1.22	15
	I2	6.4	1.24	17.2
18-mag	I3	6.4	1.23	16.8
date	box	pH	EC (mS)	h2o cm
	S1	6.2	3.00	16.5
	S2	6.1	3.10	17.0
	S3	6.2	3.30	15.5
	I1	6.6	1.11	15.0
	I2	6.6	1.13	16.7
19-mag	I3	6.6	1.14	16.7
date	box	pH	EC (mS)	h2o cm
	S1	5.9	3.10	16.5
	S2	6.0	3.20	17
	S3	6.1	3.20	15.4
	I1	6.5	1.20	14
	I2	6.4	1.16	16.4
20-mag	I3	6.4	1.14	16.6
date	box	pH	EC (mS)	h2o cm
	S1	5.9	3.10	16.3
	S2	6.0	3.20	17
	S3	6.1	3.20	15.4
	I1	6.5	1.20	13
	I2	6.4	1.16	16.4
21-mag	I3	6.4	1.14	16.5
date	box	pH	EC (mS)	h2o cm
	S1	5.9	3.10	16.2
	S2	6.0	3.20	17
	S3	6.1	3.20	15.4
	I1	6.5	1.20	12
	I2	6.4	1.16	16.4
22-mag	I3	6.4	1.14	16.5
date	box	pH	EC (mS)	h2o cm
	S1	5.9	3.10	15.9
	S2	6.0	3.20	16.8
	S3	6.1	3.20	15.3
	I1	6.5	1.20	11
	I2	6.4	1.16	16.3
23-mag	I3	6.4	1.14	16.3
date	box	pH	EC (mS)	h2o cm
	S1	5.9	3.10	15.9
	S2	6.0	3.20	16.6
	S3	6.1	3.20	15.1
	I1	6.5	1.20	11
	I2	6.4	1.16	16.2
24-mag	I3	6.4	1.14	16.3
date	box	pH	EC (mS)	h2o cm
	S1	6.1	3.30	15.8
	S2	6.1	3.30	16.5
	S3	6.0	3.40	14.8
	I1	5.9	1.16	10
	I2	5.8	1.19	16
25-mag	I3	5.8	1.2	16.2
date	box	pH	EC (mS)	h2o cm
	S1	6.1	3.30	15.8
	S2	6.1	3.30	16.5
	S3	6.0	3.40	14.8
	I1	5.9	1.16	9.5
	I2	5.8	1.19	16
26-mag	I3	5.8	1.2	16.2
date	box	pH	EC (mS)	h2o cm
	S1	6.1	2.90	15
	S2	6.0	3.20	16.4
	S3	5.9	3.40	14.3
	I1	5.7	1.16	8.4
	I2	5.5	1.15	15.7
27-mag	I3	5.5	1.18	16
date	box	pH	EC (mS)	h2o cm
	S1	6.1	2.90	15
	S2	6.0	3.20	16.4
	S3	5.9	3.40	14.3
	I1	5.7	1.16	7.8
	I2	5.5	1.15	15.7
28-mag	I3	5.5	1.18	16
date	box	pH	EC (mS)	h2o cm
	S1	6.1	2.90	15
	S2	6.0	3.20	16.4
	S3	5.9	3.40	14.3
	I1	5.7	1.16	7.1
	I2	5.5	1.15	15.7
29-mag	I3	5.5	1.18	16
date	box	pH	EC (mS)	h2o cm
	S1	6.1	2.90	15
	S2	6.0	3.20	16.4
	S3	5.9	3.40	14.3
	I1	5.7	1.16	6.8
	I2	5.5	1.15	15.7
30-mag	I3	5.5	1.18	16
date	box	pH	EC (mS)	h2o cm
	S1			14.5
	S2			15.3
	S3			13.9
	I1			6.5
	I2			14.8
31-mag	I3			15
date	box	pH	EC (mS)	h2o cm
	S1			
	S2			
	S3			
	I1			
	I2			
01-giu	I3			
date	box	pH	EC (mS)	h2o cm
	S1			
	S2			
	S3			
	I1			
	I2			
02-giu	I3			
date	box	pH	EC (mS)	h2o cm
	S1			
	S2			
	S3			
	I1			
	I2			
03-giu	I3			
date	box	pH	EC (mS)	h2o cm
	S1			
	S2			
	S3			
	I1			
	I2			
04-giu	I3			
date	box	pH	EC (mS)	h2o cm
	S1			
	S2			
	S3			
	I1			
	I2			
05-giu	I3			

Table 1. Monitoring table: the Sweden NS (S1,2,3) have an higher EC than the Italian one (I1,2,3), this is due to the major salt concentration. The Box I1 have a leak, that will be fixed during next repetitions. The pH has an averarage of 6.0.

