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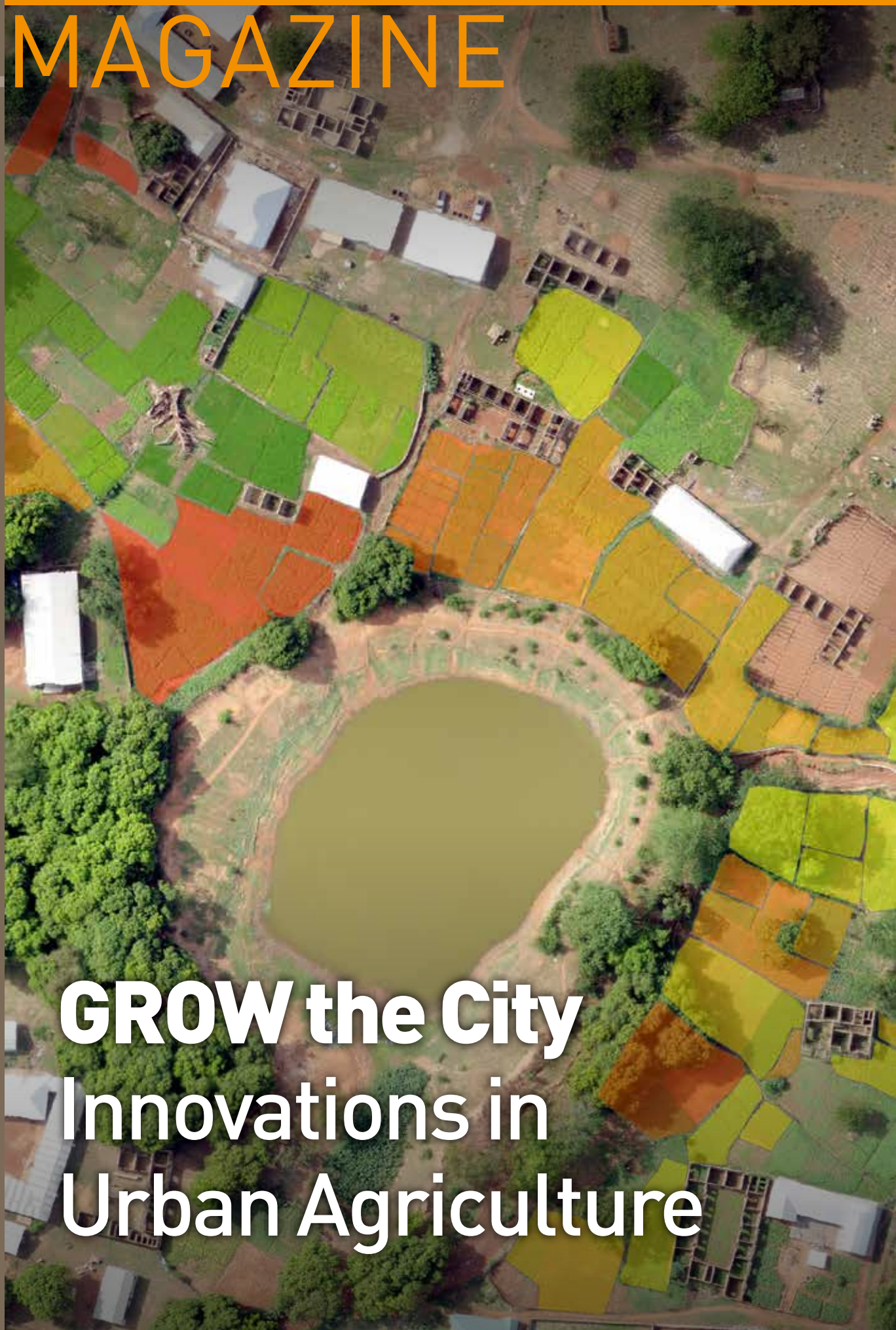

GROW the City
Innovations in Urban Agriculture

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28 Urban Agriculture magazine

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This issue is made in collaboration with GROW the City, a project supported by Oxfam Novib, and coordinated by RUAF Foundation with ETC Foundation and Wageningen UR (Applied Plant Research).
Urban Agriculture is continuously adapted to the changing urban setting. Mapping and quantifying open space and backyard gardens is important, but remains a challenge.
Photo by Johannes Schlesinger, University of Freiburg

Innovations in Urban Agriculture

Jan Willem van der Schans
Henk Renting
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An alternative design in Kenya (article on page 65). Photo: Can Ya Love

This issue highlights innovations in urban agriculture. Innovation and the various forms of innovations are of particular importance because urban agriculture is adapted to specific urban challenges and opportunities. Innovation is taking place continuously, exploring the multiple functions of urban agriculture, including food security, income generation and environmental management.

The specific interactions between urban farming systems and their diverse urban environments create specific opportunities and challenges for technical, social, organisational and institutional innovation. Key areas include: high land prices; opportunities and risks of applying recycled urban water and nutrients; food safety and risks of exposure to urban contaminants; the need to adapt and intensify production in space-constrained conditions; opportunities for agro-enterprises in accessing nearby markets; combining multiple functions; social inclusiveness; and the need to engage with a dense and often intrusive regulatory, policy and planning environment (Prain and de Zeeuw, 2007).

Various forms of Innovations

Innovation is generally defined as the process of creating something new, coming up with better solutions for existing (societal or market) needs or meeting new, still unspecified requirements. Innovations can be technical, involving new, improved or adapted products or services, or they can be more social or organisational and institutional, entailing new practices, or improvements in the strategy of entrepreneurs, farmers or organisations. They can also be in combination, often referred to as system innovations, which are fundamentally different ways in which societal needs are fulfilled. Innovations are to be distinguished from inventions, or novelties, which are just new ideas, devices, or methods. Innovations are new ideas that have a certain impact, socially or economically. Innovations are new ideas translated into practice.

The innovation landscape has become much more diverse and much more dynamic. Traditionally, ideas for new products or methods are generated in a research environment, selected and elaborated in a development environment, and commercialised in a marketing environment or disseminated by demonstrations and extension. This *closed innovation* process assures that new ideas stay within the company or knowledge infrastructure. This idea has given way, however,

Urban Agriculture as Social Innovation

Urban agriculture, and the development of sustainable urban food systems more generally, increasingly forms part of city agendas for social innovation. The complex and multidimensional issues that cities are facing can no longer be addressed adequately through traditional top-down and sectoral models of governance. There is growing acknowledgment in many cities that new governance and innovation models are needed. In this context, social innovation is intended to be a new model of value creation that tries to mobilise human talents and resources in the city as a means for problem-solving and the identification of solutions. Its characteristics are collaboration and empowerment of all involved stakeholders, and the use of new tools such as IT, online resources and social media. For this, cities need to evolve new services with their citizens by becoming catalysts and innovations brokers. It also requires new forms of leadership, and the implementation of appropriate social environments and networks that support innovation.

This social innovation approach has been applied to various thematic areas, including neighbourhood improvement, employment creation, housing development etc. Within the framework of the URBACT programme "Sustainable Food in Urban Communities" it was also applied to issues related to urban agriculture and urban food systems in a network of cities across Europe. The experiences highlighted in this project make clear that providing a stimulating environment for innovations in urban agriculture and food systems requires new roles for local governments, in which co-operation, co-creation and co-responsibility between local administrations, civil society and market parties are key factors.

Based on Jégou, F. and Bonneau, M. (2014) Social Innovation: What's behind the city scene? The URBACT Tribune 2014. More info on the URBACT project "Sustainable Food in Urban Communities" www.sustainable-everyday-project.net/urbact-sustainable-food/

to a much more *open innovation* process, in which ideas that are not selected internally spin off outside the boundaries of the firm or knowledge infrastructure to be picked up by other parties that may develop new applications for totally new markets (Chesbrough 2003), see table 2.
On the other hand, it is also possible for new ideas to develop from actual practice, as is often the case when the users of a certain technology – such as urban farmers – know best their specific needs in their specific context. This is called *lead user innovation* (Von Hippel 2005).

The innovation landscape is diverse and dynamic (for a discussion on this regarding USA see page 35). This holds for any field of innovation, but even more so for urban agriculture, which is practiced by a wide variety of people from all walks of life, who do not always have a background in agriculture. Urban agriculture in the Global South, and also in the developed world impacted by crisis, often has a rather informal do-it-yourself character (see the articles on Southern Europe, starting on page 26). Novel solutions may be developed, shared through the internet or social movements, yet are not always recognised by the formal knowledge system. On the other hand, there is increasing recognition by city authorities that this bottom-up innovation is extremely important for realising sustainable transformations (as discussed in various GROW the City meetings, see on pages 13 and beyond).

The debate on closed or open source innovation is ongoing (see table 1, box on Vertical Farming and the article on page 62). Apart from economic, market-driven innovation there is also more socially orientated innovation. Social innovation is inspired by the idea that unequal outcomes of technical, market-driven innovation should be discouraged or prevented, and that innovation should be inclusive (see box on Social Innovation). Social innovation is about new ideas (products, services and models) that simultaneously meet

Table 1. Types of urban agriculture, based on spatial location and level of control over production process

	open	mixed	controlled
building	Microclimates in and around the built environment (mushrooms, vines)	Rooftop gardens (vegetables)	LED light cabinets (vegetables) Urban livestock (rabbits) Aquaponics
inner city	Permaculture gardens (vegetables, fruits, nuts, roots) Urban livestock (bee keeping)	Kitchen and community gardens (vegetables) Urban livestock (chickens, sheep)	Urban livestock (worms, insects, etc.)
city fringe	Forest gardens (vegetables, fruits, nuts, roots)	Market gardens (vegetables)	Greenhouse nursery (vegetables)
periurban	Agroforestry (fruits, nuts) Extensive livestock (beef cattle, sheep) Ecological restauration	Mixed farming (livestock, staples, vegetables) Semi-intensive livestock (dairy)	Greenhouses and precision farming (vegetables, staples) Intensive livestock (pigs, poultry)

Source: Agriculture Economics Institute, Wageningen based on de Graaf (2011)

TERRAE participants are trained in the production for local markets (article on page 26). Photo: TERRAE

social needs and create new social relationships or collaborations in which innovations are co-produced by citizens, governments and market parties.

Social innovations are often pioneered by civic networks, small societal groups, platforms or institutes, at the fringe of mainstream society that try to re-establish ownership over certain societal problems and pro-actively generate practical solutions that are within the locus of control of the particular group (empowerment). In many cases, urban agriculture may be regarded as a form of social innovation. In the Global South, urban agriculture has been an instrument for establishing or re-establishing self-sufficiency and for fighting poverty. In the Global North, alternative food networks – where people buy directly from farmers through farmers' markets, box schemes and web shops – are a way to support family farmers and at the same time make fresh food affordable for customers with a lower income. Social innovation often adopts the vocabulary and methods of open innovation; it does not just assume that knowledge and experience are widely distributed throughout society, it actively promotes this distribution. Social innovation not only acknowledges the fact that, in this Internet age, it is hardly possible to keep others from learning about new ideas; it actually encourages people to use each other's new ideas – not for individual profit making, but for the benefit of society as a whole: (see box on Social Entrepreneurship) and articles on the GROW the City project (pages 13 and further).

Table 2. Characteristics of closed and open innovation?

Closed Innovation	Open Innovation
The smart people in our field work for us.	Not *all* smart people work for us. We need to work with smart people inside *and* outside the company.
To profit from R&D, we must discover it, develop it and ship it ourselves.	External R&D can create significant value. Internal R&D is needed to claim some portion of that value.
The company that gets innovation to market first will win.	Building a better *business model* is more important than getting to market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal *and* external ideas, we will win.
We should control our IP, so that our competitors cannot profit from it.	We should profit from other's use of our IP (license out) and we should license in other's IP whenever it advances our business model.
We will *own* all results from contract research with universities.	We will partner with universities to create knowledge and encourage use outside our field.

Social Entrepreneurship

The Blue Economy (Pauli, 2010), Social Entrepreneurship (Leadbeater, 1996), and Creating Shared Value (Porter, 2011) are approaches that seek to include social values in the development of innovative businesses. Social enterprises, at the local level and operating in urban-rural regional food systems, strive to incorporate shared values in social and environmental domains. The benefits create a positive synergy between their business goals and the well-being of the community and environment where they operate because:

1. *they are inclusive;*
2. *they create employment, meet social needs of their workforce and the neighbouring urban and rural communities, and increase human well-being;*
3. *they source their inputs locally;*
4. *they are energy-saving, recycle waste streams, and optimise the energy-water-food-nutrient nexus.*

(Based on ETC-RUAF programme development)

Traditionally, government and market parties have played a large role in financing agricultural innovation. The increasing popularity of more distributed models of agricultural innovation coincides with the emergence of new actors who are able and willing to take part in financing these innovations. New ideas only gain impact, and thus become innovations, if they are properly resourced. Backing can come from public funds and agro-industries, but increasingly also from other sources such as venture capital, philanthropic capital, crowd-funding, and/or institutional investors. Each source of funding has its own preferences and profile, and different sources may be applicable, and applied, depending on the life cycle stage of the innovation (Green deal 2013).

Innovations in Urban Agriculture

Because urban agriculture is a very diverse activity, innovations have very different expressions. Several typologies have been proposed previously (RUAF, 2006; Bhatt and Kongshaug,

Cultivation in jute bags (article on page 72). Photo: Gorakhpur Environmental Action Group

2005; Cohen, Reynolds and Sanghvi, 2012) which are flexible and are based on such different characteristics as: *organisational form* (for example, backyard garden, allotment garden, community garden, institutional garden, commercial farm) and spatial form (micro-garden, low-space/no-space, scattered in neighbourhood, food boulevard, integrated in public green infrastructure). An alternative typology, which is illustrated in Table 1, can be created on the basis of *spatial considerations* (in or around buildings, inner city, suburbs, city fringe, periurban) and agronomic considerations; the level of control over the production process (from almost full control, as in closed green houses and livestock permanently confined in stables, to some control, as in open field crops and livestock ranging in meadows, to hunting and gathering in wild or redeveloped nature).

This variety within urban agriculture implies a wide range of possible manifestations, and hence innovations, each having its own unique fit with the physical and socio-economic environment (functions other than food production that urban agriculture can provide). The range of practices encompasses inner city initiatives where the food grown is naturally adapted to the microclimates in and around buildings (such as mushrooms; see also the article on page 52), and different varieties of community and market gardens to periurban greenhouses and precision farming, to highly controlled production circumstances, such as the LED cabinets used in vertical farming (see page 62).
Sometimes it is claimed that only high-tech (controlled environment) initiatives are sufficiently adapted to the city and can solve the issue of urban food provisioning. We suggest however that low tech solutions (using or rebuilding nature's productive capacity) may be equally important. The character of innovation may be quite different in each case; for example, to increase the productive capacity of nature requires insights and skills that cannot be so easily patented. In addition, many people are critical of exclusive ownership of what nature provides. In the context of innovation, it is therefore also relevant to look at forms of high tech innovation that can also be combined with an open source strategy (see also box 3 below). It is also interesting to see that on investment fora such as the GFIA a wide range of urban agriculture types are showcased and a wide range of investors show interest in this wide range of innovations (see side bar on GFIA).

Continuous innovation

By definition, urban agriculture in itself is an innovation of more conventional models of agriculture, which are situated in rural rather than urban areas, which tend to be based on linear rather than circular models of nutrients and water use between city and countryside, and which are directed to global markets rather than to the demands of nearby consumers. In the urban context, the needs as well as the opportunities for innovation are high, leading to a higher intensity of technical innovation, more diversity in farming types, and new forms of organisation and cooperation. Urban and periurban "farms" may become specialised micro-units of intensive livestock raising and horticultural production, sometimes without the need of cultivated land (as in rooftop, hydroponic and container production). Perishable and "special niche" products dominate, especially green vegetables, dairy products, poultry, pigs, mushrooms, ornamental plants, herbs and fish. Year-round production is common through multiple crop cycles, irrigation and use of cover.

The innovative nature of urban agriculture concerns a number of different yet interrelated dimensions:
- Confined land space
- Urban metabolism
- Organisation of production
- Participation in urban design and planning

Vertical Farming: Hype or Promise for the Future?

Vertical farming, basically, is cultivating plants on vertically inclined surfaces, or in different layers within a high-rise building. This refers both to basic structures (multistory structures, sometimes referred to as "low-space, no space"; see UAM 19, and Ranasinghe, 2009) and to more sophisticated structures and buildings. An early example of such structures are the hanging gardens of Babylon. As well, reports on the use of hydroponics have appeared in many publications, although this often refers to one-layer use on rooftops (see also UAM 10 on microtechnologies) or in greenhouses. More recent use of the term vertical farming refers to the use of techniques similar to glass houses, where natural sunlight can be augmented with artificial lighting. Stacking of layers is easier now than it used to be: as LED light produces less heat than conventional greenhouse lights, the height distance between lamps and plants can be reduced.

In this issue, various contributions deal with controlled environments (the articles on modular design, page 47, The Farmery on page 50, and two articles on Vertical Farming on page 61 and 62). As described in these articles, these controlled environments offer a number of potential advantages, such as reduced susceptibility to pests and diseases and a reduced footprint, and opportunities to reduce water use, control quality, produce closer to consumers, etc. Interest abounds, especially among researchers, planners, designers and enterprises delivering the infrastructure, because it is highly innovative and visible, fits with the concept of the green circular economy, and creates options for eco-green buildings. Because of this high level of interest, the structures, designs and technologies develop rapidly, and efficiency is quickly improved. Other examples of these controlled environments are PlantLab and Plantagon (see on page 63), which claims to offer a comprehensive technology.

Despite this interest, to date only very few of the proposed concepts have been realised, and a number of challenges still stand in the way. A major obstacle is the relatively high cost of investment as compared to growing food horizontally (sunshine is free and land designated for agriculture or horticulture is cheap relative to land designated for commercial real estate or housing). Higher investment costs drive up produce prices which raises the critical question of the potential for profitability and social accessibility.

In addition, very little research has been done on the environmental impact of the constructions and the energy needed. It is argued that, to really achieve the environmental benefits, alternative energy sources like solar power need to be utilised. These, however, will require further substantial investments. Furthermore, important issues are yet to be resolved with respect to the role of growing in or on top of buildings, with regard to real estate ownership and spatial planning. New forms of organisation and new approaches to both facility management and zoning need to be developed before vertical farming can take off as an industry well integrated in the urban fabric.

Other points of concern are the social acceptance and social inclusion of vertical farming. The technology can be used to increase the supply of healthy food for urban residents, thus – in theory – improving its availability and reducing its price. In practice, however, high-end market approaches may dominate as investments have to be earned back. Vertical farming, in this respect, may benefit from experiences in other industries, where business models are based not so much on the ownership of the technology, but rather on its use (e.g., photocopy machines that charge per page copied rather than per machine). For the practice of vertical farming to truly take off, there is still an urgent need to further develop viable business and organisational models. These might range from business-driven and mainly market-oriented initiatives to social enterprise initiatives that aim to integrate vertical farming techniques more into community-based approaches. Whether these models should, and will, be developed in an open innovation context is a matter of growing debate. Groups like MIT-City Farm and the Association for Vertical Farming (page 62) are striving to make these models public, whereas larger businesses are attempting to make growing food indoors proprietary. For further clarification of potential business and organisational models, it is especially worthwhile to better analyse the experiences of "real world" vertical farming initiatives that are currently emerging around the world, especially in Asia, Russia and the USA.

In light of the great interest in Vertical Farming, some claim that these technologies are the key to the future of urban agriculture in resilient cities. This claim, however, does not take into account the present, considerable, diversity of urban and peri-urban farmers, and the multiple functions of food production in and around the cities. This diversity is illustrated in this magazine, such as flood water and waste management, greening, recreation and leisure, education, community building, and so on. In addition, in many cities around the world the main problem – more than the total production volume of specific food products – is rather the distribution of, and lack of proper access to, healthy food.

More detailed and empirical impact assessment is required, in terms of environmental benefits, economic performance and social inclusion. We hope that these first contributions on vertical farming will mark the start of a more extensive debate on the potential (as well as limitations and conditions) for vertical farming techniques within the wider framework of urban agriculture and resilient city-region food systems.

A big challenge for urban agriculture is high **pressure on the land** and **insecurity of land tenure** in urban areas. Land and space for agriculture is limited, and when available it can be contaminated; urban producers may also have to compete with a multitude of other users. Because urban agriculture, especially in the inner city, is limited by the availability of space and often is practised on small pieces of land, several articles here focus on growing crops in very small spaces and in areas where land is not fertile.

Innovations also encompass simple landless farming techniques, such as gardening in sacks (also of use in urban slum areas and in refugee camps, see UAM 21), hydroponics (UAM 10) and modular design (see pages 47 and 50) and the more recent phenomenon, vertical farming. Agricultural land in the city is scarce but many houses have flat concrete roofs, which provides space for growing crops (see also the articles on rooftop gardening and its role in adaptation to climate change in Nepal, in UAM 27), Making the best of scarce city land by using space on flat concrete roofs can also be linked to other sectors, such as health (see the article on Toronto on page 58), and linked to design (see the article on Berlin on page 55). Land scarcity and insecurity also can result in social and institutional innovation such as "land banks" for redistribution of temporary use of land (see the article about TERRAE on page 26).

Urban agriculture is also innovative in comparison to the conventional agricultural model in the way it is **spatially organised**. Traditionally, patterns of urbanisation and industrialisation led to a spatial segregation of agriculture and the city. By contrast, urban agriculture seeks to spatially integrate these two functions. There are various ways to achieve this, generally referred to as a debate between "spare" the land or "share" the land. The former refers, on the one hand, to the argument that urban development and urban agriculture should be as dense as possible, in order to leave as much space as possible elsewhere ("spare the land") for biodiversity and green space, and points in the direction of specialised agriculture being included in the urban fabric, though as a functionally separated and optimised productive activity. Land-sparing innovations typically concern intensifying production, processing, distribution and / or recycling technology (vertical farming, rooftop farming). On the other hand, it is argued that urban development and urban agriculture should be as rich as possible, where different activities are not only spatially but also functionally integrated ("share the land"). In this orientation, agriculture is envisioned as being included in the urban fabric, in such a way that it simultaneously contributes to other functions. See also: http://wle.cgiar.org/blogs/2013/05/15/sharing-or-sparing-land-for-nature. Land-sharing innovations typically are about intensifying the restoration of natural ecosystem functions and their exploitation as productive urban landscape, and about exploiting possible synergies and trade-offs between different activities and functions, such as adaptation to climate change (see the article on Gorakphur, on page 72), biodiversity, recreation, etc. This is also further elaborated in eco-city planning, green corridors and integrated planning concepts such as Continuous Productive Urban Landscapes, and in the promotion of City Region Food Systems. The debate at the GROW the City meeting in Almere (see page 19) also focussed on the opportunities for "sharing", or optimisation of multiple functions of urban

Biogas reactor in the Netherlands. Photo: René van Veenhuizen

Mobile toilet designed by Practical Action, Bangladesh (article on page 77). Photo: René van Veenhuizen

agriculture, while UAM 27 illustrated the role of urban agriculture in climate-smart and resilient city development.

A lack of clean water may also limit urban agriculture, and this is a key determining factor in the development and use of technologies; at the same time large amounts of organic wastes are available in cities. The closing of nutrient and water cycles by means of urban agriculture sometimes provides alternative solutions to expensive infrastructures. Innovations in urban agriculture may therefore also seek to further the development of closed loop farming (see articles on pages 68 and 71 here, and in earlier issues: UAM 20, 23 and 26). At one time, environmentalists regarded the city as a parasite since, rather than producing its own food, it encroached on the wider region in which it is located, polluting water, air and other resources (Odum 1989). Innovations in urban agriculture, however, increasingly propose a more nuanced approach in which cities feed on agriculture but at the same time agriculture is feeding on cities, by using or reusing its nutrient-rich waste water, its waste energy and its urban green waste to re-build the soil. There is increased interest from practitioners as well as city governments in integrating agriculture in the **urban metabolism**, the flows of energy and matter that encompass the urban system's input, throughput and output. The debate in the GROW the City meeting in Rotterdam looked into this issue (see page 24). and called for a more proactive, more systematic analysis of urban flows and what they can contribute to the city (see also on page 47). A more systematic analysis and development of innovations is needed.

Another dimension in which urban agriculture is innovative is the way in which it **organises the production, processing and distribution chain** (both social and market innovation). Whereas, in traditional food supply chains, many parties stand between producer and consumer, urban and periurban agriculture is generally characterizeds by short supply or value chains. In the shortest chain, urban dwellers grow their own food (self-provisioning through allotments or community gardens), a practice that may be considered as "backward" from the standpoint of mainstream economics as it supposedly lacks the benefits of division of labour and specialisation on the one hand and must incur the high costs of urban land on the other. Increasingly, however, we also see urban agriculture as a sophisticated strategy for employment creation (or even a survival mechanism), not only in the Global South but increasingly also in Global North countries facing economic crisis, such as in Southern Europe (see articles on pages 26-34). The debate in the GROW the City meeting in Utrecht explored this issue (see page 22).

Urban agriculture emerges as a way to **reconnect** farmers with urban dwellers, and to bridge the gap between industrial agriculture and increasingly demanding urban consumers in the Global North. Urban agriculture is innovating in new ways to create transparency (not based on formal certification schemes but on direct contact and supervision) and new ways to meet consumer demand (just-in-time, demand driven), and also in new ways for citizens to engage

Drone used for aerial photos of urban agriculture in Ouagadougou. Photo: René van Veenhuizen

as participants, co-producers and co-creators (consumers co-creating urban agriculture practices in terms of finance, labour, market insights, etc.), and in urban planning. Urban farmers experiment with new products and services, benefitting from urban microclimates in and around the built environment, and answering to segments in urban consumption that are not addressed by the conventional system (ethnic food, edible landscapes, etc.). The debate in the GROW the City meeting in Groningen looked into this issue (see page 10). One of the conclusions here was that the role of the municipality needs to change into that of a facilitator, allowing its citizens to explore new ways of community and production.

Facilitating innovation

Urban agriculture is increasingly recognised as a vehicle for the development of, and the transition to, productive and sustainable cities. Since urban farming systems vary widely – from purely subsistence to fully commercial and from micro-units to large enterprises – there is a need for a multi-actor and transitional approach that caters to the development needs and opportunities of the variety in urban food provisioning requirements. This variety implies a wide range of possible manifestations, and innovations, each having its own unique fit with the physical and socio-economic environment.

A focus on business models, enterprise and micro-enterprise development and enhancement of entrepreneurial skills will greatly enhance the innovation process (in production

Pigeon farming on roofs in Dhaka is a lucrative business.
Photo: René van Veenhuizen

Global forum for innovations in agriculture
2015 | ADNEC | Abu Dhabi
9-10 March: Exhibition
9-11 March: Conference

Hosted by the City of Abu Dhabi, capital of the United Arab Emirates, and in partnership with the Abu Dhabi Food Control Authority and a wide variety of sponsors and contributors, the Global Forum for Innovations in Agriculture (GFIA) was held for the first time on 3–4 February, 2014.

The GFIA brought together participants from across the agricultural spectrum: over 3000 participants from 60 countries, more than 120 exhibitors, and NGOs and ministerial delegations from the countries UAE, Netherlands, Ghana, Zambia, Kenya and Tanzania. A number of innovations also included in this issue of the UA Magazine were presented in fifteen-minute long TED-like talks, during which speakers sought to convince the audience why their innovation would change prevailing thought about agriculture. GFIA was presented the "Best Conference" award at the Middle East Events Award Ceremony. As one of the GFIA partners, RUAF supported the attention for urban agriculture and food systems by putting the issues of participative innovation and social inclusion on the agenda (see below a short report on the round-table session organised by RUAF).

The 2015 GFIA is planned for 9–10 March. The 2015 edition will include partnership initiatives on post-harvest waste reduction, ICT, a workshop on hydroponics and algae production, and a forum on innovations in water technology, including recovery and reuse by IWMI. In addition, it will also focus on **Edible Cities, building resilience with urban agriculture,** including discussions on vertical farming, planning and design, climate smart urban food systems, and stakeholder collaboration.

GFIA 2014 Roundtable Session: Promoting Social Inclusive Innovations in Urban Agriculture

The objective of this roundtable was to discuss experiences with scaling up innovations in urban agriculture, and how to strike a balance between social impact on the one hand and economic viability on the other. It was facilitated by René van Veenhuizen of RUAF with Jan Willem van der Schans of Wageningen University and Research, The Netherlands.
A discussion was held with panellists from IWMI, University of Arizona, Farm City Rotterdam, MITCityFARM, MASDAR Institute, Tamagama University, Puranatura and the Aga Khan Foundation.
The focus of this discussion was on food systems in and around urban areas, adapted to specific urban conditions such as confined space, proximity to consumers, and food safety. System innovation refers to improvements in the relations between various actors, e.g., multiple land use, short food supply chain development, and closing urban waste cycles, which are often a combination of technical, organisational and market developments.

A major challenge is to strike a balance between social impact on the one hand and economic viability on the other hand. To further professionalise and scale up urban agriculture innovations, external investment may be needed. But if urban farming projects focus on economic viability only, they do not really differ from conventional agriculture, which is likely to be more efficiently organizeds. If urban farming projects focus on social inclusiveness alone, it is unclear whether this can be scaled up and whether it can make a real impact on urban challenges. Clearly then, both economic viability and social inclusivism are required, in varying intensity at the different stages of development. This is often a matter of social innovation more than technical innovation. Two cases were introduced and discussed. One introduced by IWMI related to urban waste recovery and reuse, and how to bring in business approaches to make the initiatives more robust. The other case, by University of Arizona, building on ''anytime, anywhere" agriculture and referring to agriculture operating in fully controlled environments, applied to locations with arid land, or places with a shortage of land, like cities. The participants referred to cases from their own experience.

It was also mentioned that, in the innovation of urban agriculture, we should look not only at costs, but also at the willingness to pay for increased access to fresh and nutritious food. Costs will be reduced when innovative forms of city farming mature, but it is also a matter of credibility and legitimacy. Urban agriculture should use more decentral, direct marketing channels in addition to the conventional, more centralised distribution channels. In order to gain competitive advantage over the current food system, urban agriculture would need to distinguish itself: with new forms of growing (closed nutrient loop, low energy), new varieties (perishables) and new ways of relating to customers (co-creation). In addition, agriculture adapts itself to the city, but the city will also adapt itself to agriculture and food. Cities have been optimised to a number of other things than food, but with current initiatives and insights, cities need to include and adapt to include agriculture. More sharing of data on economic performance as well as social and ecological performance is required.

Economic viability and social impact are not always at odds. Cases illustrate that economic performance is increasingly important, even for publicly financed socially orientated initiatives. It is also clear that there is no silver bullet to provide a solution to world food insecurity; it is very likely that a portfolio of solutions is needed, sometimes high tech (led light growing facilities) and sometimes low tech (pasture land for roaming livestock).

Development of UPA and short-chain food delivery involves the creation – or re-creation – and strengthening, at the city-region level, of networks and linkages, many of which were broken in earlier processes of globalisation and specialisation. UPA is driven by initiatives of market parties (including producers), government agencies and civil society. Generally, initiatives that build on a balanced and complementary mix of governance mechanisms (e.g., through public-private partnerships, multi-stakeholder platforms and an increased role for SMEs) appear to be relatively successful and more resilient.

A design of a vertical farm in Berlin (article on page 55). Photo: VFA

as well as in processing and marketing). There are a variety of business types, and showcasing this variety is important. Cutting across these types are various business aims: cost saving, cost recovery, revenue generation, profit maximisation, portfolio diversification, social enterprise, etc. Business models must always be attuned to the specific contextual setting and historical conditions which determine the success or failure of a case. The participatory nature of multi-stakeholder processes can play an especially important role in success and impact. Successful innovation requires facilitation of bottom-up initiatives, using mixes of financing, active networking and farmer/entrepreneur participation in neighbourhood and city platforms (undertaking joint situation and innovation analysis and policy reformulation).

In the urban setting, innovations in agriculture are heavily influenced by local institutions, policies and regulations, at various levels which not always are mutual supportive. Innovation in many cities may be constrained by existing legislation, the informal legal status of urban agriculture, lack of land-use security, and lack of support from technical and financial institutions. Given the challenging urban conditions, support to (innovation in) urban agriculture needs to focus firmly on giving space to, and building problem-solving capacities of, the main actors: including citizens and the urban producers and entrepreneurs (in problem analysis, analysis of specific requirements of various market segments, identification and testing of alternative solutions, building strategic alliances).

Rotterzwam Growkit. Photo: Rotterzwam

Many cities have created and are actively supporting platforms, councils (including those whose focus is food), and specific agencies for urban agriculture; many cities are also implementing related policies and programmes. RUAF facilitates this with its Multi-Stakeholder Action Planning and Policy Formulation (MPAP, Dubbeling et al, 2010), and is supporting City Region Food Systems. Innovation processes in urban agriculture have a better chance of success if they are part of an integrated approach to urban development and are embedded in an enabling institutional and policy environment.

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RUAF Foundation

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GROW the City: Learning Networks between North and South for Innovations in Urban Food Systems

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Daniel de Jong

What do cities like Rosario, Groningen, Cape Town, Toronto, Lima, Almere and Rotterdam have in common? Although situated in different parts of the world and characterised by very diverse socio-cultural and economic contexts, these cities are all at the forefront in the development of urban agriculture and sustainable regional food-provisioning systems. The project GROW the City, which ran in the Netherlands from September 2013 to July 2014, brought these pioneers of urban agriculture and urban food strategies from all over the world to the Netherlands to share and discuss with pioneers in the Netherlands, their practices, experiences and challenges.

Informal Urban Agriculture Cafés as anchor of the project.
Photo by: Daniel de Jong

Introduction

The GROW the City project aimed to enable the integration and exchange of knowledge and experiences with urban and peri-urban agriculture (UPA) and urban food strategies worldwide. It is a joint initiative of the RUAF Foundation in collaboration with the ETC Foundation and the Wageningen UR Department of Applied Plant Research. It was financially supported by the GROW fund of Oxfam Novib in the Netherlands.

The GROW the City project was undertaken within the framework of the OXFAM worldwide GROW campaign for a more sustainable and just food system, and was designed to focus attention on urban agriculture and urban food policies as possible strategies and perspectives of action for realising such system changes. The core of the approach of the GROW the City project was the exchange and integration of urban agriculture knowledge and experiences in the global South and the global North, and particularly in the Netherlands. In many ways, the development of urban agriculture and urban food systems in the global South is characterised by more, and different (frequently better developed), initiatives than in the global North. This is especially true with respect to social integration of urban agriculture initiatives in the broader urban system, policy approaches for climate change adaptation and mitigation, or integration of urban agriculture into urban territorial planning. Therefore, there are several interesting opportunities for joint learning, exchanging best practices, and drawing lessons from the global South.

Often, the approaches of UPA initiatives in the global South, as seen from the Netherlands, bring in new and different perspectives and are therefore original, inspiring and refreshing. In the Netherlands as well, a wide range of ideas and initiatives is emerging around UPA. However, these are often still fragmented, and too often obstructed by rigid procedures and a lack of information on the one hand and adequate support from involved governments and organisations on the other. A fresh look, reflecting on successful experiences elsewhere, can help to bypass such institutional and habitual stumbling blocks.

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The Dutch City Network on Urban Agriculture 2.0: building and extending

The GROW the City project built upon the experiences and structure of the Dutch City Network on Urban Agriculture 2.0 *(Stedennetwerk Stadslandbouw 2.0)*, which is described on pages 38-41. The City Network was facilitated by two of the organisations that collaborate within the GROW the City project (Wageningen UR and ETC). Furthermore, the GROW the City project also built upon the pioneering networking activities that were realised as part of the City Network, even though GROW the City was explicitly designed to go beyond the City Network experiences.

Excursions as valuable means to exchange experiences. Photo by: Patrick de Baat

By establishing learning exchanges, the GROW the City approach made explicit linkages with urban agriculture experiences in other countries, especially in the global South. Little is still known in the Netherlands (and the global North more generally) about experiences with UA in the global South, even though these are often developed at a considerably larger scale and with more extensively developed relations with markets and policy at the local level.

Another innovative aspect of GROW the City was the deepening and extension of existing networks related to urban agriculture in the Netherlands: from networks principally centred around civil servants involved in UPA (as is mainly the case with the City Network on UA) to the additional inclusion of citizens and entrepreneurs involved in urban agriculture and urban food-related initiatives. The idea was that a strengthening of dialogue between different stakeholder groups and persons interested in urban agriculture and urban food strategies (governments, and also citizens, entrepreneurs, community organisations, etc.) would provide a basis for new dynamics and spin-offs to local initiatives, as has been experienced under RUAF multi-stakeholder initiatives in various cities.

Furthermore, GROW the City explored possible methods and work forms for stimulating social innovation. First, the project aimed to use the potential of social media such as *Facebook*, *Twitter*, and *LinkedIn* to facilitate and strengthen social networks. This made it possible to address otherwise difficult-to-reach target groups for activities. Also, it enabled the building of a virtual "social community" around the topics discussed within the GROW the City project, to interest relevant social actors for organised events in cities and, after the celebration of events, obtain feedback from participants. Additionally, the work forms and methods that were applied in GROW the City events were designed to stimulate open and participative communication, to strengthen and interconnect social networks, and to address specific needs and challenges perceived relevant by stakeholders in each specific context. More generally, the project aimed to support community-based forms of social innovation, which are not introduced from outside but rather emerge from the strengthening of joint learning processes and that are co-produced by citizens and local governments (Murray et al 2011; MacCallum et al. 2009).

Urban Agriculture Cafés as anchors

The anchors in the GROW the City project consisted of four so-called *"Urban Agriculture Cafés"* which were organised in four different cities in the Netherlands. These Urban Agriculture Cafés were informal, easily accessible, public events where various types of stakeholders involved and interested in urban agriculture and urban food strategies in that city could meet, interact, and exchange experiences. The Cafés formed the central events where network-building and North-South and North-North learning exchange between UPA experiences within the GROW the City project took place.

Each Urban Agriculture Café had its own specific central theme, which ranged from urban agriculture and climate change or urban food strategies and logistics to aspects like citizen participation, business models, nutrient recycling, etc. Each Café was organised in collaboration with a Dutch host city, represented either by the local municipal government or by civil society organisations involved in UPA issues. The specific central theme for each Café was selected and elaborated in dialogue with these local host organisations, and was intended to reflect specific needs, challenges and questions faced by urban agriculture and urban food provisioning in the host city. Relevant experiences elsewhere were selected, and a representative from a related initiative in the global South was invited to come to the Netherlands and share their experience. In some cases, representatives from other related experiences in the global North joined the event on their own initiative or upon invitation by host cities.

A project website (www.growthecity.eu) and social media pages such as Facebook (www.facebook.com/GROWtheCity/) and Twitter (#growthecity) were established for promotion and communication. Each Urban Agriculture Café was preceded by targeted social media activities closely related to the central theme, including blogs, content articles and short, inspiring videos. Together, these social media activities generated a social community in which the Cafés were embedded and by which they gained extra significance. Additionally, each Café was supported with fact sheets on urban agriculture experiences in the Dutch host city and in involved cities elsewhere in the global North and South.

An overview of the four Urban Agriculture Cafés

From autumn 2013 to summer 2014, four Urban Agriculture Cafés were organised in different cities across the Netherlands. The cities were selected on the basis of a number of criteria, including: the expressed interest of city governments and civil society organisations in hosting an Urban Agriculture Café; the realisation of a sufficient spread of Cafés over different parts of the country; the inclusion of a range of different relevant thematic aspects of urban agriculture and urban food strategies; and, where possible, links with other important events in order to increase coverage of the GROW the City event.