Processing data obtained from daily measurements, the resulting average of pH is 6.09 (**Fig. 8**) and the value of EC (**Fig.9**) is 2.22 mS/cm. Analizing the two different NS, the values of pH and EC are respectively for A) and B): 6.5 and 3.26 mS/cm, 6.13 and 1.19 mS/cm.

Concerning the water use, it is constant for all systems, except for I3, which has a loss due to tearing of the plastic film (**Fig.10**).

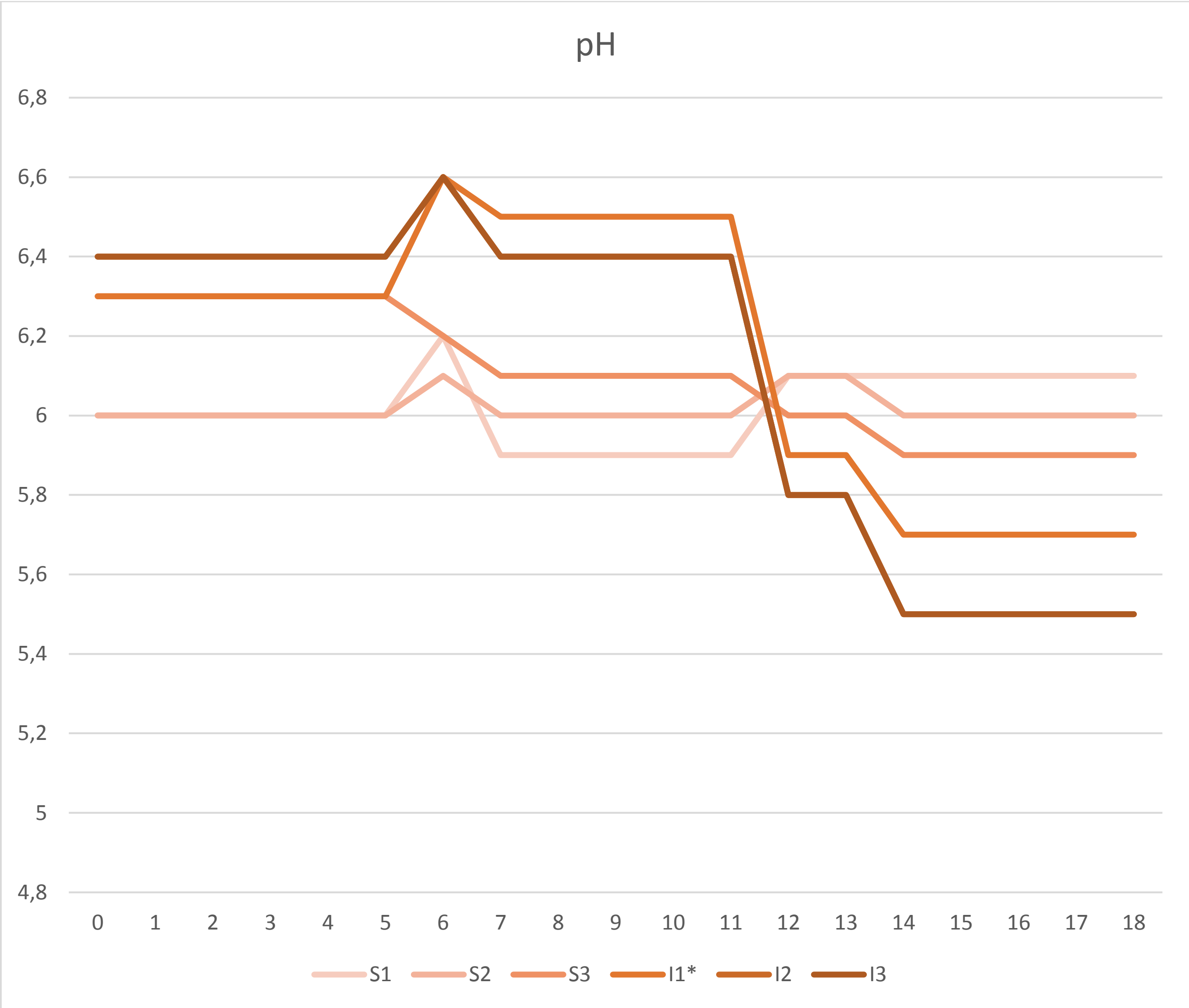

Figure 8. pH values monitored from the transplanting day, 13rd May 2015. Values are are decreased gradually, but still acceptable since near to the optimum value of pH 6.0.