In the end, a balanced selection of cities around the country was realised, with an interesting mix of different thematic aspects of urban agriculture and food. Also, to various degrees, the Cafés were organised in collaboration with local municipal governments and/or local civil society platforms active in the cities.

- The first Urban Agriculture Café was organised on 22 November 2013 in the **City of Groningen** in the north of the Netherlands, within the framework of the local "inspiration festival" called "Let's GRO". For this first UA Café, the central theme, selected and elaborated in dialogue with the municipal government of Groningen, was *"Citizen participation in the design and management of urban agriculture spaces"*. The challenges faced by the municipality Groningen in this area were discussed in relation to experiences with participatory planning and incorporation of UA in spatial planning in the cities of **Rosario (Argentina)** and **Ghent (Belgium)**. The afternoon also included an excursion for UA Café participants to urban agriculture initiatives in Groningen.
- The second Urban Agriculture Café took place on 16 April 2014 in the **City of Almere** in the centre of the Netherlands. Here the UA Café was organised in collaboration with the municipality within the framework of the preparations for the Floriade International Horticultural World Expo which will be held in the city of Almere in 2022. The motto of the Floriade Almere 2022 is "Growing Green Cities"; in the time until the expo the municipality has ambitious plans to develop a prototype of a Green City in which urban agriculture and regionalised food provisioning also play an important part. The central theme selected for the UA Café together with the municipality was therefore *"Feeding the City"*, with the key question, *"How can city-countryside relations be constructed and strengthened at different scale levels?"*. The challenges of Almere city in this respect were discussed in relation to experiences with the upscaling of UA experiences in the

Accesible work forms facilitate social innovation.
Photo by: Daniel de Jong

Informal contacts help to strengthen social networks.
Photo by: Daniel de Jong

cities of **Lima (Peru)**, **Toronto (Canada)** and **Milan (Italy)**. In the afternoon, an excursion was also organised for UA Café participants.

- The third Urban Agriculture Café was held on 16 May 2014 in the **City of Utrecht** in the heart of the Netherlands on the occasion of the national Day of Urban Farming. Here, the UA Café was meant to be complementary to the national Day of Urban Farming, which mainly attracts representatives of municipalities, companies and research institutes. By contrast, the UA Café focused on issues faced by local community and civil society initiatives for urban agriculture and food in and around Utrecht. The Café was organised in collaboration with the municipal government of Utrecht and the civil society platforms *Eetbaar Utrecht* ("Edible Utrecht") and *Lekker Utregs* ("Tasty from Utrecht"). The UA Café focused on the central question, *"How can local initiatives for urban agriculture be made robust and sustainable?"*. The challenges for civil society initiatives in Utrecht were discussed in comparison to the experiences of the community gardening initiative Abalimi/Harvest of Hope in **Cape Town (South Africa)**.
- The fourth Urban Agriculture Café took place on 10 July 2014 in the **City of Rotterdam** in the West of the Netherlands. Here the central theme for the UA Café was *"Harvesting Nutrients"*, i.e., nutrient recycling and its possible synergies with urban agriculture and regional food systems. This central theme was chosen in line with the central topic, "Urban by Nature", of the International Architecture Biennale Rotterdam (IABR); this celebration, from 29 May to 29 August, generated a lot of attention for the flows of nutrients, energy, water etc. that make up the "urban metabolism" of the city. The activities in Rotterdam were organised in collaboration with the municipal government of Rotterdam as well as the Dutch Nutrient Platform and the local civil society platform *Eetbaar Rotterdam* ("Edible Rotterdam"). In the afternoon a "Circular Clinics" event was organised with the municipality and the Nutrient Platform; the event explored advantages of centralised and/or decentralised forms of nutrient recycling. In the evening an Urban Agriculture Café was organised together with *Eetbaar Rotterdam* and the Nutrient Platform; this Café looked into experiences of local entrepreneurs and community initiatives which build on closed nutrient cycles in their activities. The challenges and experiences in Rotterdam were discussed in relation to experiences with nutrient recycling in **Tamale (Ghana)** and **Ghent (Belgium)**.

Lessons learned

The experiences with North-South exchange around Urban Agriculture in the GROW the City project made clear that there is a great potential to learn from each other and mutually strengthen social innovation and change processes between different countries in North and South. Until now there was very little known amongst people involved in Urban Agriculture and Urban food policies in the Netherlands about the richness and diversity of experiences elsewhere, and especially in the global South. The GROW the City activities have contributed to increased consciousness and knowledge of such experiences and demonstrated the powerful role that direct, personalised exchanges can play in these. They also demonstrated that practitioners from outside often can give valuable insights and recommendations for initiatives in the global North, because they are capable to think "out of the box" and look beyond particular local contexts.

Additionally, the various Urban Agriculture Café that were organised in different cities demonstrated the strong potential of social innovation methods and social media in strengthening and extending social networks. As such, the GROW the City project has been successful in building bridges between existing policy networks around Urban Agriculture in the Netherlands and stakeholder categories such as entrepreneurs and civil society organisations that were not yet strongly represented in these. These strengthened social and policy networks provide a basis for the further development and innovation of Urban Agriculture and City-Region Food Systems in the nearby future.

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Participatory Planning for Edible Cities in Rosario and Groningen

Marieke Koot

Excursion to Edible City initiative in Groningen. Photo by: Henk Renting

The first Urban Agriculture Café of the GROW the City project was organised in the city of Groningen, a regional centre with ca. 200,000 inhabitants in the north of the Netherlands. Urban agriculture in Groningen has increased markedly in the last years and is an important policy topic. An important challenge for the municipality is how to better integrate urban agriculture into city planning and organise citizen participation as part of this. This challenge was discussed with the city of Rosario, which has a wealth of experience in urban planning for urban agriculture. Laura Lagorio from the National University of Rosario was invited as an expert, in view of her involvement in participatory urban agriculture design projects. Wout Veldstra, who is responsible for urban agriculture in the Groningen municipality, welcomed her to his city.

Groningen Edible City

The city of Groningen started promoting urban agriculture and community gardening as a form of citizen participation in public green areas in 2009. In follow-up, the municipal food policy "Groningen Grows Healthy", in 2012, created space specifically for such initiatives. Through the "Edible City" project, in which the municipality works together with the Nature and Environment Federation Groningen, it is possible for citizens' groups to establish collective vegetable or herb gardens, or plant fruit trees in public parks, in consultation with the municipality. This can, for example, be on a derelict field in a neighbourhood or on a lawn or park between flats or houses. This form of citizen participation in "edible green" has been very successful. By now, there are already more than 50 locations in the city, of which some were visited during an excursion for the Urban Agriculture Café. With a few exceptions, though the municipality did not take the initiative, the plans from citizens and entrepreneurs are actively supported and facilitated by the municipality, e.g., with contacts, some money or in-kind support for infrastructural works and the designation of plots.

Challenges for urban planning

While the Edible City project is successful, it also raises important questions. Plots are generally designated only for a limited period, and there is no clear designation for agricultural use within urban planning. In the Netherlands, urban planners and architects are not yet interacting sufficiently with the urban agriculture movement. As a consequence, UPA is not a topic taken into account in design processes, and is at best seen as temporary land use. How can the planning and design of public space for urban agriculture as part of city planning be improved?

Discussions at the Urban Agriculture café. Photo by: Matty Baars

Planning of spaces for urban agriculture in Rosario

The municipality of Rosario, Argentina has a long tradition of promoting urban agriculture, not only as a means to contribute to food security and income generation, but also to provide recreational and educational functions and help to preserve the city's green spaces. Following the boost of UPA during the economic crisis in Argentina, the Rosario municipality developed an active policy framework for the support and regulation of urban agriculture. The incorporation of UPA in spatial planning has been an important focus, in addition to support for commercialisation at local markets and training in agro-ecological production methods. The municipality actively created a network of multifunctional spaces for urban agriculture, consisting of, among others, four Urban Gardening Parks, numerous community gardens, productive spaces along railways and roads, etc. In 2013, a total of 67 hectares of land were designated for UPA, of which 22 hectares are currently in production. Also, several projects with different types of designs of public spaces for urban agriculture were implemented by the Rosario municipality in collaboration with the National University of Rosario. For example, the project "Making the Edible Landscape" (2004-2006) aimed to design spaces for jointly growing food for living and combining it with other goals, such as increasing social cohesion and creating sports and meeting facilities.

Key role of citizen participation

A key success factor for Rosario's policies has been to mobilise citizen participation in the design and management of green spaces for UPA. Participatory design, and participatory planning more generally, contribute to more socially inclusive forms of governance and help to bridge the gap of distrust between citizen groups and local governments. The challenge for the participatory design of community gardens in Rosario was to link architects, urban planners, local and national governments, social movements, slum inhabitants and urban gardeners. They managed to work together in a bottom-up process of planning, design and management of spaces for UPA, for which an intense dynamic of training and community workshops was needed. Landscape architects and designers had to learn to trust and work with the community and pay attention to community needs in order to ensure a balanced participation of various groups.

Marieke Koot

Gardens in Molino Blanco garden park, Rosario. Photo: Making the Edible Landscape

FEEDing the City: Approaches to the Upscaling of Urban Agriculture in Almere, Toronto, Lima and Milan

Henk Renting

Excursion to Onze allotment gardens under glass. Photo by: Henk Renting

In 2022 the city of Almere will host the World Horticultural Expo Floriade, with the central motto "Growing Green Cities". In the years until the Floriade, the municipality has ambitious plans to develop Almere as a prototype for a Green City, of which urban agriculture and regionalised food provisioning are an important part. A key question for the municipality is how to build bridges between existing successful, but small-scale, UPA initiatives and challenges at larger scale levels. During the GROW the City Urban Agriculture Café on 16 April 2014, Almere had the opportunity to share experiences in the upscaling of urban agriculture initiatives with such other cities as Lima (Peru), Toronto (Canada) and Milan (Italy).

Almere Floriade 2022 - "Growing Green Cities"

Almere is a special city for several reasons. First, it is situated on newly reclaimed land in the polders in the centre of the Netherlands. It was founded quite recently, in the 1970s, and is thus a young city without a long history, which has made it possible for Almere to be flexible and creative in its planning approaches. Second, Almere is facing important development challenges, not the least of which is the expectation that it will alleviate growth pressure from the neighbouring city of Amsterdam. The population of Almere, currently more than 190,000 inhabitants, is projected to double by 2030.

Almere's proposals for the Floriade reflect these challenges. As urbanisation continues, quality of life increasingly depends on the quality of cities. Almere was developed as a "Garden City", incorporating considerable green spaces in the urban structure, and for future growth it will be important to consolidate and strengthen this model into a "Green City". The motto for the Floriade therefore is "Growing Green Cities", and for the period until 2022 the municipality has challenged itself to become an exemplary "Green City" in four thematic areas.

Under **FEEDing** the city, agriculture is to be brought (again) into the heart of the city, both to contribute to food production and as a means to enhance social cohesion, education, and awareness of where food comes from. **GREENing** the city expresses that green areas are considered key for quality of life, and are crucial assets to attract investments and cultural activities. **ENERGIZing** the city implies a focus on closing cycles, increasing energy efficiency, and self-sufficiency in energy generation. Finally, **HEALTHYing** the city refers to the contributions of healthy, fresh and local food and of green spaces to the well-being and health of Almere's inhabitants.

FEEDing the City: challenges at different scale levels

The key challenges Almere is facing for the theme FEEDing the City, as discussed during the Urban Agriculture Café, is how relations between the city and the countryside can be

strengthened at different scale levels and, more generally, how successful UPA and regional food provisioning initiatives can be upscaled. This requires building connections between innovations at three different scale levels (see Figure 1).

Figure 1. Building urban-rural connections at different scale levels

At the **micro-level**, urban agriculture and local food initiatives increased markedly in recent years, to some 50 initiatives in 2010. These are mainly community gardens aimed at strengthening social cohesion, or school gardens where UPA is integrated in educational programmes. Another example is the *City Farm Almere*, a professional organic farm started in 1996 that created strong links with citizens as visitors and customers and currently uses 160 hectares in and around the city, largely on land owned by the municipality.

At the other extreme, Almere is located in a highly production-oriented agricultural region with farms that are strongly integrated in world markets. At this **macro-level**, linkages between the city and the countryside are still poorly developed, even though some production types (e.g., tulip bulbs) have added value in preserving the typical, open landscape around the city.

Finally, at the **meso-level**, in the coming years many opportunities to strengthen city-countryside relations and develop innovative forms of urban agriculture will emerge. To provide Almere with regional larger-scaled food initiatives connections of the city with urban or periurban and rural producers are needed. Some farms may also create new economic perspectives by rebuilding direct links with the city, as did the horticultural enterprise *ONZE* who stopped producing for the world market and now rents out allotments in the greenhouse to citizens. The *Oosterwold* region pays specific attention to the meso-level. It is an area of 4.300 hectares east of the city where new green housing is developed through an innovative open planning process. Citizens can present their own plans on the condition that building proposals be combined with agricultural uses on 50% of the land. It is hoped that this experiment with "do-it-yourself" urbanism will result in innovative forms of UPA and strengthen linkages between the city and the countryside.

Different strategies for upscaling and strengthening urban food systems

At the Urban Agriculture Café, the challenges faced by Almere in strengthening relations between city and countryside at different scale levels were shared with experiences from three other cities in different parts of the world: Toronto, Lima and Milan. The exchange made clear that different strategies are available for upscaling and strengthening UPA and regional food systems; these may be applied by city governments, depending on specific local settings.

Toronto: Food Policy Council bringing together local stakeholders

The city of Toronto, represented by Lauren Baker, is particularly interesting to Almere for its experience with the Toronto Food Policy Council (TFPC), founded in 1991 as an innovative platform to engage citizens in local policy making on food and agriculture. Since then, the TFPC has become an international reference followed by many other cities in Canada, the USA and, increasingly, also Europe. The TFPC brings together citizens and local policy makers engaged in food issues, and by doing so has become a focal point for new policy dynamics surrounding food and agriculture in Toronto. Initially, the focus of the TFPC was mainly on food and public health, but now it covers all aspects of the food system, including agriculture, economic development, wellbeing, social justice, and environmental sustainability.

Local and international guests at the Urban Agriculture Café. Photo by Daniel de Jong

Henk Meijer explains Almere's challenges. Photo by Daniel de Jong

The TFPC has generated important spin-offs to local policies related to Feeding the City, e.g., the *GrowTO – Urban Agriculture Action Plan for Toronto* established in 2012, which defines policies and support measures for food-growing efforts by Toronto's citizens. Another example is the *Golden Horseshoe Agriculture and Agri-Food Strategy – Food and Farming Action Plan 2021* for Toronto's green belt, which aims to strengthen relations with the city, among others by creating value chains that build on local distinctive qualities.

Lima: municipal policy promoting urban agriculture

Urban agriculture in Lima (Peru) has come up in a very different context with a direct need to improve food security for disadvantaged groups. The metropolitan municipality of Lima has extensive experience with promoting urban agriculture and was identified by FAO as one of the 10 leading cities in *"Growing Greener Cities"* in Latin America and the Caribbean. In 2012, the municipal policy programme *"Mi Huerta"* (My Garden) was established to promote urban agriculture as a strategy for environmental improvement, food security, social inclusion and local economic development. As part of this, various investments and support measures were put into place.

In 2013, 1,000 urban gardens were established, benefitting 20,000 inhabitants. These consist of family gardens, community gardens and school gardens, and mainly provide food for home consumption. *Mi Huerta* also promotes vegetable sales by producers on local eco-fairs and gives support through training, promoting producer associations, developing marketing concepts and establishing infrastructures. Also, links with environmental management are strengthened, through the reuse of grey water for irrigation and the establishment of educational gardens in public parks that form part of Lima's green infrastructure.

Milan: agricultural districts linking the city with periurban areas

Milan (Italy) is interesting to Almere because it hosts the *World Expo 2015* with the motto *"Feeding the Planet. Energy for life"*, which has clear parallels to the Floriade agenda of Almere. Additionally, in Milan several initiatives have come up that successfully connect the city with surrounding periurban areas. The establishment of the *South Milan Agricultural Park* in 1990, the first agricultural park in Italy, and with 47,000 hectares the largest in Europe, gave a strong initial stimulus for developing territorial policies and initiatives on tourism and land management in Milan's periurban areas.

Lauren Baker (Toronto) and Andrea Calori (Milan).
Photo by Daniel de Jong

Andrea Calori, scientific food coordinator of Milan's Food Policy, reflects on the Almere Urban Agriculture Café

"What I found impressive about the UA Café was that politicians, students and professionals discussed so easily at the same level, in an open way and without hierarchy. It was also striking to see that Almere municipality makes such a clear choice for combining food, environment and lifestyle and connects this with the city's development and urban planning. This is rare, within Europe as well, and certainly for a city with such a rapid growth rate. It is interesting that Almere, as a city without a clear and pronounced history, is creating a new identity and personality in which agriculture and environment play a prominent role. For the situation in Milan I have learned several concrete lessons, for example the management of municipal land by a city farm for which environmental management criteria make up part of the contract. And also the way in which Almere city mobilises young people and entrepreneurs as "Urban Greeners" is an approach that we can use in Milan."

In recent years, this was complemented by initiatives building local food networks around the city, for example *Mercato della Terra ("Earth markets")* organised by Slow Food and ca. 120 consumer cooperatives for local and organic products, organised by social movements and entrepreneurs. Recently, institutional innovations are also emerging, supporting the integration of agricultural, rural and urban food policies by establishing "agricultural districts" in the periurban zone, while Milan's city council decided to start elaborating a Local Food Policy. Milan's experience demonstrates the important role that the empowerment of local actors can play as a potential force for creating interrelations between the city and countryside.

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Working Towards Robust Urban Agriculture Initiatives in Cape Town and Utrecht

Patrick de Baat
Henk Renting

Rob Small sharing Abalimi's experiences. Photo: Daniel de Jong

How can urban agriculture initiatives be made sustainable over time in terms of organisation and finances? This was the central question of the Urban Agriculture Café organised in Utrecht on 16 May 2014 within the framework of the GROW the City project. Its special guest was Rob Small, co-founder of the organisation Abalimi Bezekhaya which has been organising urban gardening activities in Cape Town (South Africa) for many years. Their "Harvest of Hope" project combines gardening for home consumption with a social enterprise selling over 600 boxes per year of locally produced organic vegetables, all grown and distributed by "micro-farmers".

Challenges for emerging initiatives in Utrecht

Many bottom-up initiatives in the areas of urban agriculture, community gardening and local food have emerged in and around Utrecht over the last decades. During the Urban Agriculture Café, five initiatives of citizens and entrepreneurs shared their experience and challenges in building a sustainable and robust organisation in an environment where there is not much support from local governments. The initiatives from Utrecht ranged from the "Food for Good" gardening initiative, which works with migrant communities and produces for home consumption and the local food bank, through the "Funghi Town" start-up business that is looking for space to grow mushrooms in unused buildings, to the local platform called "Eetbaar Utrecht" ("Edible Utrecht"), which brings together several UPA and gardening initiatives. Also, upcoming initiatives from the neighbouring cities of Zeist and Dordrecht presented their experiences and challenges.

Similarities between Utrecht and Cape Town

A common challenge for UPA initiatives in the Netherlands is that they manage to break even yet are hardly viable in the long run. Therefore there is a lot of interest in potentially viable business models and income earning options for UPA, as well as organisational strategies to valorise them. In this respect, the presentation by Rob Small on Abalimi's experience with facilitating the development of community gardening in Cape Town, going from social initiative for home consumption to commercial business, was highly appreciated, and similarities to the Dutch situation were recognised.

Especially the step in this "farmer development chain", from a sustaining activity that produces for people's own consumption to a (semi-) commercial activity in which market demand and requirements become more prominent and business like choices need to be made, was generally considered to be critical. Making a profit means potential job creation, but it also means that a more individual mindset emerges that needs to be accommodated within the group and may challenge some of the social benefits of the initiative in earlier stages as well as reduce the number of people that profit from these benefits. It seemed that the goals of some of the Dutch initiatives were not yet fully coherent in terms of their diverse ambitions: to be spaces for self-production and at the same time supply to multiple chains (like food banks or restaurants) that have varying quality demands.