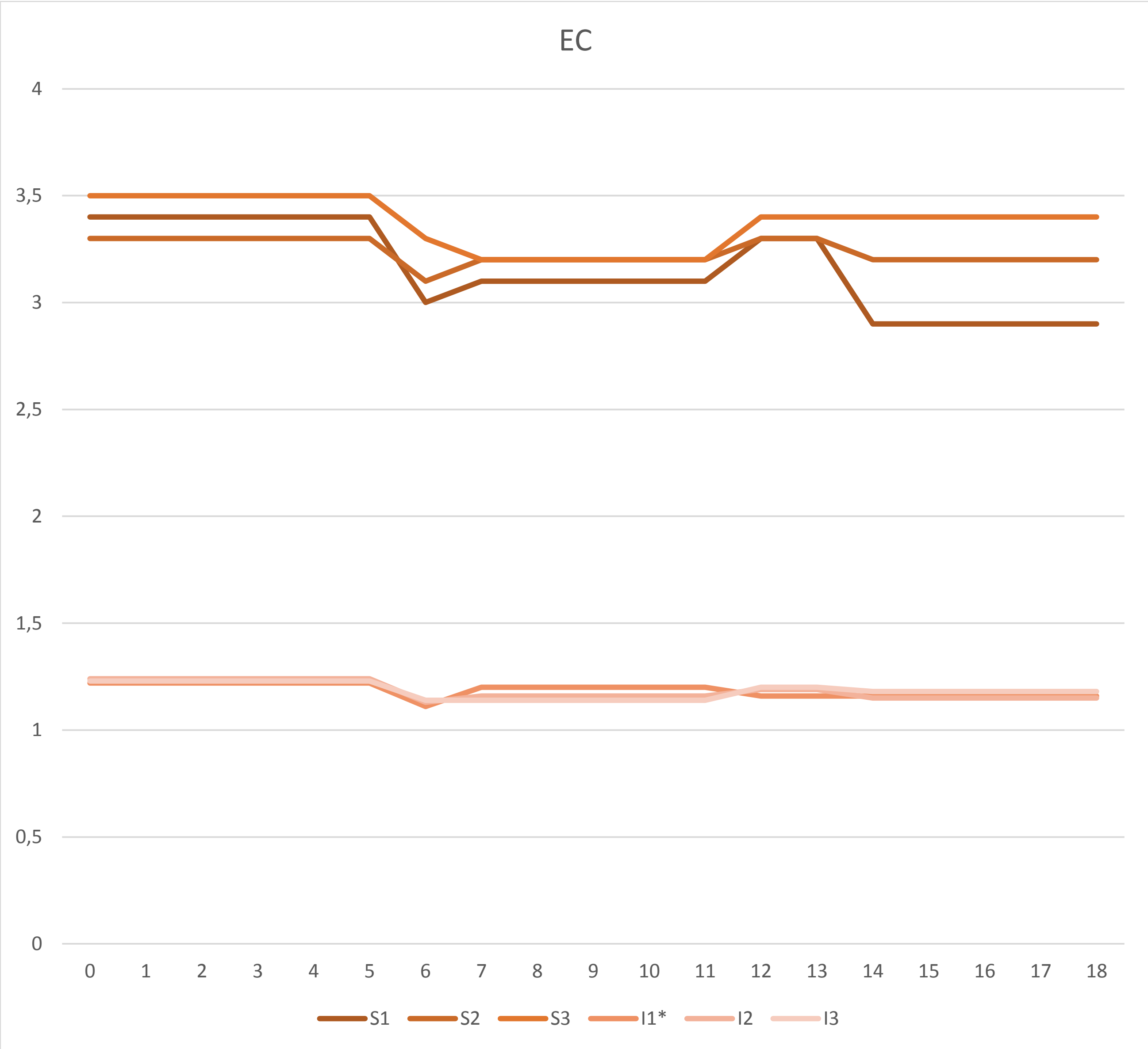

Figure 9. EC values monitored from the transplanting day, 13rd May 2015. Two NS have different salt concentration.

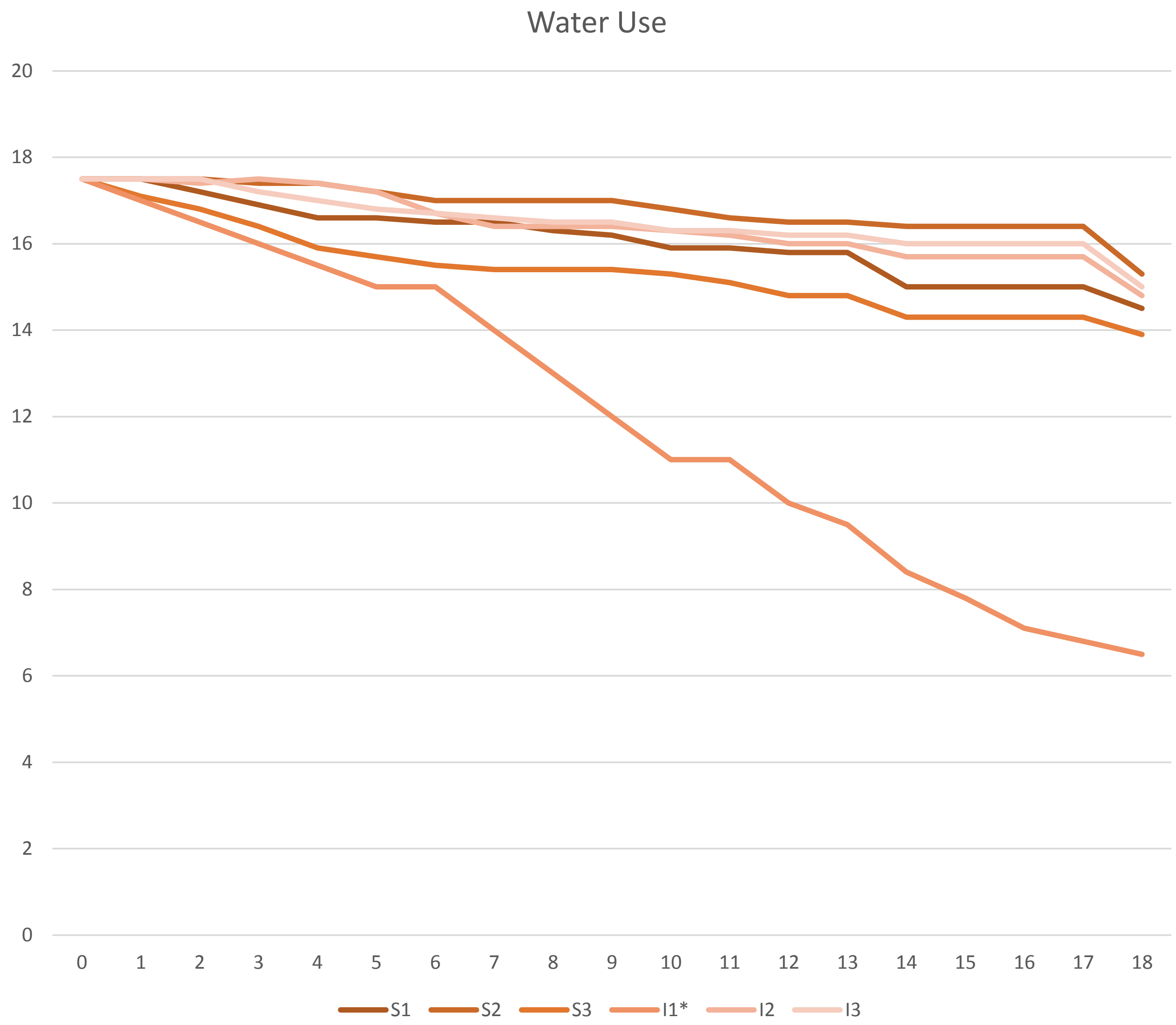

Figure 10. Water consumes monitored from the transplanting day, 13rd May 2015, by measuring the decrease of solution with a meter.

CONCLUSION and DISCUSSION

The floating system is a simple way to grow vegetables, especially leafy ones. The trial was carried out in Alnarp, but it could be conducted also in Malmö as a solution for urban self – production and workplace creation. In addition, it could be a social tool to create relationships between local and immigrant populations.

UA also could be an instrument for improving the architecture of cities. Given the weather conditions (T°, RH % and precipitations) produce could grow under protected or unprotected conditions. The next phases of this STSM will be to repeat the trial in collaboration with the research group of microbial horticulture (SLU) and Tim Delshammar.

A more in depth article, which will show the result of the work is already being written. Later, using productive data of 1m^2 of floating system producing different species and using the selected NS (Italian o Swedish one), the potential productivity of the whole city of Malmö will be calculated, since a study on flat surfaces has already been done.

However, according to literature, we can aspect yields ranging from 2.9 to 3.7 kg m^{-2} (Fecondini *et al.* 2009), that depends by climatic conditions during the growing season (for leafy vegetables).

Concerning lettuce, plant fresh weight for the different varieties ranged from 69.0±6.2 to 82.0±6.6 g Fecondini *et al.* (2009) obtained similar yields (ranging from 47.3 to 90.6 g plant^{-1} with one type of nutrient solution and quite higher ones 104.2 to 154.9 g plant^{-1} with another nutrient solution).