Success factors

Rob Small stressed the importance of support by local municipalities in this critical stage of initiatives. This does not necessarily have to be financial support, but may also consist of flexibility and support in obtaining licenses or facilitating linkages between consumers, citizens and these emerging social enterprises to establish their place in a highly competitive food market dominated by supermarkets and larger businesses.

Another success factor in the case of South Africa is the strong organisational structure and continuity of the initiative. Abalimi provides agricultural extension and training to producers and also has been instrumental in developing quality criteria and marketing structures for the organic vegetable boxes grown by micro-farmers. Abalimi functions as an NGO and therefore has no profit goal; it can provide these services which, for individual producers, may represent considerable costs and often are not provided by government services. In the Netherlands, because such intermediate support organisations for urban agriculture are lacking, the South African experience appears to hold relevant lessons in this respect as well.

Patrick de Baat
Henk Renting

Lively discussions with local UA initiatives in Utrecht. Photo: Daniel de Jong

Harvesting Nutrients in the Cities of Rotterdam and Tamale

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Ongoing urbanisation confronts cities worldwide with challenges with regard to providing resources such as clean drinking water, healthy food and green energy. Future scarcity of nutrients such as phosphorus also draws attention to the need to close nutrient cycles within the city. These challenges and perspectives were discussed during the GROW the City Urban Agriculture Café in Rotterdam.

Challenges for Harvesting Nutrients in Rotterdam

The city of Rotterdam is a hotspot for urban agriculture in the Netherlands. Some of the leading UPA initiatives, such as *Uit je Eigen Stad* ("From your own city") or the mushroom farm *RotterZwam* (see page 52 onward), are located here, and Rotterdam is the first Dutch city to install a Food Policy Council. One major issue there that is attracting attention is the challenge of improving nutrient and wastewater management. This challenge has good potential, as wastewater companies are willing to collaborate in exploring options for valorising phosphorus from wastewater as fertiliser (water boards across the Netherlands are experimenting with this). Moreover, Rotterdam, the largest European harbour, imports large amounts of nutrients in the form of cattle feed for Dutch animal husbandry, and there is a growing consciousness among local authorities of the need to improve the city's nutrient balance.

The 6th International Architecture Biennale (IABR), celebrated in Rotterdam spring–summer 2014, provided an excellent platform for putting this topic on the local policy agenda. The central theme of the IABR was "Urban by Nature" under which various aspects of the city's "urban metabolism" of flows of products, people and energy were addressed. A discussion on closing nutrient cycles and on possible forms of reuse in urban and regional agriculture, looking at urban metabolism from a food and agricultural perspective, fit in perfectly. The closing of cycles and valorisation of nutrients at the local level, moreover, opens opportunities for boosting the local economy through the application of a circular economy approach.

Circular Clinics and Urban Agriculture Café

Against this background, the GROW the City project organised two complementary events on 10 July 2014 in collaboration with the Dutch Nutrient Platform and relevant local actors such as the municipality of Rotterdam, the civil society platform Edible Rotterdam and various initiatives. In the afternoon, professionals from municipalities, companies and research organisations gathered in a "Circular Clinics" workshop to discuss potential for the reuse of phosphorus from wastewater as well as some scenarios for implementing such measures in Rotterdam. In the evening an Urban Agriculture Café was arranged with citizens and entrepreneurs, on the topic of experiences with valorising nutrient cycling through entrepreneurial and community-based economic activities.

Inspiration from WASH program in Ghana

Bizoola Gaanda of University of Development Studies, Tamale (Ghana, see also the article on page 71) was invited as an international expert. He played an inspiring role at both GROW the City events: he shared experiences with nutrient recycling and agricultural reuse in his country. The global South has a wealth of experience with the (productive) use of wastes for urban and other agriculture and nutrient recycling, and in some locations more of this experience has been gained than in the global North. In Tamale, farmers have been using waste water and faecal sludge for many years (see earlier issues of the UA Magazine). Mr. Bizoola is also collaborating with RUAF in the Dutch WASH Alliance (see UAM 28). He presented experiences from more than ten years of working with multiple stakeholders on safe and productive reuse of liquid and solid waste in Tamale, including several concrete examples of how nutrient cycles and agricultural reuse may actually be connected or reconnected at the local level. While the context of wastewater management and agriculture in Ghana is very different from Rotterdam, these concrete examples gave a clear and inspiring idea of mechanisms through which linkages can be established at the local level.

Decentralised or centralised wastewater management

The central focus of the Circular Clinics workshop was possible scenarios for improving nutrient recycling from wastewater

Reuse of waste water in Urban Agriculture in Tamale (Ghana).
Photo: Bizoola Ganda

Siemen Cox shares experiences of Rotterzwam (see also article on page 52): Photo: Daniel de Jong

in the context of Rotterdam. Municipal governments and water companies are increasingly aware that better use should be made of nutrients in wastewater as a valuable resource. This is especially the case for phosphorus, for which it is clear that future availability from mineral sources is limited, and that wastewater and faecal sludge will play a key role as future sources of phosphorus. Technical options are available (some are in use) for isolating phosphorus from wastewater and processing it into struvite, a pelletisable fertiliser that can be used in agriculture. However, (old) infrastructure, public opinion and acceptance, and legislation still hamper widespread use of these technologies.

An important question is whether centralised or decentralised models of wastewater management are more appropriate for implementing this type of nutrient recycling. Various proposals and experiences where shared and discussed at the Circular Clinics. Topics ranged from scenarios for centralised processing of wastewater into struvite, which might profit from scale advantages, to more decentralised approaches which make it possible to combine phosphorus recovery with other forms of reuse. One example concerned revitalising the harbour area of Ghent (Belgium), where a complete neighbourhood is to be disconnected from the overall sewage system. Wastewater will be processed at the neighbourhood level into struvite, and waste streams are used for decentralised energy production. The Clinic participants agreed that a step-by-step process is required, with several pilots and joint learning, in both the Global North and South.

Valorising recycled resources

While the Circular Clinics mainly focused on wastewater management, the Urban Agriculture Café centred on options to valorise (the closing of) nutrient cycles as a resource base for community-based and entrepreneurial economic activities. The UA Café highlighted initiatives in Rotterdam that combine the closing of nutrient cycles with building new social and economic activities at different scale levels. A first initiative, focused at the neighbourhood level, promotes the composting of household waste at the community level. This is an innovative way to close nutrient cycles at the local level, as organic waste in the Netherlands is generally separated and taken away to centralised composting plants. This neighbourhood composting initiative, which is supported by both the municipality and the Edible Rotterdam platform, provides a central location in the neighbourhood where citizens collectively compost their garden and kitchen waste. In exchange they receive a share of the compost to use in their gardens.

By contrast, the mushroom-producing UPA enterprise RotterZwam valorises closed waste cycles at the *city level*. The initiative collects coffee waste from bars and restaurants throughout the city; later this becomes the substrate for growing oyster mushrooms which are then sold to local restaurants. In this manner the initiative also contributes to establishing a circular economy. The third initiative highlighted in the UA Café aims to valorise closed cycles at *regional* level. This organic, multifunctional farm, "Hoeve Ackerdijk", is situated in the periurban areas scattered throughout the city-region of Rotterdam, and provides a range of products and services for the city.

Conclusion

Both of these GROW the City events in Rotterdam made clear that there are important possibilities for further strengthening synergies between waste recycling and urban agriculture in Rotterdam. The comparison and exchange of experiences from elsewhere (Ghent and Tamale) proved to be valuable as a means to generate new perspectives and explore scenarios. The Circular Clinics and Urban Agriculture Café also underlined the need to involve citizens' groups, governments and entrepreneurial initiatives to establish an adequate social basis for successful innovations in such a new overarching thematic area.

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TERRAE Municipal Network: Boosting the Local Economy

Franco Llobera Serra
Marian Simon Rojo

Signing of the TERRAE contract. Photo: TERRAE

The budgets of local authorities in Spain decreased sharply with the economic crisis, making necessary new, low-cost but highly effective formulas to foster the local economy. In addition, youth unemployment rates were above 50 % early in 2014. Within this context, a group of municipalities founded the TERRAE network.

An innovative approach was developed to overcome economic downturn, supporting self-employment of new farmers by providing training and access to land and local markets. TERRAE seeks to leverage local resources, including abandoned rural or urban plots and public land for facilities that will not see construction in the near future. The TERRAE approach is an example of institutional innovation in which municipalities try to find new ways of supporting sustainable local food systems in times of economic crisis.

Pilot project for job creation

Between 2010 and 2013, the Spanish Ministry of Agriculture and the trade union *Comisiones Obreras* (CCOO) launched a pilot project called TREDAR. This was in response to the decline of tobacco farming in the region Extremadura (bordering with Portugal) due to changes in the European common agricultural policy (CAP). These changes resulted in massive layoffs in the sector, in a region which has the fourth highest unemployment rate in the European Union. With the support of municipalities in the region, TREDAR trained unemployed people from the tobacco sector in organic agriculture. They also brokered contracts for these newly trained micro-farmers with groups of at least 10 consumers in the capital city of Madrid. Together they would agree on a box scheme; consumers would pay 40 euros per month in return for 20 kg of at least five seasonal vegetables. Customers could specify which product they disliked, but not which vegetables they wanted.

This first pilot took place between June and December 2012, and involved 8 unemployed individuals and 85 consumers from 8 work sites in ministries, trade union offices, and training and research centres, as well as 2 industrial companies around Madrid. After these six months, half of the consumers renewed their contract for another semester. Those who left the scheme argued that they found it difficult to get used to the low diversity of vegetables delivered during the winter, or they complained about box presentation and transport conditions. Follow-up projects were designed to address these problems, as is explained in the next section.

Scaling up with flexibility and diversification

In 2010, the Red TERRAE *("Network of AgroEcological Reserve Territories")* was initiated by a partnership of different (mostly rural) Spanish municipalities which had previously been involved in the TREDAR project. TERRAE built on the earlier experience, focusing on local connections with restaurants and retailers. It has developed more flexible contract conditions regarding dedicated time and price, as well as volume of products. The TERRAE method and brand emerged from a collaboration between local municipalities, restaurants, consumers, land owners and unemployed people in order to guarantee the preservation of rural territories and agrarian landscapes by enhancing agro-biodiversity and self-employment.

Start small in order to go far

By April 2014, TERRAE had grown into a network of almost 30 municipalities from eight different Spanish regions. They are working together to implement a method which combines training in organic agriculture, mentoring of new micro-farmers and providing access to land.

Training. Each participant takes a 50-hour training course. The basic notions of agro-ecology are put into practice in subsistence gardens. After 6 months, those willing to continue move to the next "proto-entrepreneurial" stage, which includes 110–150 hours of training and support by municipal advisors. This course also implies the start of an internship under the supervision of TERRAE. Each proto-entrepreneur earns almost 400 euro per month (cost included). In the second year, participants are requested to register as entrepreneurs in the national social security service. The beneficiaries are stimulated to professionalise and to take official courses on organic agriculture like those proposed in conventional programs for agricultural education (e.g., for young and new farmers). This step-by-step method enables the unemployed to get involved in local agriculture gradually, to build new relationships with consumers and to become knowledgeable about agro-ecological principles.

Mentoring. Each project facilitates contacts between the very small start-up activities of producers and local restaurants and retailers through the TERRAE brand EcoKm 0. It includes a stepwise system of contracts between municipalities, unemployed people and local consumers (see Box).

Access to land. TERRAE has initiated a land bank to offer land to entrepreneurs once they have to leave the municipal gardens. The land bank has currently more than 1.200 registered users, with 230 demands for land, of which most are not yet met. At the end of 2013, 88 parcels totalling 60 hectares had been distributed. The demand thereby exceeds the amount of available land, which is one of the main challenges that municipalities involved in TERRAE try to resolve.

From self-supply to self-employment. Contract systems developed by TERRAE

***TERRAE 0**. Contract for **self-consumption**. Participants receive 50 hours of training in agro-ecology. Each participant is offered 50 square meters on an individual plot on municipal land. The contract runs for 6–12 months and specifies working conditions and the supervision of the DILAS advisor. In this first stage the trainees are not allowed to sell their production.*

***TERRAE 1**. Once the participant has gained enough agro-ecological experience, they move to the second stage with the support of the local council and the DILAS advisors. Each participant is provided with nearly 1,000 square meters and is trained in **production for local markets** (TERRAE 1.2, Contract for local markets). If they are really advanced, they sign a contract with **a local restaurant or shop** to provide seasonal vegetable boxes for 2–12 months (TERRAE 1.3). The restaurant that signs such as contract with a specified price, weight and duration receives the brand TERRAE EcoKm 0, which stands for "local seasonal food supporting opportunities for new entrepreneurs".*

***TERRAE 2 and 3**. After one year of self-employed labour practices, the beneficiaries must register in the social security service to continue with the TERRAE contract, support and brand. When they reach organic certification they enter the TERRAE 3 stage.*

These contracts are signed by the micro-farmer, the DILAS advisor, a local councillor, and, when relevant, the holder of the restaurant.

Defining local agro-ecological policy plans. Photo: TERRAE

Small garden producers in la huerta Granja Escuela. Photo: TERRAE

A key element of the TERRAE approach is the central role that the local agro-ecological municipal promoters or advisors (called DILAS, standing for *"Promoters of Local Agro-ecological Initiatives")* play. They are responsible for integrating plots in the land bank, identifying locations for municipal gardens, raising training funds from regional institutions, and also for monitoring the participating unemployed; they also explore potential interest from restaurants and local food retailers and establish contacts with them. As well, they decide on the targeted beneficiaries and specify topics and activities for training depending on what contributes to food sovereignty within the specific characteristics of the territory.

Main lessons and perspectives

TERRAE is a promising experience that enhances the development of the organic agricultural sector and tackles some of the real problems and challenges that local municipalities and unemployed people are facing due to the multiple crisis. Initially, unemployed people learn and gain experience with organic gardening for self-consumption. Later on, with support of municipal DILAS advisors, they work towards increased production, professionalization and direct selling oriented to local markets.

Both DILAS advisors and the municipalities have a central role in the process. The municipalities sign the contract with the restaurants and the micro-farmers, they monitor the learning process, and ensure that all the partners respect their commitments. Together they help in creating an innovative culture of promoting and monitoring self-employment, and in developing agro-ecology and food sovereignty through facilitating new social and economic networks at the local level.

The experience of municipalities that are united within the TERRAE network is increasingly becoming a social and institutional laboratory in which new public policies are developed that seek to generate employment and promote local food networks, incorporating new farmers and bringing into practice principles of food sovereignty. In line with this, one of the tasks of the DILAS advisors that is increasingly gaining importance is the definition of "Local Agro-ecological Policy" (LAP) plans, together with relevant municipal councils. These LAP plans are intended as comprehensive sets of policy measures and actions to promote local employment and food systems.

One key aspect of the measures and activities implemented in TERRAE municipalities is that these go beyond traditional sectorial and urban-rural divides. Employment creation by means of local, agro-ecological food systems is not only a matter of agricultural policy; it also requires social policy and measures aimed at consumption and logistics. Neither are these systems only rural by nature, since many new farmers have a background in the city, and creating linkages with cities plays a key role in the successful development of marketing channels.

Several TERRAE municipalities are exploring the potential relation between urban agriculture and the reuse of organic waste, whereby consumers return their organic waste to producers in order to feed pigs or poultry. Such a circular economy approach would close nutrient cycles, create cheap fertiliser and lower waste management costs, and simultaneously reduce carbon footprints.

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Revalorising Urban Agricultural Land-Use: AVAAL and the Agricultural Park of Alta de Lisboa

Leonardo Veronez de Sousa

AVAAL - the Agricultural Park. Photo: AVAAL

Portugal has a rural history. Only with the establishment of democracy in 1974, and entry into the European Community in the 1980s, did the country begin a remarkable process of industrialisation. Agriculture did not disappear from the city, and it continued to find specific social and territorial expressions within green spaces in and around towns. With the deterioration of the economic situation, the demand for urban and periurban gardens has regained attention as a possible contribution to subsistence and social cohesion.

Lisbon is historically surrounded by agricultural production areas. However, in the 1950s, evicted urban citizens, rural migrants in search of industrial work, and returned migrants from former Portuguese colonies started to occupy these areas called the *Alta de Lisboa*. Until 2000, the inhabitants of the *Alta de Lisboa* were responsible for the construction of all housing infrastructure; there was no municipal urban plan. In 1998, the Municipality of Lisbon signed a protocol for a public-private project to develop the area. One part of this protocol is that a private company is to build social housing in return for the construction of private properties. The first social housing units were built in 2001.

The "Association for the Environmental Improvement of *Alta de Lisboa*" (AVAAL) was initiated in 2009 by a group of residents. Their first objective, in response to the shortcomings of the area, was to create environmental spaces in the neighbourhood. They succeeded in obtaining a public area of 8000 square metres for periurban agricultural production, for the benefit of the poorest residents. The park, in the end, will consist of about 110 plots, and it is estimated that about 400 people will benefit from the production, directly or indirectly.

The experience of AVAAL is unique for several reasons. The first factor is that the Municipality of Lisbon signed a protocol for the transfer of agricultural land for the construction of the park, with AVAAL and the development company of *Alta de Lisboa* (SGAL). This protocol became a precedent for other civil society associations which also claimed the right to use and manage public spaces. As a result of the protocol, the Municipality of Lisbon also intensified a policy on green areas, which has led to the development of 8 municipal agricultural parks.

Another innovative aspect is the effort to create access for mentally and physically handicapped people to a part of the

Illustration of the "Accessible Garden". Photo: AVAAL

park. This "accesible garden", which comprises a small part of the park (see map) that can also be accessed by wheelchair, has been open since 2011 and has served about 8 handicapped gardeners. This type of inclusive space in periurban agriculture is unique in Portugal and has led to quite some publicity for AVAAL.

A third important element is AVAAL's capacity for social mobilisation. Since the signing of the protocol and the start of work at the park, its members have performed various activities relating to the environmental principles of the association. Projects were grounded in agriculture and ecology, and focused on the rehabilitation of green spaces, the development of school gardens, and inter-generational projects on agricultural knowledge. The main bottlenecks and limitations for the association are related to the financial capacity and the funding of their projects.

In conclusion, AVAAL is an innovative example of social innovation and the ability of people to demand the civic use of public space. The association has successfully achieved, by legal means, the establishment of shared management of urban and periurban space for agricultural uses. As a result, the initiative of AVAAL has had important spin-off effects in the creation and expansion of agricultural areas in Lisbon, and also a municipal policy on green areas.

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The Accessible Garden can be accessed by wheelchairs and is open since 2011. Photo: AVAAL

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Urban Agriculture Springs up in Greece

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In recent years, urban agriculture has spread remarkably in Greece, considering that there is no historic tradition for this activity. Diverse actors, such as community groups, agro-diversity networks and local governments, are developing projects with various aims and organisational patterns. They are all trying to deal with particular aspects of the multidimensional crisis that Greece is facing.

Greece has been one of the first European countries suffering from the present crisis. Financial crisis, bank rescue, public indebtedness and austerity policies have contributed to a situation of urban impoverishment, unemployment and cuts in public services (social, health and education). One million people in Greece are unable to pay for their basic diet. The growing difficulty with food access for the most vulnerable population (unemployed and retired people) has led to a bigger concern about the agri-food system. The "potato movement" began in the spring of 2012, when Greek farmers started to sell their potatoes directly to consumers as a response to the low prices offered by intermediaries. This was the most visible event of a movement that is reconnecting farmers and consumers, through direct selling, local markets and community food groups.