This experiment was useful to evaluate which solution was the best as a pre-study. We used Italian cultivar seeds, but because of the photoperiod, they are not compatible with the climate of northern Europe. For this reason, in next repetitions, we will use same species, but Swedish cv., to ensure the best development of plants.

Foreseen publications/articles resulting from the STSM

The following article is being written:

Low tech roof top hydroponics system as a solution in sustainable urban horticulture in Northern Europe

Daniela Gasperi[1], Francesco Orsini[1], Sammar Khalil[2], Tim Delshammar[3], Andrea Kosiba Held[2], Giorgio Gianquinto[1], Beatrix W. Alsanius[2]*

*corresponding author

Confirmation by the host institution of the successful execution of the STSM

1(1)

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Certificate

I hereby confirm that Daniela Gasperi, candidate for a Short-Term Scientific Missions (STSM) TU1201 under COST-Action Urban Agriculture Europe and coming from the Department of Agricultural Sciences – UNIBO (University of Bologna), has done her research project on the implementation of modified soilless systems cultivation.

The research project took place between April, 1st 2015 and May, 31st 2015.

Tim Delshammar

Senior lecturer

Department of Landscape Architecture, Planning and Management

Swedish University of Agricultural Sciences

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Other comments

Unfortunately, it was not possible to finish the experiment, due to complication in finding materials. However, it was a positive experience, which gave me the opportunity to relate to others researchers and to participate at events.

On 22nd April I attended the meeting organized by the students of the master's degree in agroecology (SLU) (**Fig. 11**) and visited the green roofs of Augustenberg (**Fig. 12**).