In the last years, community and institutional urban agriculture initiatives have arisen in Greek cities, merging food production, urban ecology, food sovereignty, social links and new ways of thinking and inhabiting the cities. Community gardens are part of the social innovations developed by citizens' projects involving self-protection, social care (migrants and homeless support, self-managed health centres, community kitchens, etc.) and alternative sociality (cooperativism, occupied factories, barter networks or time banks), developing diverse alternatives to build a transition strategy from the local level.

As well, municipal programs are addressing social vulnerability, developing social integration and food access strategies for people in need. In addition, there is the remarkable role of Peliti, a network for biodiversity and local seeds, which collaborates with most of the urban agriculture projects. Together, these initiatives represent interesting forms of

Agios Dimitros allotment garden. Photo: N Morán and JL Fernández

Examples of Community gardens

***Per.ka**, an acronym for "periurban crops", came to light in 2011, in order to cultivate an abandoned military site, occupied and transformed into a public park by the people of northern Thessaloniki. The first Per.ka group began to grow food organically. As more interested people arrived, new groups were formed, composed of 30-40 people who take care of part of the site, demarcating individual and common plots, and constructing resting and storing spaces. Presently there are 7 Per.ka groups, which makes about 200 people. This collective project is grounded in cooperation and ecology; they support public land property but also community management. All of the Per.ka groups join in a fortnightly assembly where common tasks and activities are decided upon. They also participate in the Movement of Direct Distribution of Products in Thessaloniki (Anoixto Diktio).*

***Ellenikó Community Garden**. The former Athens airport, located on the southeast coastline of the city, was supposed to become a metropolitan park, but the crisis stopped this project. A community group conceived an alternative development that could deal with the environmental, economic, educational and social crisis. They worked with the university on their proposal, collected signatures in support of the project, and staged a symbolic olive-tree planting on the airport site. The municipality has lent them a 2,500 m² area contiguous to the airport, where they have begun a community garden, diffusion and training activities as well as traditional seed-giving, supporting garden projects in schools and sharing their products with municipal social kitchens.*

social innovation in response to the multiple crises that Greek society is facing and which, increasingly, also is resulting in new forms of municipal policies to support urban agriculture and local food systems.

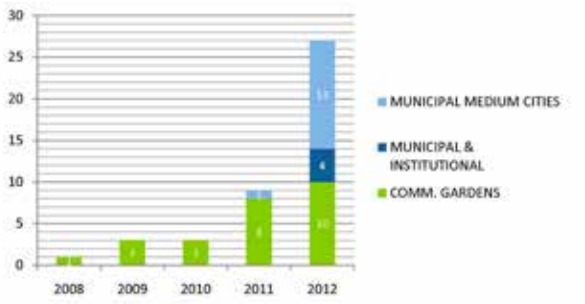

Table: Allotments and community gardens, evolution 2008 – 2013

Community gardens

Community gardens have appeared within a context of social protest movements. The first one, in December 2008, was due to the death of a 15-year-old boy shot by the police, in the Athens neighbourhood of Exarchia. This fact set off massive mobilisations throughout the country, and the biggest riots in its recent history (Stavrides, 2010). In Athens we can find examples of community gardens from this first wave, developed by left-wing militant groups in occupied public spaces and facilities: Navarino Park in Exarchia; Votanikos Social Centre, located in a closed municipal greenhouse; and Agros in Tritsi Park.

The Square's Movement in 2011, in response to the austerity policies, and making visible the political and confidence crisis, led to local assemblies that began several projects in the neighbourhoods. New community gardens appeared, sometimes launched by people directly involved or close to the movement, or simply inspired by a new way of coping with big problems. These gardens are created by more diverse and heterogeneous communities, and they have greater social support, but are not without conflict with the local governments. Two projects that illustrate the progress of the movement in different cities are Per.ka and Ellenikó Community Garden (see Box 1).

Maroussi allotment garden. Photo: N Morán and JL Fernández

The emergence of Municipal Garden Allotments in Greece in times of crisis

Currently, among the most popular paradigms of Urban Agriculture in Greece are the Municipal Garden Allotments (MGAs), which first appeared in 2011–12. The local municipal authorities announced these gardens primarily as social policy projects and a means to alleviate some of the problems urban dwellers faced due to the economic crisis and the collateral lack of public support to vulnerable groups. People have embraced the idea to be given, for free (or a symbolic price), a plot in order to grow their own food and support the daily diet for the whole family.

In 2013, during field research in two MGAs in Northern Greece (Alexandroupolis and Thermi-Raidestos), the motives of the stakeholders were disclosed. The economic crisis played an important role in the decision of the municipalities to establish vegetable gardens, given the alarming phenomena of neo-poverty and malnutrition in a growing portion of the urban population. At the same time, another motivation expressed by local authorities was to cultivate social responsibility and solidarity by requiring that the growers offer 10 % of the crop in the social grocery of the municipalities. Environmental concerns are also at the forefront, through organic production, composting of urban food waste and greening the city. Among the urban farmers, the main motivations to participate in the MGA were, according to specific questionnaire responses (in order of importance): "to produce my own food", in other words a social demand for food re-appropriation; "to have affordable quality food", meaning economic relief for households; and "to strengthen the community bond and for leisure", especially at this time of crisis when people are also deprived of entertainment and fun. After the first harvest, during focus-group discussions, the growers highlighted conviviality, leisure and enhancing community bonds as the most precious functions of the garden, as well as re-connecting to their rural past. Obviously, in times of crisis and socioeconomic precariousness, a sense of social safety is imperative.

The crucial question facing the municipal allotments is about their sustainability and viability. The analysis of the case studies showed that the MGAs are still more a short-term action of social policy rather than institutional and long-term sustainable urban planning. In fact, urban agriculture initiatives face a set of constraints (bureaucracy delays, land use pressure and conflicts, financing difficulties, etc.). Moreover, even if farm land is provided by local authorities, it is used only on a temporary basis due to lack of a cadastre and of a proper institutional framework to legitimise urban agriculture as a specific land use. These issues are critical for the duration of the projects and can be strongly affected in the future by higher levels of real estate speculation. For the moment it seems that it is the economic crisis in relation to real estate collapse that "protects and maintains" the municipal garden allotments in the absence of other competitive land use.

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Community gardens have become central actors in the reflection on the urban model, the future of public spaces, and the role of abandoned or vacant plots within the city, by the reclamation of public land and the fight against its privatization. They are also bringing the food debate into the urban social movements, developing self-managed ways of meeting human needs, collaborating in the spreading of local seeds and learning about organic farming. Finally, they're linking the preservation and expansion of green urban areas with the development of an agro-ecological production model based on local resources. They're doing all this through the development of small-scale projects that can be seen as field trial spaces, where alternative answers to the crisis are being explored, and fragments of a new city are being tested.

Nevertheless, these initiatives suffer from marked precariousness: insecure access to land, scarcity of economic resources, lack of political support, and such limiting factors as availability of water. Furthermore, community gardens have difficulty influencing public policies beyond the local scale. The coordination between the projects is weak, although there are informal networks and occasional collaborations. However, at least for the time being, they are proving the civil society's capacity to regain underused urban spaces and to bind local communities.

Municipal programs

In 2012 the first public policies promoting allotment gardens (the Municipal Garden Allotments see BOX 2) entered the picture, developing social gardens for self-consumption for vulnerable groups. Initially, medium-sized cities, such as Alexandroupolis, started these programs that spread quickly across the whole country: Thermi, Kalamata, Tripoli, Larissa, Veria, Edesa, Lesbos and Crete.

Metropolitan districts of Athens are carrying out allotment garden programs as well. Maroussi and Agios Dimitros have been the first ones doing it. They have a similar procedure; the local government is responsible for preparing the land

Aristotles university garden, Thessaloniki. Photo: N Morán and JL Fernández

Community garden Per.Ka.3. Photo: N Morán and JL Fernández

and the watering system, which, in both cases, is made up of small tanks that are refilled by trucks. Individual plots (25–50 m2) are assigned to people living in the neighbourhood. There are special requirements for access to these plots: low income, unemployment, retirement, large families. Another selection criterion is proximity to the site, in order to make accessibility and daily control easier.

The plots are for free, although part of the products must be sent to municipal social services to be cooked in social kitchens. Organic production systems are compulsory, and there is technical support from municipal workers or from collaborating organisations such as the NGO Anodos, that works daily in the Agios Dimitros allotments, helping the gardeners to design their plots, and supervising the tool and water distribution.

Social allotment gardens have triggered a new use for vacant public plots; besides, they are playing several social roles, providing neighbourhood meeting places, and improving gardeners' self-esteem when they enjoy the activity, although some people can also experience it as a sign of social failure.

Peliti

One of the central entities holding up the agro-ecological movement in Greece is the Peliti Alternative Community, a social network that works on biodiversity and local seeds. Peliti is the dialect name of the oak tree, which has traditionally been planted in the village squares, and around which local communities used to meet. In the shade of Peliti we can find professional farmers, amateur growers, allotments, school vegetable gardens or community gardens.

For almost 20 years, Peliti has been mobilising the preservation, collection, exchange and multiplication of Greek local varieties, through a network that has now reached more than 120.000 growers. Participants save seeds, and share and exchange them with others. Seeds are distributed freely by post or at local festivals. There are 12 local groups of Peliti throughout the country, organising exchange and training events. Since 1999 Peliti has been holding an annual national festival, every April, with seed exchanges, workshops and conferences.

In 2012 Peliti started a seed bank in Paranestiou, supported by the municipality; a database of local varieties has been created; and samples of them are being packaged and preserved.

Conclusion

Municipal allotments and community gardens are different yet complementary. The former can, through the assignment of individual plots, fulfil the basic food needs of families. Community gardens focus on agri-food learning and reflection through common work and cooperation; moreover, they show that public spaces that can no longer be maintained by the public administration can be recovered by community groups.

These social initiatives have shown by their small examples that urban agriculture projects have the potential to impact not only food access, but also social cohesion, education and employment, developing an alternative social, economic and environmental model, and making the most of public spaces and resources.

Still, much more can be done. All of these urban agriculture initiatives point to a wide range of opportunities; even though big investments and large projects are no longer possible, new ways of urban development can be explored through the agro-ecology and local development approach.

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Innovations in Urban Agriculture and their Impacts: a Study Tour to the USA

Regine Berges

Growing Home Chicago. Photo: I. Hartmann

Members of the INNSULA research project (Innovation and Sustainability Analysis of Urban Agriculture: www.innsula.org) analysed several innovations in urban gardens and urban farms in the USA in order to provide inspiration for activists and governments in Germany. Six of the projects are presented here, along with the areas they impact, ranging from environmental, social, and economic areas to gardening issues.

In 2012, researchers of the INNSULA research project, funded by the German Ministry of Education and Research (BMBF), visited urban agriculture projects and interviewed persons involved with urban agriculture in the USA. The USA was chosen because North America has a very active and progressive urban agriculture community and is thus considered to be at the forefront of innovation in this field. Community gardens and urban farms in particular have been present there longer than in Germany. The assumption is that the innovations found in the USA are transferable to and supportive of new projects in Germany.

Urban agriculture innovations

In urban agriculture, gardeners have to adapt to the spatial, economic, environmental and social conditions of the city. For example, land availability, soil contamination and water availability influence the activities in urban agriculture projects. Often, standard solutions from rural agriculture are

Water collection system Green Thumb NYC in Phoenix Community Garden Photo: I. Hartmann

not applicable in a city or to the size of the project. Therefore urban agriculture projects are prone to the "do-it-yourself" approach, resulting in the development of new products, concepts or practices by experimenting and testing (Hartmann et al. 2013). For better comprehension we grouped the innovations analysed during the study visits according to the areas of main impact: resource efficiency, education, food security and health, enabling business, and enabling gardening. These categories are still very open, and some of the innovations can fit into several of them; this demonstrates the multifunctionality of these innovations.

The study visit

In a pre-study, we first searched the literature for innovations and interesting projects. Based on this, 19 gardens, farms, organisations and enterprises in New York City, Amherst (Massachusetts), Philadelphia and Chicago were visited, and representatives were interviewed on the topic of urban agriculture and innovations. One of the results of the study is the compilation of particularly outstanding projects selected as best practice examples (Hartmann et al. 2013). Their innovations are presented here. Something was considered to be an innovation if we could put it into one of the categories of innovation sub-processes marking the innovativeness: something brand-new (invention – highly innovative), adjusted innovation (adaption – medium or moderately innovative) or utilized innovation (adoption – innovative).

The innovations and their impacts

In the six projects presented here we found sixteen innovations, of which ten are highly innovative and can thus can be classified as inventions, three as adaptions and three as adoptions. This shows the high innovativeness of the selected cases. The largest group of innovations applied in the urban agriculture projects addresses the environmental topic of resource efficiency. Availability of space is less of an issue for traditional agriculture, but within cities even buildings become a production opportunity. Especially innovative in this field is The Plant in Chicago (www.plantchicago.com). This social enterprise has established a food-producing and processing company-consortium in an abandoned meat-packing facility. The people behind this initiative have invented a recycling concept for the building with a planned reuse of 80% of all materials found in the building. In addition, they developed a concept for combining waste and energy flows to close loops and produce electricity and heat. Finally, they adapted an aquaponic production system by which they reduce water consumption.

Likewise, Green Thumb (www.greenthumbnyc.org), a publicly funded program supporting community gardens in NYC, strives to reduce water consumption by promoting an adaptable rainwater collection system. This also turns the constraint of access to water for open spaces in urban areas into an opportunity by using the omnipresent roof area. In contrast, waste reduction and compost production are goals of the compost toilet at Greensgrow Farms (www.greensgrow.org) in Philadelphia. Innovators there accelerate the composting with the help of solar energy, thus improving the existing concept of compost toilets. The resulting compost is used for ornamental plants only. Another exemplary path to resource efficiency is taken at Growing Home in Chicago (www.growinghomeinc.org). This social enterprise operates two urban farms and a third farm in the countryside. The operation is certified organic, bringing this label to urban agriculture and thus guaranteeing that mineral fertilisers and chemical pesticides will not be used.

Education is an important social issue addressed by innovations in urban agriculture. Here urban agriculture takes advantage of its proximity to the people and of the educational potential associated with gardening. Into this category falls the participatory university concept found in the permaculture garden (www.umasspermaculture.wordpress.com) of the University of Massachusetts (UMass) in Amherst. The creation and operation of the edible campus garden is based on a university course which is prepared by

teachers and students in a participatory manner. Another best practice example, focusing more on the education of the public, is the pop-up garden established each year by the Pennsylvania Horticultural Society (PHS) (www.pennsylvaniahorticulturalsociety.org) in Philadelphia. The publicly accessible edible garden occupies a prominent inner-city open space for one gardening season. It offers information materials, and workshops are held there. The produce is used by local chefs in their restaurants. Opening up new opportunities for young disadvantaged people is the aim of the vocational training program of Growing Home in Chicago. The training takes three months, and includes theory and practice of agricultural production, processing and marketing, and also touches on associated topics like healthy nutrition.

Food security and health are important challenges in cities and are addressed by urban agriculture. Gardeners do not intend to help only themselves; they also share their produce. One very innovative example of this sharing, formalised in a complex system, is the City Harvest Program of PHS in Philadelphia. Participating gardens and farms receive materials, seeds and seedlings and other support and, in return, donate a certain part of their harvest, which is passed on to needy people. The concept is also special in that the seeds and seedlings are produced by prisoners as part of a rehabilitation program. Similar donation schemes have been adopted by community gardens and NGOs in other cities. For example, a part of the Phoenix community garden in New York City is grown for a nearby soup kitchen.

Urban agriculture includes not only non-profit, but also for-profit initiatives. In the latter, urban farms and social enterprises create innovative concepts or tools which enable their business to access financial support or reduce expenses. One innovation in this category is the Canteen Supported Garden at UMass in Amherst. The student-run Franklin Permaculture Garden provides the university's cafeteria with some of their produce and, in return, gets financial support. To save money, Greensgrow Farms developed a low-budget cool room by integrating an air conditioner into a shed where the harvested produce can be kept fresh for some time before it is sold. Furthermore, Greensgrow Farms also enables other local entrepreneurs to go into business, by building a community kitchen certified for food processing that can be rented by companies. The kitchen is also used by the farm itself, for processing and for cooking workshops. Another way to receive funds has been adopted by Growing Home in Chicago. They raise money for certain assets via crowdfunding, enabling small online donations and transparency regarding the collected sum.

Franklin Permaculture Garden Amherst. Photo: R. Berges

Enabling gardening is also an issue addressed by various innovations found in urban agriculture, two of which are presented here. The first is the development of a multi-functional garden shed by Mees Weis architects for Green Thumb in New York City. The "gardenhaus", for which the construction manual is publicly accessible, is a greenhouse and tool shed in one, and costs less than USD 1000. Green Thumb also created a concept to better provide for well-functioning community gardens, by requiring a functional gardening group and an elected representative for support and advice in each of their gardens.

Lessons learned

The urban agriculture projects presented here all apply several innovations. The fact that most of these are inventions signifies that urban agriculture is highly innovative. On the one hand, the high percentage of inventions is due to the case selection, but on the other hand it shows the necessity of adapting to the urban setting – necessity being the mother of invention. Mostly the need derives from a shortage of resources, or from their high costs. Space, water, energy and nutrients are precious goods in our society, especially from a sustainability perspective. Thus the urban agriculture projects use methods to provide these resources themselves, or to tap unused sources. Through the innovations presented here, new networks are formed and new stakeholders are involved in urban agriculture, such as universities, canteens or underprivileged youth. Furthermore, there are now social enterprises combining urban agriculture with various social aims. This illustrates that introducing urban agriculture into a new setting, like a university, or by using it as a means to achieve goals other than vegetable production, is a basis for innovations, too. Moreover, it is remarkable that the innovators are not necessarily gardeners, but can also be supporting organisations, as in the case of Green Thumb NYC.

The innovations found on the study visit have been published in a best practices brochure available online in German and English (Hartmann et al. 2013). We hope the examples will be a stimulus for existing and developing urban agriculture projects as well as for governments wishing to support urban agriculture. This would broaden the possibilities for urban agriculture in Germany.

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Dutch City Network Feeds the Innovation of Urban Agriculture

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Alexandra van Huffelen, Alderman of Rotterdam (left) presents the UA charter to the Dutch Minister of Agriculture Sharon Dijksma (right).
Photo: City Network on Urban Agriculture

Since 2010, the Dutch City Network on Urban Agriculture (Stedennetwerk in Dutch),has linked up civil servants of fourteen cities in order to *see* opportunities, *share* knowledge and *solve* issues on urban agriculture in their cities. Though it started as an internally focused network for civil servants to learn and share experiences, the network gradually evolved into a more outward-oriented Community of Practice that seeks to incorporate a broader range of participants. Participants developed an urban agriculture charter to influence local and national policies in support of urban agriculture.

In recent years urban agriculture has been developing vigorously in the Netherlands. Community gardens have popped up in several cities, innovative entrepreneurs have started urban farms, and allotments are popular. Despite this growing interest, urban agriculture in the Netherlands remains small, fragmented and without coherence. It is a niche innovation, far from being part of routine practice. Cities can take the lead in embedding urban agriculture in daily life by facilitating local initiatives, linking national and local policies and developing shared knowledge and experience. However, while local authorities see the value of urban agriculture, they struggle with their position concerning its development. Is it a hype or will it last? How should it be facilitated, and how could that be managed in times of budget cuts and loss of capacity?

Recognising the fragmentation of initiatives and the lack of urban political coherence, the Department of Applied Plant Research of Wageningen UR and the Netherlands Rural Network started to connect various pioneering cities. This resulted in a *"City Network on urban agriculture"*, whose main aims are to share and develop knowledge, exchange experiences, inspire with local practices, set local and national agendas and create legitimacy for urban agriculture by turning it into a serious perspective for city councils.

A niche between two regimes

In the Netherlands, 16.8 million people live on 3.4 million ha of land, making it one of the most densely populated countries in the world, with ca. 490 people per km^2. This tremendous urbanisation pressure fuels strict planning regulations focused on keeping the rural landscape open and undeveloped (Van Remmen and van der Burg, 2008). Regulations safeguard space for the Dutch agri-food complex; about 68% of Dutch open space is in agricultural

production (PBL, 2013). The Dutch agri-food complex is considered a competitive and a successful player on a global scale. The Netherlands is thus both an urbanised and an agricultural nation.

However, both the spatial planning and the agri-food system are under pressure in the Netherlands. Peak oil, food security, animal welfare and high carbon footprints shed doubt on the global agri-food system. The real-estate market – the motor behind Dutch planning – collapsed due to the financial crisis. This led to numerous vacant urban and periurban lots, and raised concerns over food provenance. Both issues stimulated an increase in a wide range of urban agriculture initiatives (Veen et al., 2012). Urban agriculture, in other words, was recognised and reinforced as a niche between the agri-food system and spatial planning. As food production becomes part of the urban landscape and civil society, municipalities can take the lead in facilitating the development of urban agriculture (Cohen and Reynolds, 2014).

The City Network on urban agriculture

In 2010, Wageningen UR and the Netherlands Rural Network brought together various pioneering cities with the aim to establish a "learning network" to support the development of urban agriculture in the Netherlands. In 2014, this City Network on urban agriculture *(Stedennetwerk Stadslandbouw)* consists of fourteen Dutch cities (figure 1). Most of the members are civil servants who "pioneer" with urban agriculture in their municipality to stimulate locally grown food and related social activities. Approximately four times a year they come together in network meetings. These meetings focus on learning clustered around three main topics: seeing, sharing and solving.

- *Seeing* refers to getting new input and inspiration. Meetings are organised in a different city each time so that members can visit each other's initiatives. In addition, each meeting is organised around a central topic on which members share knowledge. Furthermore, local stakeholders are invited to give diverse input and points of view.
- *Sharing* refers to the exchange of knowledge, experiences and ideas between network members and, if necessary, specific experts from outside the network are invited to join the meetings. Sharing is also about developing a shared vision regarding urban agriculture's future. The meetings offer ample opportunity for discussion and the network composition is relatively stable.
- *Solving,* finally, refers to the hands-on approach during the meetings. Common questions are distilled and members look for solutions together.

The City Network on Urban Agriculture links civil servants from 14 cities. Photo: City Network on Urban Agriculture

Discussion sessions make part of the network meetings. Photo: City Network on Urban Agriculture

From a network to a Community of Practice

The City Network gradually developed from an internally focused, loose network towards an externally focused community, with the characteristics of a Community of Practice (CoP). A CoP is a group of people *"who share a passion for something that they know how to do, and who interact regularly in order to learn how to do it better"* (Wenger, 2004, p. 2). CoPs, like the City Network, share three fundamental characteristics of communities (Wenger, 2004): 1) Domain (i.e., urban agriculture); 2) Community (i.e., pionieering civil servants), and 3) Practice (i.e., local facilitation of UA). This development occurred in three main phases.

In the **first phase** the network consisted of individual pioneers who did not yet know each other, and were thus not connected. They were struggling with similar questions and similar ambitions – to get urban agriculture on the local agenda – and tried to achieve these in similar ways, by linking initiatives in the city. They had different approaches to urban agriculture, however, and practiced it with different goals in

Network meeting at Onze allotment gardens under glass, Almere. Photo: City Network on Urban Agriculture

mind (e.g., social cohesion, health or education). Moreover, urban agriculture in their cities was at different stages of development.

In the **second phase** the network took off: pioneers came together to learn from each other and share their experiences. Despite their different views, network members developed a common definition of urban agriculture (food production for the city, within the city region), and while specific aims differed, members shared the fact that none of them focused on food alone: social motivations were important for all cities. Also, almost all members had difficulties gaining support for urban agriculture from the city council and among colleagues. However, though there were differences between network members, there were commonalities as well, and these served as binding mechanisms. In this phase the network was mostly internally oriented, focused on dealing with the issues that members faced, and members developed a shared language.

We have now reached the **third phase** in which the network aims to gradually expand into a CoP that incorporates a broader range of participants. It is time for new input, time to share lessons learned with broader audiences and to connect with policy at the national level. The network is opening and scaling up and becoming externally oriented. Followers join the pioneers, enlarging the network. Pioneers share their knowledge and new knowledge is added. Social media provides a means to extend networks, by means of an open LinkedIn group for example. Also, the network started with an international orientation, by cooperating with RUAF and ETC in the Oxfam Novib-funded GROW the City project, linking up RUAF's international urban agriculture experiences in cities such as Rosario, Lima, Toronto and Cape town (see pages 12-23). In this phase, the network also started to work on its impact and realised that decision makers need to be enticed to "look at the bigger picture of urban agriculture", that social benefits of UA may exceed public investments and that policy makers need to create their own legitimacy. The main challenge, then, is to put urban agriculture squarely on local and national agendas. In spring 2013, the City Network therefore launched its urban agriculture charter.

The urban agriculture charter

The urban agriculture charter addresses the steps necessary for urban agriculture to evolve from scattered initiatives into a coherent perspective. Four challenges are addressed: 1) create space for experimenting; 2) support regional food chains; 3) facilitate quality improvement, and 4) connect local initiatives. The charter also suggests actions for local and national authorities. The alderman of the city of Rotterdam embraced the idea of the charter and supported the network by bringing it to the attention of city councils. Presently, 25 city councils, including those of the cities of Rotterdam, Amsterdam, Groningen, Utrecht, The Hague and Almere, have endorsed the charter. It has thus become an important tool for legitimising urban agriculture. This process shows as well that UA initiatives, although still fragile and fragmented, are increasingly supported by local and national authorities.

Discussion sessions make part of the network meetings. Photo: City Network on Urban Agriculture

Conclusions

In its initial stages, the Dutch City Network on Urban Agriculture supported network members by learning from each other and sharing experiences regarding how to deal with local issues. The network is now evolving, towards a broader Community of Practice that stimulates urban agriculture nationwide. The role of Wageningen UR and the Netherlands Rural Network was to bring people together and to facilitate the learning process.

The innovative nature of the network lies in the fact that it has enabled individual pioneers working in their municipalities to learn from, and connect to, others in similar situations. Through sharing visions, challenges and solutions they pointed the way for the future of urban agriculture. The City Network brought people together with central roles in connecting and facilitating local UA initiatives. A broad spectrum of connections was shaped by linking these central people in a national network. Being part of a network also legitimised members' (time) investment in UA. This is reinforced by the urban agriculture charter, which created a common language connecting different cities and contexts. Hence, cities can be a catalyst in innovating urban agriculture from a niche towards the mainstream.

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Leeds Edible Schools Sustainability Network

Tom Bliss
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Food production and outdoor teaching area at Sharp Lane Primary School, Leeds Photo: Ian Dickinson

There is a growing interest in both urban agriculture and sustainability, as framed in terms of climate change, landscape, economic uncertainty and resource shortages, while issues involving child health and well-being are increasingly causing concern. Education is key, especially in terms of sustainability teaching and the production of food by schools on school premises.

The Leeds Edible Schools Sustainability Network (www.lessn.info) is, at this date, an un-constituted, informal group of organisations and academics, all based or active within the Leeds district, who share core values with regard to the well-being and sustainability agenda; and who are all, in various ways, involved in supporting educational establishments and related organisations in the growing (often on school premises) and consumption of local food, the promotion of resilient and healthy practices including outdoor work and teaching about healthy school food, and the development of effective education on topics concerning sustainability.

Urban agriculture in the UK

It has been suggested that cities could become largely self-sufficient, at least for fruit and vegetables, by using concepts such as Continuous Productive Urban Landscapes (Viljoen and Bohn, 2008) and "urbalism" to maximise food production within the urban and periurban zones (Bliss, 2010). In the UK, a number of cities, including Brighton and Bristol, and towns such as Totnes and Todmorden are also now aiming to reduce their "food miles" (Lang and Paxton, 1994) down to "food yards" (Warhurst, 2013). These initiatives are achieving varying degrees of success. But are these ideas no more than utopianism in a country where food is currently cheap and readily available? Some would say so, but the rising costs of food and fuel, combined with static income, high unemployment and a tightening of the benefits system are already causing significant problems.

In 2012-2013, food banks in the UK fed ca. 350,000 people - of whom over 125,000 were children (Trussell Trust, 2013) - and many believe that the situation could deteriorate substantially in the near future. The former Chief Government Scientific Adviser, Sir John Beddington, suggested that the world is facing a "perfect storm of food shortages, scarce water and insufficient energy resources that will threaten to unleash public unrest, cross-border conflicts and mass migration as people flee from the worst affected regions" (Barclay, 2012).

Beddington argues strongly for a major increase in GM crops and, not surprisingly, the agri-tech industry concurs. But the

topicality of these techniques (not least the power they place in the hands of a few multinational companies), and resistance from environmental organisations for health and biodiversity reasons, must be weighed against the concomitant advantages of urban agriculture with its benefits to health, well-being, social, localising and entrepreneurial activities. (Leake et al. 2009).

So in the UK today, actors from all sectors of society – from research institutions, central and local government, NGOs, the business sector, local groups and organisations to families and individuals – are exploring different ways to develop viable urban agricultural systems.

The role of education

Schools have a key role to play in educating children about food, food production, and the role of plants in the environment. They also may help them to achieve a healthy diet, to become fit and happy and, to an extent, to reach out to engage with these issues in the wider local community.

Many children are worryingly ignorant about food. Recent research by the British Nutrition Foundation among more than 27,500 school children found that 29 % of primary school children believe that cheese comes from plants, and that 18 % believe fish fingers come from chicken. Meanwhile, 10 % of secondary school children believe that tomatoes grow under the ground (BNF 2013). There is even anecdotal evidence that some adults may be equally ill-informed.

Ignorance also extends to food growing, where expertise in the UK has declined significantly since the Dig for Victory campaign of WWII educated the civilian population in the cultivation of home-grown fruit and vegetables (Hay 1942). The project was considered a success, with 1,400,000 allotments (often newly made in parks and on public land) producing nearly a million tonnes of vegetables by 1943. Fruit and vegetables were never rationed, and the home-growing of food contributed to substantial improvements in diets and eating habits (Medical News Today, 2013)

Today many children are very poorly nourished. The School Food Matters (2013) website reports that:
"92 % of children consume more saturated fat than is recommended, 86 % too much sugar, 72 % too much salt, and 96 % do not get enough fruit and vegetables. The UK now has the highest rate of obesity in Europe, with one in three children overweight or obese by year 6. Obesity in children under 11 has risen by over 40 % in ten years. If this trend continues, half of children will be obese or overweight by 2020. The financial impact of obesity is estimated to become an additional £45 billion per year by 2050 with a seven-fold increase in NHS costs alone. Junk food diets are causing other health problems too. For example, type 2 diabetes – once known as "late onset" and traditionally found in the over-40s – is increasingly found in adolescents. A poor diet also has significant effects on children's behaviour, concentration and mood. Children with diets lacking in essential vitamins, minerals and essential fatty acids tend to perform worse academically, cannot concentrate and are more aggressive."

Meanwhile, food prices are rising, putting additional pressure on household budgets. Following a report by the restaurateurs Henry Dimbleby and John Vincent of the Leon chain, The National Department of Education has proposed that, from September 2014, the National Curriculum include cooking, growing and food education (School Food Plan, 2013). Secretary of State for Education Michael Gove suggested that pupils in Key Stages 1 to 3 should be taught practical knowledge, skills and crafts working in fields such as "horticulture: to cultivate plants for practical purposes, such as for food" (Proposed National Curriculum for Design and Technology 2013). If implemented, this is to be welcomed, but already it would appear that many schools are not only managing to grow food on school premises, sometimes in significant quantities (and occasionally even involving livestock), but also managing to teach this – and wider issues concerning sustainability – within the existing curriculum.

However, there appear to be many schools which are doing little or nothing – perhaps due to lack of opportunity for one reason or another, or through lack of will or interest, or due to some other cause. Anecdotal evidence suggests that, in the Leeds district, around 300 educational establishments may be involved in some activity (some of it significant or even exemplary), while a further 80 may not. It was the emergence of this disparity, which sparked the formation of the Leeds Edible Schools Sustainability Network (LESSN).

Leeds Network

To date, Leeds has not been at the forefront of these initiative, but neither has it been idle, as the track record of the LESSN partner organisations testifies. One of the key local players is Feed Leeds. This is a constituted group and network of more than 40 organisations (including local authority and university departments, food growing and volunteer projects and others) involved with sustainable local food in one way or another. Many partners are very active, and some genuinely innovative.

The initial idea for LESSN emerged from the work of Feed Leeds, "a network of individuals and organisations working in partnership to promote and support food growing in Leeds for its economic, social, environmental and health benefits" (www.feedleeds.org). Feed Leeds had noted that some schools in Leeds appeared to be exemplars in terms of food growing and sustainability, while others appeared to have achieved little to date.

With the assistance of the Leeds Sustainability Institute, research is ongoing to:

1) establish a baseline dataset on existing school practices, attitudes, ambitions and restrictions.
2) discover which strategies and approaches are bearing fruit (both from Leeds schools' experiences and from other sources).
3) Develop a set of tools which schools can utilise to improve their performance.

New relationships are currently being developed with the Food For Life Partnership (FFLP) and Leeds City Council (LCC) School Wellbeing Service to deliver workshops for teaching staff. It is hoped that, if successful, progress will be monitored and this research will feed into the above research objectives.

By sharing existing information, LESSN members identified 386 establishments to be included in the research. Of these, 186 schools have registered with the Campaign for School Gardening, 105 schools are listed as Leeds City Council Sustainable schools and 6 schools have livestock. However, 79 schools do not appear to have engaged in any related activity to date. The data is stored and includes (where available): head teacher contact details, gardener/grower contact details, and notes on growing activity at the school. The schools are also indicate on the LESSN web map available on the website (www.lessn.info).

Curriculum, consumption and beyond

The LESSN, FFLP and LCC workshops target both the new curriculum and the new school meal arrangements. Essentially, LESSN and FFLP will be filling the gap that LCC is not currently equipped to provide – mainly the food-growing element – by delivering workshops for staff on how to start and nurture fruit and vegetable growing schemes, how best to incorporate this activity into both the curriculum and the wider school culture, how to maximise education and leadership as regards healthy eating, and how to benefit from teaching and working outdoors.

The intention is, by example (driven by the enthusiasm of students) and by direct engagement with parents/guardians, to reach beyond the school gates into the local community in order to help promote local food growing, cooking and consumption in the home.

Future

LESSN continues its research to develop a growing picture of the situation and monitor change as the project progresses. The network will work with the FFLP and Leeds City Council School Wellbeing Service to help provide curriculum-focussed teaching tools and advice and to engage further with expert partners, schools, school teams and school-centred communities.

In spite of its ad hoc formation and informal process, at this stage LESSN would appear to be a success, although there is still much to be achieved. The chief constraints remain lack of time available to work on the project, very limited funding, and difficulties making contact with the most informed people within school teams. LESSN continues to work to resolve these issues as best it can.

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Polytunnel food production at Farsley Farfield Primary School, Leeds Photo: Ian Dickinson

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Back-to-School Farming Initiative in Liberia: Leading Student Farmers Back to the Land and into the Classroom

Nico Parkinson

Before Liberia's civil wars, agriculture was an integral part of the education system. As long back as 1960, the Ministries of Education and Agriculture - with US government aid and in partnership with US Peace Corps volunteers - created the first youth organisation for cooperative extension by land grant universities, called the 4-H Club in Maryland County in southeastern Liberia. Thirty years later, there were some 27,000 4-H Club members, 1,950 clubs and nearly as many gardens (see www.4-h.org). Then the country erupted in civil strife.

"When I was in grade school, I remember visiting my school garden," says Edwin Kwakpae, the Ministry of Education's representative in Grand Bassa County. "When I left the country during the war, I used those skills to survive. I'm a living witness to the benefits of knowing how to grow your own food." Ten years after the end of the war, the majority of Liberians live in poverty, depend on agriculture as a livelihood and grow their own food for survival. Over 60 % of the nation's GDP comes from the agriculture sectors, however most of this comes from rubber and palm oil plantations.

Still, due to the bleak situation of their parents, most Liberian youth do not want to work in agriculture, do not aspire to become farmers, and dream of moving to a city where they hope to get both an education and jobs in other sectors. The youth have little access, if any, to land due to the existing traditional land tenure systems. Community elders control the majority of land available for farming, and this control enables community leaders to exploit youth labour. Community elders give young farmers the right to till community lands, yet they do so on a verbal basis while retaining the power to withdraw that right at any time. The elders can revoke those rights, even if the young farmers have cleared the land, made improvements and already planted crops.

Nearly 70 % of the Liberian population is under the age of 30. Many of these young adults have been forced to drop out of school during the 14-year conflict, cannot pay school fees or no longer have a school to go to, as half of Liberia's schools were damaged in the conflict. Like their elders, the majority of Liberia's youth – *classified as 16–35 years old* – are subsistence farmers and depend on agriculture.

Adding value to cassave farming

"It's hard to make money from raw cassava," says Etta Briggs, a 30-year old farmer living in Grand Bassa, Liberia. "The cassava tubers are heavy, take time to prepare and need to be fresh. The processed cassava is better for marketing." The cassava-to-gari process takes Etta three days, requiring her to peel, grate and press the cassava tubers before drying on a large open fire to turn it into gari, the flaky derivative, both light in weight and ready to eat. Etta never learned cassava processing when she was a young girl because she was mostly on her own. When she was born, she lost her mother, and by the time she was six her father succumbed to malaria. She never went to school and never learned anything beyond growing cassava and selling it for very little money.

Throughout her life she developed trading skills. Like other women in her position, Etta survived on only a few dollars a day and utilized agriculture purely for subsistence. Later, her older sister and four children became more dependent on Etta. Today Etta feeds five people in the household.

Etta Briggs, a 30-year old farmer living in Grand Bassa.
Photo: Nico Parco, FED

Students grow food at the school garden site. Photo: Nico Parco, FED

In April 2013, she got the opportunity to learn new processing techniques while attending night school. The partnership of the USAID Food Enterprise Development Program for Liberia (FED), the local NGO Community Youth Network Program (CYNP) and the USAID-funded Advancing Youth Project gave her and 21 youth farmers an opportunity to learn agriculture and processing techniques in the field during the day, and reading, writing and arithmetic in the classroom in the evening.

FED provided the farmers with agricultural training, cassava cuttings, vegetable seeds and tools. In addition, FED gave group leaders training on better processing methods, new ways to not only process cassava, but also how to make cassava starch, pepper sauce, and potato green flakes. "I can keep my gari for up to a year looking for buyers, and my dried greens keep for six months," explains Etta, who now plans and sorts her products according to the day's market.

Ebola outbreak, closed schools

In August 2014, the government announced a temporary closure of schools as part of the country's attempt to isolate the Ebola virus. Although the classrooms were closed, many students continue to grow food at the school garden sites. Furthermore, students like Etta Briggs have taken their agriculture experience home to their own communities.

Like Liberian refugees a decade ago, today's Liberian youth face similar challenges of a different nature. In some parts of Liberia, Ebola has led to rising food prices and potential food shortages. Knowledge and willingness to participate in agriculture are needed more than ever.

Since 2011, the FED project has supported 290 schools in Liberia with agriculture extension services, equipment and mentoring. In 2014 alone, some 4,500 students received hands-on skills training in agriculture. The students were all involved in vegetable gardens and cassava fields covering a total of 60 hectares.

"Reintroducing agriculture into our schools is a challenge," explains Junior Toe, the founder of local youth empowerment organization CYNP. "But we know that Mama Liberia will benefit if more people start seeing agriculture as a vocation and not as a means of survival."

That's why in 2015, in addition to school gardens, FED is increasing activities that bring Liberian youth (aged 16–35) into the agriculture sector. The programme is linking youth farmers to established farms as part of an outgrower project that intends to bring large amounts of organically grown vegetables to domestic and international markets.