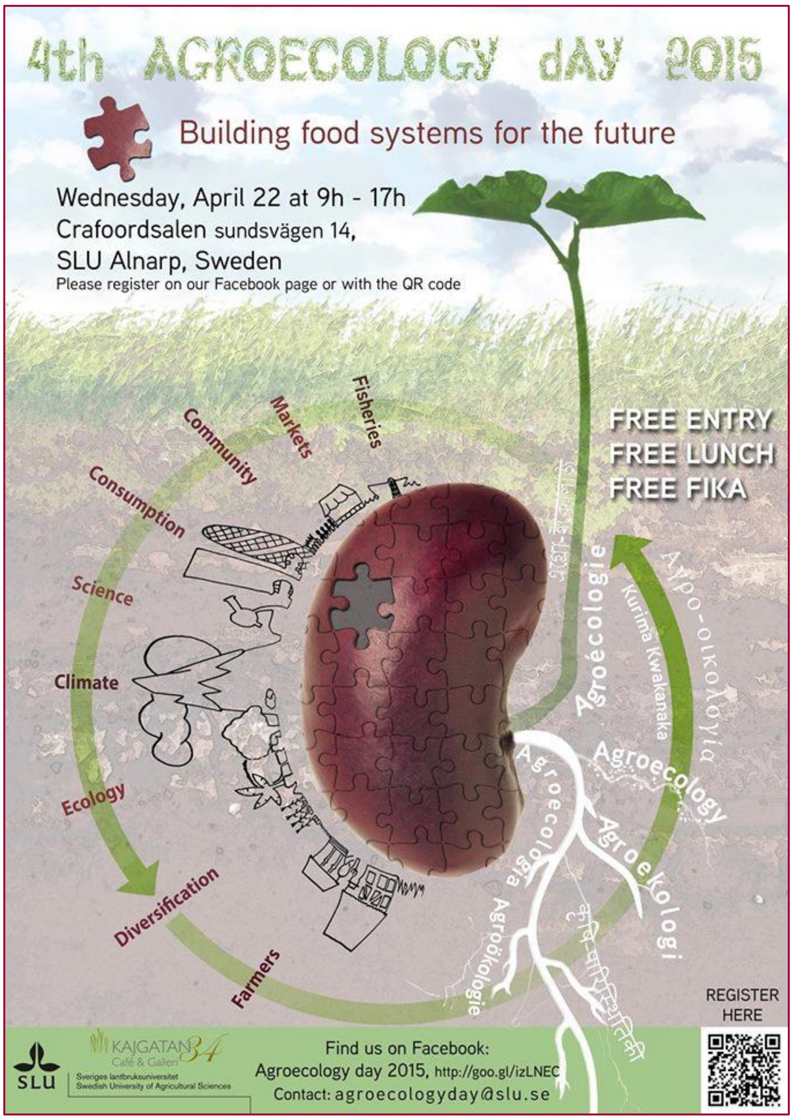
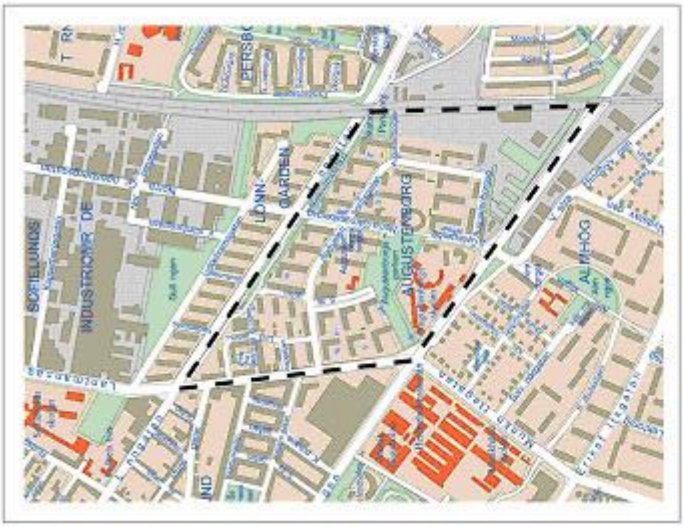


Figure 11. "Agroecology day 2015" event poster



Source: www.luda-project.net

Figure 12. "Augustenborg", one of Sweden´s largest urban sustainability projects, supported by the government´s Local Investment Programme and also financed by key local partners within Malmö City and the MKB housing company. 11st April 2015.

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Photos by Daniela Gasperi.

Bologna, 30/06/2015

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