In addition, the program is placing seed money into small businesses focused on ancillary services in the agriculture sector, jobs that aren't directly involved with growing crops, but which provide support services to the farmers to get their produce from farm to market. These jobs include collection and transportation services as well as the provision of power tilling and other mechanised services.

The jobs that FED has already created through small rice-processing centres throughout the country are going to the younger generation. These machine operators play a major role in the rice and cassava value chains, turning raw material into food for local markets.

In June 2014, Liberia's Minister of Education, Etmonia Tarpeh, took part in the dedication of the C.B. Harris Memorial primary school, located outside of Monrovia. On the school grounds is one of the program's school gardens, approximately half a hectare of okra, peppers, cabbage and other vegetables. Gardeners as young as six years old work with a teacher every day after school, learning the best way to plant seeds and harvest food.

"Every school should have at least an acre for gardening in the school's backyard. These demonstration fields can teach the students and make a difference in their lives while improving food security in Liberia," she said in her remarks.

In the wake of the current Ebola crisis, the youth in highly populated, periurban areas such as those around Monrovia are desperate for ways to become part of a successful sector. Stimulating youth involvement, through school gardens, training and direct interventions, is the only way to ensure the sustainability of the country's struggle to become independently food secure. As long as young people are involved on every level, survival is guaranteed.

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Farm City and Hortus Aquarius: A Modular and Synergetic Design Approach in Practice

Gilbert Curtessi
Maarten Feberwee

Farm City comprises a concept that can be applied for the creation of agricultural clusters with economical, ecological and social features, in order to create optimal economic and ecological performance. Several case studies have been created in the last 2 years. In this article the Farm City concept will be illustrated by 2 examples: the Rotterdam Zoo in the Netherlands and Hortus Aquarius in Oman.

Farm City is a design tool developed by Gilbert Curtessi (Happy Shrimp, Allcomm, Transmare & EnergyTransformers) and Maarten Feberwee (Ecomimics, Revaho). Curtessi's background as an entrepreneur and researcher is related to the first tropical algae and shrimp farm (known as Happy Shrimp Farm) in the Netherlands making use of residual heat. In this project a 2-km infrastructural connection with a powerplant was realized to supply residual heat for the growth of shrimp, Salicornia and micro algae. The cultivation was based on a modular system design.

Feberwee finished his master's in Industrial ecology at the TU Delft by writing a thesis on the modular concept of Farm City. Curtessi and Feberwee identified a symbiosis with each other's projects and started working on the design concept from 2012. Nowadays, the aim is to actually find stakeholders willing to design, finance and realize agro-energy cluster companies based on the Farm City principles.

Farm City is focusing on food production, in combination with education, recreation and health care. Farm City's ambition is the creation of balanced business cases. The target is to achieve a optimal level of social, economic and ecological results. Farm City applies modules according to a systematic (industrial ecology) view. Industrial ecology is the study of material and energy flows through industrial systems. Key principles are the analogy with natural ecosystems, a holistic and systematic approach and multidisciplinary collaboration. (Garner and Keoleian, 1995).

A module relates to a certain agricultural process, technology or physical space. By input-output flows of organic materials, energy and water, the modules interact with each other and with other external flows, in order to create a closed system to the greatest extent possible. This concept can serve as an example of "metropolitan agriculture" in Western Europe for other delta cities around the world.

Rotterdam; Blijdorp Zoo

The design of Farm City Blijdorp consists of a landscape park covering the existing parking area, a greenhouse and a vertical farm combined with research facilities and student housing.

The design of Farm City Blijdorp: aerial and street view. Photo: FarmCity

The proposition is based on high value products such as flowers, food, animal feed and bulk products such as biogas and fertiliser. Input of organic materials originates from the zoo and surrounding urban areas. The primary goal is to keep flows of organic materials, energy and water in the system as long as possible. Biodegradable waste from the zoo, households in the neighbourhood, private gardens, the landscape park and the vertical farm will be enough for conversion into valuable compost and energy.

The management of Blijdorp Zoo has a keen interest in sustainable development and an established Greenteam is managing and investigating possible interventions. The Zoo accommodates a large aquarium called the Oceanium. This building is located in the expansion area of the zoo, which includes a new entrance and parking area. This parking area (3.2 ha) can potentially be transformed into a multifunctional agricultural cluster. (see: www.blijdorp.nl).

In Blijdorp Zoo multiple flows are assimilated: mainly manure and various other organic materials. These flows consist of biodegradable waste (35,000 kg – 50-60 % moisture) and wood residues (10,000 kg). The restaurants release frying oil, currently used to power a ship owned by Blijdorp for the transport of salt water. The zoo requires approximately 1.2 million m^3 of gas for heating, of which the Oceanium consumes 30 %. In addition, the zoo consumes large quantities of water from different sources, which amounts to a total of 219,300 m^3 annually. Wastewater at the zoo is partly discharged to surface water (ponds etc.), partly transported through filtration beds; both salt and black water are discharged to the sewage.

The high-rise vertical farm provides energy and animal feed. The system could contribute to a drastic decrease in food miles and reduced animal feed costs. The extensive landscape park could function as a natural filtration and collection system for rainwater. A combination of a biopowered CHP (Combined Heat and Power) and biofermentation plant can convert flows of manure, black water and biodegradable waste into heat and electricity highly efficiently.

The extensive landscape park functions as a natural filtration and collection system for rainwater. As this results in a water collection unit of 3.2 ha underneath drainage, the water is not transported into the sewage system. Another advantage is the cooling effect the parking deck could provide for parked cars during periods of heat.

The next step will be a detailed design to connect these flows of water, materials and energy. Development can be enhanced by a team of available stakeholders, e.g., a real estate company, the zoo itself, universities and a parking management organisation (see figure).

Social, ecological and economic benefits for Rotterdam

- *Sustainability in agriculture; (re)circulation of energy, water and organic flows (e.g., nutrients);*
- *Establishment of parks for agriculture and cultural activities;*
- *Growth in real estate value by creating an aesthetic space over the existing parking lot;*
- *Local animal feed and food security and access to food reduces transport in a traffic dense area;*
- *Landscape park supports biodiversity and provides a habitat for plants and small animal species;*
- *Application of biological systems e.g., pollination services, water filtration, fermentation;*
- *Commercial exploitation of a large surface obtained through multiple uses of space;*
- *Introduction of a variety of vegetable and animal species.*

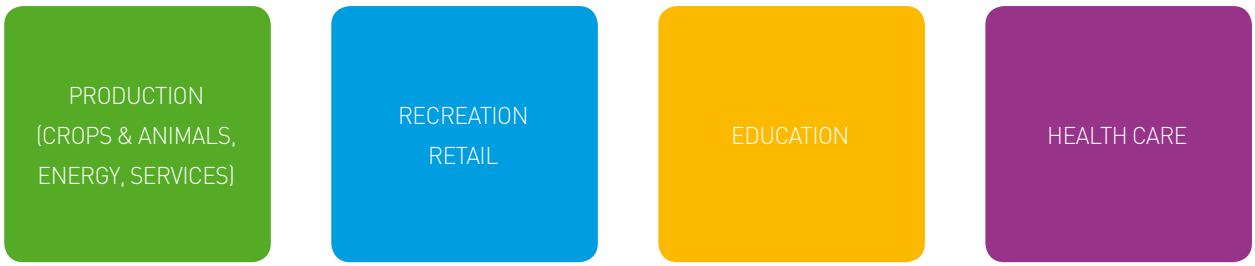
Oman; Aquapolis and the "Hortus Aquarius"

In the coming decades our world population is expected to grow rapidly. This development will lead to large amounts of sweet water being used for the production of food and drinking water, to supply households and industrial branches. A solution for water scarcity in line with the Farm City principles is the saline desert farm called Hortus Aquarius, which is currently being developed together with international stakeholders.

This project is part of the Aquapolis Centre in Oman, currently developed by Lim Shrimp. Construction of the Aquapolis Centre (2000 million tonnes shrimp production capacity) was started in 2014. The Lim Shrimp organisation is responsible for operational matters and necessary actions regarding the final business case. Analysis and discussions are currently taking place about how to integrate shrimp and vegetable production systems.

By cultivating, presenting and selling saline vegetables, consumer demand for culinary ingredients will be fulfilled within the United Arab Emirates region. Implementing a modular and phased growth in production capacity during the start-up keeps the company process controlled and reduces certain risks.

The Hortus Aquarius is unique in the sense that it simulates a semi-natural cultivation method. Curtessi initiated the design concept together with Lim Shrimp, and functions as coordinator/business development party. Feberwee, owner



Farm City combines food production with recreation, education and health care. Photo: FarmCity

of Ecomimics, "a creative process and design engineer company", assumes responsibility for a large part of the design and technical proposition of the Hortus Aquarius, together with Revaho, "a wholesale water and irrigation products company based in the Netherlands". Feberwee and Curtessi, with the input of stakeholders, are responsible for the final design, business model and investment overviews necessary for implementation. The marketing and distribution will be executed by an existing and experienced stakeholder once the product is fully developed. Initial support for the Hortus Aquarius project in Oman will be given by IMARES, part of Wageningen UR.

Social, ecological and economic benefits for Oman

The Hortus Aquarius will be a visually attractive garden where edible saline products are produced using a durable, innovative and socially responsible method of production, without interference in the natural processes. The design will be based on a modular semi-controlled infrastructure and processing of nutrient water-effluent. The crucial factor of successfully creating a Hortus Aquarius is the availability of salt and a minimum of fresh water in a controlled environment. Additional nutrients from other agricultural processes rich in Nitrogen, Phosphorus and Potassium are available as a useful nutrient flow. This is beneficial to ecological and operational results.

The Hortus Aquarius is unique in this sense: it simulates a semi-natural cultivation method. Once the germination phase has taken place for about one week (using fresh water), there are four weeks left for the product to grow towards its desired size using daylight and salty effluent. This salty effluent is collected from a central point in the Aquapolis Centre, which is part of a circular aquaculture system. Using tidal irrigation systems, the saline vegetables will be irrigated in a semi-controlled environment. After irrigation the effluent from the saline vegetable lagoons is collected in a basin and stored for further re-utilisation. The system secures year-round availability of fresh saline vegetables.

Hortus Aquarius comprises certain innovative aspects that can provide a solution for current and/or future problems:

- Modular and symbiotic system production by industrial ecology principles – the residual water from the shrimp is used for irrigation and contains a natural fertiliser for saline vegetables, reducing the use of external sources.
- The irrigation method for the saline vegetables acts as a biological filter that expands the technical and economic performance of the shrimp production system.
- Reducing waste flows – water and energy are used efficiently within both companies, reducing the waste flows and eliminating the need of extra water or another polluting energy source.
- Continuous production – the Hortus Aquarius solves the problem of seasonal availability and quality/freshness of saline vegetables.
- Provides labour opportunities.
- Natural development surrounding the Hortus Aquarius.
- Potential for market development, combining aquaculture and horticulture is both innovative and practical.

Bringing theory and practice

Currently the concept of Farm City finds itself in a stage where practical implementation of a theory is encountering design aspects. During the last decade many theories and designs were developed in the field of sustainable agriculture, industrial ecology and clustered modular agro-energy systems; now the step needs to be made to practical examples demonstrating the advantages of modular integrated agro-energy systems in our urban environment.

It is also evident that, to a large extent, location, climate and atmosphere define the modular system and its design. A desert climate in Oman is completely different than the Rotterdam climate. The input and output flows and demands differ completely. This fuels the authors' confidence and motivation to continue with their mission to develop the concept of agricultural modular designs.

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The Farmery: Urban Grocery, Café and Farm

Benjamin Greene

The Farmery by Amy Edwards. Photo: Ben Greene, The Farmery

What if you could visit the farm every time you visited the market?

The Farmery is an innovative urban market and farm designed to produce and sell locally made food. The Farmery combines a retail grocery, a cafe and indoor agricultural systems that raise the value of food by offering the customer an educational and stimulating food shopping experience. At The Farmery, urban consumers can witness and participate in the growth and harvest of crops and fish. The Farmery grows a portion of the produce and fish it sells, reducing the complexity and costs of locally sourced food by consolidating the entire food distribution system. Growing food in the store allows The Farmery to provide the consumer with the freshest possible fare.

The Farmery was initially conceived as a thesis project for founder Ben Greene's Master of Industrial Design program at North Carolina State University. The Farmery was inspired by the incredible attention local food was getting and the lack of retailers that sell local food. After researching the complex journey the food takes from the farm to the grocery store, Ben realized that there was an enormous opportunity in bringing the farm and the retailer together to grow and sell at the same site. After 4 years of innovating The Farmery's growing systems through numerous prototypes with his business partner Tyler Nethers, the pair raised USD 25,000 through a Kickstarter fundraising campaign. They built the "Mini-Farmery", a shipping container of 6 metres, completely covered in plants, that replicates on a smaller scale many of the features of the larger, 250 m2 Farmery. Having just completed a start-up accelerator in San Francisco, California, the team is now prepared to execute the first full-scale version of The Farmery and is currently in negotiations for its first site in the southeast region of the USA. Construction is expected to begin next year and the opening date is anticipated to be in late summer of 2015.

The Farmery uses an aquaponic growing system to create an ecosystem that exists within the shopping environment. The growing system has three components: a raceway tank designed to look and perform like a stream, where biofilters convert wastes to nutrients and filter this water through vertical growing panels 61cm wide by 213cm high, where our crops uptake the nutrients. It's an organic growing system that relies on beneficial bacteria to reduce disease and eliminate the need for constant sterilisation. Gourmet mushrooms are made a part of the living river by recycling their excess wastewater into it. The 'stream' is located on the first level and the growing panels and gourmet mushrooms are located on the second level.

The Farmery features modular shipping containers on the outer edges of the store and also in the second-floor growing areas. Using shipping containers enables the Farmery's unique design and atmosphere through making possible large open areas, and providing structure for the vertical growing systems. The shipping containers provide structural support to the building itself, acting as enormous trusses

Consumers harvest their own crops. Photo: Ben Greene, The Farmery

Illustration of the Farmery's interior design. Photo: Ben Greene, The Farmery

that allow the growing and retail systems to be combined. There is potential for the system to be modular, but the focus for the shipping containers is really on lowering construction costs for the first full-scale Farmery location. As a result of the second floor being created out of shipping containers, the costs are far lower and amount to only 25 % of the structure's costs.

The Farmery is designed to improve margins on local food to enable small local farmers to move from the fringes of our food system and into the centre stage of a retailer. The Farmery is able to achieve much higher margins on the products grown on-site than a typical farm selling through wholesale channels. The Farmery is able to offer much cheaper mushrooms than can typically be found at grocery stores.

We reduce costs by eliminating the 36 % inventory loss incurred on the complex journey from the farm to the retailer, and we improve the quality of the produce by offering the freshest product possible. Further margin increases are effected through the model of locating a café, farm and grocery store on-site: whatever is not selling well in the grocery section can be turned into a higher-margin product in the café, and this also lowers the food costs in the café. The growing system can be certified organic, but the Farmery team sees that as unnecessary because The Farmery's growing system is more transparent than organic certification. For example, customers are immersed in an environment,

The Farmery features modular shipping containers.
Photo: Ben Greene, The Farmery

surrounded by food growing, so they can see the food's growth cycle happening as they make their purchase decisions; this better educates them about the true value of the processes used to grow their food and establishes a more intimate connection to their food. When customers walk into The Farmery they will discover that flavor resides not only in food, but also in the environment that surrounds them. The Farmery is a living building.

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RotterZwam, Edible Mushrooms from Rotterdam

Siemen Cox
Mark Slegers

In his book *The Blue Economy* (See box), Gunter Pauli offers 100 business cases of things you can do locally with waste. Growing oyster mushrooms on coffee grounds is one of them. While we are both working towards more sustainable livelihoods, Pauli's book inspired us to start RotterZwam, an edible mushroom business in a former tropical swimming pool in the city of Rotterdam.

From waste reduction to food production

Coffee is, after oil, the most-traded commodity in the world. The Netherlands produces about 120 million pounds of coffee waste per year; Rotterdam alone produces 6 million pounds annually. Only 0.2 % of the coffee ends up in your cup, and the remaining 99.8 % is wasted. RotterZwam uses that waste as a main input for their production process growing oyster mushrooms on coffee grounds. It is our ambition to convert as much as possible of that 6 million pounds into food. We strive to do that partly through growing mushrooms in an abandoned swimming pool in the city centre, and we also developed and sell a Growkit that helps people to convert their own coffee grounds into food at home.

Besides coffee grounds, we also use coffee husk, another waste product, for growing our substrate. At first we used straw to mix with the coffee to give the substrate, and therefore the mycelium, more air. By focussing on reusing as much waste as possible, we found that instead of straw we could also use coffee husk. Husk is released when roasting coffee beans, and roasters normally throw it away as they regard it as waste. The advantage of using husk over straw is that the husk is already pasteurised and is a by-product, whereas straw needs to be bought and requires additional processing and thus energy before it can be used. We have made supply agreements with the majority of the micro roasters in Rotterdam as well as with roasters in the surrounding region to collect enough for our production. We pick up their husk, stored in plastic bags, for free on a monthly basis. Instead of giving the bags to the municipal waste collectors, they gladly give it to us as it makes no difference in their operations and they like being part of our initiative.

RotterZwam's focus is very local because transport of food over long distances yields: a) high CO_2 emissions and energy costs, and b) a system that is very sensitive to disruptions, because it relies heavily on just-in-time delivery. Every supermarket clerk can tell you what happens when even two trucks are late: empty shelves.

The transportation of used coffee waste also brings challenges. We prefer to use fresh coffee grounds for the process, as otherwise we need to pasteurise it before we can use it, adding high energy input and costs to prepare it to be suitable for growing fungi. An advantage of small-scale local production is the short chains, so having fresh grounds is not an issue. We close a circle of raw materials to production and consumption in 3,7 km — On a cargo bike!

Furthermore, we do not see the oyster mushroom as an

Mark & Siemen from Rotterzwam. Photo: Rotterzwam

ultimate goal. We see opportunities for extracting enzymes from our substrate when we are "finished" with it, which could be beneficial for the paper industry. After extracting the enzymes, the residue is suitable to use as animal fodder and as a high-quality compost for farmers in the nearby Hoeksche Waard. These are just two examples of possible uses of the by-products we foresee in the near future.

We also compost a portion of our substrate with compost worms on-site using a system of Hungry Bins (see www.rotterzwam.nl/producten/hungry-bin-wormenbak-voor-thuis/ which is in Dutch, or go to www.hungrybin.co.nz/).

Market demand

We have found that it is not difficult to sell our mushrooms. We had orders coming in through Facebook without doing much (or actually any) marketing. People are very interested in our initiative because they like that we:

- produce food locally instead of transporting it all over the world;
- use coffee grounds for food production instead of burning it in a waste incinerator;
- produce mushrooms that transform nutrients to output 25 times more efficiently than meat does;
- grow gourmet mushrooms on the waste of the city (coffee grounds) in the waste of the city (abandoned real estate).

We earn about 50 % of our income from mushroom production. We sell them for 10 euros per kilo to restaurants and catering businesses and 15 euros per kilo to consumers. We want to

Oyster mushrooms. Photo: Rotterzwam

produce about 7,500 to 10,000 kilos annually in order to make around 100,000 euros per year. In addition, we developed and sell the Growkit for household use and we will soon be selling the Hungry Bin for worm composting. We also give workshops and offer work-placement opportunities, and have translated one of Gunter Pauli's fables into Dutch in order to inspire children to keep dreaming.

One of the challenges we face is upscaling our production. We sell mostly grey oyster mushrooms but we also grow yellow and pink ones, and we harvest twice to three times from a block. Many of the restaurants like to order large quantities of up to 5 kilos per week. Because our total production is currently about 20 kilos per week, we need to step up production. We recently finished our crowdfunding campaign; we received € 20,000 that we can use to grow

The Blue Economy as Inspiration

The Blue Economy is a new business approach that is receiving increased attention in debates on sustainable economic development and circular economy. The Blue Economy concept was introduced by Gunther Pauli, a socially engaged thinker and former CEO of the Ecover company in Belgium. The core of the Blue Economy is to focus on what happens with materials when they are thrown away. The strategy is based on the principles of nature: the waste of one system becomes food for another system. It may take a while and some complex processes, but in the end the materials (nutrients in nature) cycle back to their original form.

Gunther Pauli chose to name his concept and approach the Blue Economy out of disappointment, and as a critique of the Green Economy. The Blue Economy concept especially became known when Pauli, with his Zero Emissions Research & Initiative (ZERI) network of scientists and entrepreneurs, published the report "The Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs". This report was written by ZERI for a project of the United Nations Environment Programme (UNEP) called "Nature's 100 Best" with the aim of finding sustainable, nature-inspired solutions for industry and society and in order to contribute to achieving the UN Millennium Development Goals. The hundred best solutions, which have the potential to change existing business models, were finally collected and published in the book "The Blue Economy".

The Blue Economy is a business and societal response to environmental, resource and social challenges and goes beyond sustainability as it is generally presented. It tries to find "disruptive" new ways for industry and people to work within natural systems, promoting and using cyclic, systemic, biomimicry-based regenerative processes that massively reduce impacts and consumption. More importantly, it claims to restore nature while dramatically reducing costs, maintaining profits and securing happiness and well-being. The most important elements of the Blue Economy approach are: (1) Cyclical economy, (2) No waste, (3) Upcycling, (4) Local & diverse, (5) Renewable energies, and (6) Creation of new companies and inspiring entrepreneurs.

Mushroom production from coffee waste was one of the successful business models presented by the Blue Economy approach, conceived because only 0.2 percent from the biomass harvested for coffee is ingested and the rest is simply left to rot. The Chinese scientist Shuting Chang demonstrated in his lab in Hong Kong that coffee serves as an ideal substrate for farming tropical mushrooms, while at the same time generating jobs, income and food security. Chido Govero, an orphan from Zimbabwe, was one of the first to set up her own business mushroom farming on coffee waste. Since then the model has been followed in many other places.

www.theblueeconomy.org

from start-up to the growth phase. We would like to grow first to 50 kilos a week and then on to 150 kilos a week. We are interested in collaboration and getting in touch with other producers, and we are looking for refrigerated containers to expand our business.

Impacts achieved

We have found that a lot of companies and NGOs want to talk to us. They would like to investigate ways of placing unemployed people with us so they can readjust to a work rhythm. Also, former convicts could seek a training position at our urban farm. People like to work with us and like to offer their knowledge and expertise on administration, marketing and business opportunities.

Interns from Sweden, France, Belgium and the Netherlands have completed our internship, working with us for one week to learn the process of preparing substrate. We taught them how to work with local government, and also other things we have learned over time about setting up the process, the techniques needed to adapt large-scale equipment for small-scale production, and so on.

Several companies are implementing the business case of growing mushrooms on coffee grounds, but few are willing to share the recipe. It takes approximately two years to master the process if you start from scratch. Because of the huge potential for job creation, the reuse of abandoned buildings, local food production and profitable small-scale urban farming, we want more people to know how this works. That is why we started the **Mushroom Learning Network** (www.mushroom-learning-network.org) together with Charles van der Haegen, Ivanka Milenkovic and Camila Amaya Castro, and the help of a few others. On that platform we share the business case and the details of the growing process. That way entrepreneurs all over Europe (and beyond) can learn about the business case, share knowledge and add their expertise.

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Introducing Rooftop Greenhouses to the City of Berlin

Kathrin Specht
Rosemarie Siebert

What solutions are available to connect food production and buildings? Policy makers, planners, activists, homeowners, architects and other relevant stakeholders were brought together in order to explore these options in a series of workshops held between 2011 and 2013.

The aim was to identify possible farming models and describe their implementation in or on urban buildings for the metropolitan area of Berlin. This resulted in the development of a stakeholder network called "ZFarm – Urban agriculture of the future" (www.zfarm.de) and a manual to enable the government, politicians, citizens and future operators to deal with rooftop greenhouses in Berlin.

Food production in and on buildings in Berlin

The city of Berlin (Germany) has a long tradition of inner-city gardening. Family-home gardens, school gardens and garden plots (so-called *Schrebergärten*) can be found all over the city. These facilities have been used mainly to grow fruit and vegetables in wartime and in times of limited food availability. But in recent years a new momentum has developed, and new types of urban food producers are focusing on urban farming activities that are taking place around, but also in and on urban buildings.

The term "Zero-acreage farming" (ZFarming) is used by the authors to describe all types of urban agriculture that do not use farmland or open spaces: rooftop gardens, rooftop greenhouses and edible green walls, as well as innovations such as indoor farms or vertical greenhouses (Specht et al. 2014). In recent years, ZFarming has become a topic of interest among a variety of local stakeholders in Berlin, even though it still faces several uncertainties.

As in many other cities worldwide, Berlin has seen an increase in recent years in rooftop gardens, rooftop greenhouses and indoor farms. These have been planned or set up by both activists and non-profit associations or private initiatives for social as well as commercial purposes. According to its proponents, ZFarming promises to fulfil multiple functions and produce a range of goods, all of which may have a positive impact on the urban setting. It promises environmental benefits, such as reducing the environmental impact of architecture, reducing food miles, and improving resource and energy efficiency. The social benefits include improving

A photomontage of strawberries in a rooftop greenhouse overlooking the Potsdamer Platz in Berlin. Credit: Jōichi Itō (Wikimedia commons), photomontage by Axel Dierich

Prototype of container farm tested by Efficient City Farming (ECF) with aquaculture in container and hydroponics in greenhouse.
Photo: ECF Farmsystems Berlin

community food security, providing educational facilities, linking consumers to food production, and serving as a design inspiration. In economic terms, it provides potential public benefits and commodity outputs (Specht et al. 2014).

At the same time, because this is a very new concept for food production and is thus at an early stage of research and development, it involves some limitations and difficulties. For some applications, the various individual technologies are known, but they have never been used together as required for ZFarming. Other applications require entirely new building materials or cultivation techniques (especially for indoor farming) that have not yet been developed. As well as technical constraints, other critical aspects pose problems, namely the high investment costs; the exclusionary effects (due to restricted accessibility, exclusive products and customers); and the lack of acceptance of soilless growing techniques (Specht et al. 2014, Thomaier et al. 2014).

Designing urban innovations together

A participatory approach called "Regional Open Innovation Roadmapping" (ROIR) was chosen to investigate the potential and problems involved in implementing ZFarming projects in Berlin. ROIR is an instrument for participatory decision-making and the implementation of innovations. It depicts in advance the entire development, implementation and launch of a project in detail, and includes from the outset the expertise and opinions of all relevant stakeholders (Phaal et al. 2004, Schwerdtner et al. 2010).

The ROIR process started with the identification of the relevant stakeholder groups. To achieve a balanced and comprehensive group, a variety of experts relevant to ZFarming were approached and invited to participate in the ROIR process. We invited stakeholders in each of the key expert groups:

- Activists & projects – NGOs, project groups and initiatives currently planning or actually setting up ZFarming-related projects
- Lobby groups, associations and unions – e.g., horticulture, real estate, landscape architecture, green roofs and farmers' associations
- Planning and construction – e.g., architecture, recycling and greenhouse planning
- Politics and administration – e.g., departments of environment, health, consumer protection, urban development, climate
- Researchers from fields associated with ZFarming – e.g., energy and building, aquaponics, urban planning, plant physiology, agriculture
- Sales and distribution – stakeholders likely to grow, sell or distribute ZFarming produce, e.g., supermarkets, restaurants and university refectories.

Representatives of the various stakeholder groups met in a series of workshops held between 2011 and 2013. Initially, the stakeholders focused on all ZFarming types, including rooftop gardens, rooftop greenhouses, vertical fruit and vegetable gardens, and even technologically complex multistory indoor farms. But as early as the first phase, the participants decided to focus on rooftop greenhouses as the most promising type for the city of Berlin. First, the stakeholders defined a list of sustainability aims that any ZFarming project should fulfil (e.g. improvement of water efficiency, energy efficiency or employment). For indoor farms the stakeholders saw the required amount of energy as a major disadvantage, while for rooftop gardens the climatic conditions in Berlin only allow a very short growing season. Based on a comprehensive analysis of the expected economic, ecological and socio-cultural effects of the various innovative proposals, a joint decision was made by the stakeholders in the second workshop in favour of rooftop greenhouses as having the most development potential.

In the following steps and meetings, the topic of rooftop greenhouses was examined in detail. Due regard was paid to the technical, social, economic, environmental, administrative and political framework conditions required to ensure their successful implementation, and how these conditions can be established.

During the roadmapping workshops, the stakeholder network (of around 50 participants) called "ZFarm- urban agriculture of the future" (www.zfarm.de) was established in Berlin; jointly, this network created a practical guide[1] to enable the government, politicians, citizens, and future

operators to deal with rooftop greenhouses in Berlin (Freisinger et al. 2013). The topics covered include all of the steps involved, from initial brainstorming to the finished rooftop greenhouse. Among other things, checklists for site analysis, production planning, financial planning, and public relations are provided.

The way forward

As became evident during the ROIR process, rooftop greenhouses have some potential to contribute to the sustainable development of the city of Berlin. According to the members of the ZFarm network, rooftop greenhouses can help improve resource efficiency, increasing social capital and enhancing Berlin's economic strength in the medium to long term. The establishment of rooftop greenhouses offers opportunities for new partnerships and networks and requires interdisciplinary exchange among actors who have not cooperated before. Considering their aims, market orientation and transformative potential, rooftop greenhouses have been classified in five categories (Thomaier et al. 2014):

1.) Commercial: the main purpose of the greenhouse is to run an economically viable farming business;
2.) Image-oriented: the greenhouse is not the main source of revenue but serves as an add-on to another food business, such as a restaurant, that processes and sells the produce;
3.) Social and educational: the main purpose is to communicate social and educational values, such as greenhouses on schools, universities or hospitals;
4.) Urban living quality: the greenhouse serves as a recreational space on residential or commercial buildings, where residents or employees can grow their own food and enjoy a green oasis;
5.) Innovation incubator: the greenhouse serves the purpose of promoting new food-production concepts; these greenhouses are often pioneer or demonstration projects operated by NGOs or research institutions.

Most stakeholders specified that the main project's aims should be to educate people, create social interaction and demonstrate alternative forms of food production and resource recycling, and that they should explicitly but not solely focus on "profitability". Most of the stakeholders involved in Berlin emphasised that while projects should, of course, be economically self-sufficient, their real value lies in the production of non-market goods. In keeping with this notion, they therefore reject purely consumption-driven models. Some even see it as a risk that large companies could seize upon the idea of ZFarming and turn it into an exclusively profit-oriented and unsustainable business in which ZFarming would be reduced to an urban version of industrialised rural production. In the case of Berlin, the participants of the ZFarm network largely agreed that operators need to use the positive potential meaningfully, by focusing on local resources and energy-efficient production, building new market structures, and including social and educational aspects.

In order to successfully realise the sustainability of rooftop greenhouses, the various disciplines and stakeholders need to continue to work hand-in-hand to establish pilot projects, whether on residential buildings, supermarkets or schools. From there, one can start to investigate the social, economic and environmental effects of the rooftop greenhouse and gain experience about what needs to be endorsed or adapted to enable rooftop greenhouses to make a valuable contribution to sustainable urban development.

Front-page practical guide "Something is growing on the roof"

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1) The manual "Es wächst etwas auf dem Dach. Dachgewächshäuser. Idee, Planung, Umsetzung" is available as a free download pdf at www.zfarm.de. The English version "Something is growing on the roof. Rooftop greenhouses. Idea, planning, implementation" will be available in January 2015.

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Growing a Healthy Community: the Green Roof at Access Point on Danforth, Toronto

Lara Mrosovsky

Educational workshop about herbal medicine with Danette Steele the herbalist. Photo: Lara Mrosovsky

Access Alliance in Toronto is the first Community Health Centre (CHC) in Ontario, Canada to have an intensive Green Roof. Since 2011, this Green Roof functions as a teaching garden through a programme called Green Access. Green Access weaves together social, community and environmental health. This experience is showing the way forward for the health sector: integrating urban food into a range of programmes that improve community health and well-being.

The location of this 597 m² Green Roof is on the second floor of AccessPoint on Danforth, straddling Toronto and Scarborough. The social and geographical location has shaped the activities happening on the rooftop. AccessPoint on Danforth is contained within a high-rise and high-density area around Victoria Park and Danforth known as Taylor Massey. Food insecurity is a persistent problem, while unemployment and precarious employment further increase the barriers to accessing adequate healthy food. Fresh, organic produce is not readily available and access to space for gardening is severely limited.

In this context, staff and participants use Green Access to teach and learn skills for growing food in small spaces. People who get involved in the programme not only take a share of the harvest from the garden but also take away tools and information for growing their own. An especially relevant skill is building experience with balcony gardening. Workshops and trainings are hosted on a range of other urban agriculture related skills from seed saving and composting to healthy eating and food preservation.

Mixed support

The idea for a green space and/or garden came from looking at the needs of the local community. While there was limited space on the property at ground level, the building already had a section of flat roof. A special set of circumstances made it possible to invest close to Canadian Dollar 150,000 in green infrastructure for a building that the organisation is actually renting.

The provincial government (specifically, the Ontario Ministry of Health) was instrumental in establishing AccessPoint on Danforth when it awarded funding to Access Alliance for setting up satellite sites. This coincided with the community funding organisation United Way's Building Strong Neighbourhoods Strategy, a social improvement plan which identified the City's priority neighbourhoods - high-density,

high-needs areas in the inner suburbs - where social services were historically lacking. United Way was ready to support the creation of multi-service hubs of community services in priority neighbourhoods. They supported the Hub of Community Services with operating dollars and brought in big donors to support the capital investments. Extra funding from Bank of Montreal covered Green Roof installation costs.

Especially for non-profit agencies who wish to invest in Green Roofs or other gardening initiatives with overhead costs, this effort to bring together combinations of public and private support (and good timing) is important. Gaining support and approvals from multiple sources may be a key to development of green infrastructure within health and community services.

The building is a Hub of community services – 5 organisations, including a Community Health Centre, with a full range of primary health services integrated with settlement services, allied health providers like social workers and dieticians, and a variety of community programmes serving youth, families and seniors. Although the target population for Access Alliance are the most vulnerable new immigrants and refugees, these kind of hubs are designed to serve everybody in the local area.

Staffing

Staffing was then needed to bring the rooftop to life – by planting a successful garden as much as establishing a range of programmes and partnerships that bring a high level of participation to the garden. Two staff (a Health Promoter and a part-time Community Health Worker) are on salary to coordinate all aspects of programming and food production. For instance, a visiting school group is engaged in transplanting, watering and mulching seedlings in early spring, thus accomplishing an educational activity for the kids and a labour-intensive seasonal task in the garden at the same time. All of the programmes and services at AccessPoint on Danforth have participated in growing the garden on the roof and many of them benefit in some way from the harvest. Energy-saving features include rainwater harvesting and a passive solar water heater.

The Roof Top Garden

More than a garden, the rooftop is also a social space, with deck areas, seating and barbecues that various groups use for gatherings, meetings and events. After Year 1 some additions and improvements were made to the rooftop that better allows its use by programmes and community members. We built a pergola for shade so people could sit comfortably during the daytime hours when the building is open. Pathway improvements made the planting beds easier to access and a special raised edge was installed in the children's area so that tiny gardeners could get involved in planting without stepping on the beds/plants. These design elements became evident after using the garden for a year and finding out what kind of features could make the space more usable. For anyone planning a similar initiative I would recommend having a programme staff / frontline staff / gardener involved in the design phase to anticipate these kinds of needs. Otherwise be prepared to make some changes or additions after the first year – because inevitably, the architect's design can only take the end-user so far.

Fresh, organic food

Fresh salads are supplied to the community kitchen, which is utilized by Access Alliance, partner agencies, and community groups throughout the week. Roof garden ingredients are used in community kitchen recipes, served as part of snacks, and distributed to programme participants. As the Green Access programme evolves, more of the people cooking in the community kitchen are aware of fresh harvest being available from the rooftop, and in some cases the meal planning chart included an extra column to identify a garden ingredient for each week's recipe. The fresh flavour and beautiful appearance of the produce serves as an outreach tool to advertise the benefits of locally grown organic food and to bring more people into gardening. For example, the selection of herbs grown for tea has been expanded (peppermint, lemon grass, tulsi basil and chamomile to name a few) that, once dried, supply a quaint tea cart that travels between meetings held in the building.

Plant selection has not varied a great deal from the initial crops grown, though the roof gardening is constantly adapted to the learning along the way. Large plants like pumpkin and watermelon have been largely avoided from the beginning, as have root crops (except the occasional bed of carrots). But roof tops provide different kinds of microclimates than other gardens. The first year it was found that cool-weather greens get stressed and bolt almost immediately when the weather heats up. The full sun and heat are not conducive to production of lush leafy crops except when they're planted in the few shady areas, like those in containers underneath the solar water heater. The heat-loving plants that thrive in the full sun and shallow soil of the roof garden are mainly chili peppers, tomatoes, eggplant, okra and beans. Most of the tomatoes planted are bush varieties, better suited than large vining plants to the windy conditions and soil depth of only 20 cm. Bush tomatoes also require less staking – an important detail because the shallow soil and the wind make staking a challenge unless plants are grown around the perimeter where they can be supported by fencing. The rooftop garden also features miniature varieties. About 30 raised boxes are dotted around the roof and have a 60 cm soil depth to allow larger plants to grow (e.g., grape vines, globe cedar) and contain aggressive plants with a tendency to spread (e.g., tansy, hops, mints). A diversity of culinary and medicinal herbs are cultivated. Among 40+ perennial and annual herbs, the best suited to the hot dry conditions are the thymes, lavenders and chives. In the pollinator garden (not irrigated), drought-tolerant native species flourish. There's even a prickly pear cactus (*Opuntia humifusa*) that bore fruit.

The beds with annual, fruiting plants are watered by a drip irrigation system on a timer. The timer is critical during the heat of mid-summer when watering should ideally happen in the early hours, before the building is open. The soil is enriched with a combination of rich top-dressing (compos-

Garden group harvesting tomatoes. Photo: Lara Mrosovsky

ted duck manure) and liquid fertilisers (like vermicompost tea), keeping in mind that organic matter absorbs more water and increases the weight per cubic foot of soil. Other organic amendments include kelp meal, greensand, bone-meal, insect frass, mycorrhizae and vermicompost.

Linking the garden to the Hub

Some plant choices are geared towards specific programmes and collaborations. For example, a menu of 15 culinary herbs plays an essential part in the Savoury Garden tour, a collaboration with the Access Alliance dieticians. It uses the garden for education on reducing sodium, one of the risk factors for hypertension that can be controlled. Savoury Garden explains high blood pressure and introduces easy-to-grow herbs as a flavourful substitute for salt. This educational programme was created (by dietetic intern Eugene Jeong) because hypertension was one of the top reasons for visits to health providers.

This Savoury Garden is only one example of a collaboration within the Community Health Centre that has simultaneously served to generate interest in gardening and growing while addressing a pressing health concern of service users. Specific herbs are cultivated that match informational profiles and research that supported the development of the programme. The success of this partnership depends on the plants and the garden as well as the expertise of the health providers (in this case, dieticians) in the clinic.

Urban agriculture knowledge is propagated on the roof as well as in innovating partnerships: included in working together with TESS (Toronto Employment and Social Services), adding a gardening theme to their "Let's Talk" programme. This has led to compilation of a toolkit for use by Public Health and TESS City-Wide. When developing partnerships with non-gardening groups we are always looking for possibilities to spread the knowledge and practice beyond the Green Roof.

Building Alliances

The Green Access programme demonstrates a coming together of Urban Agriculture and Community Health. Both stand to benefit from these kinds of combinations and there is much to be learned by others in both fields. One challenge of building initiatives like Green Access in an economic climate of austerity is that many community organisations aren't in a position to innovate and develop new, multidisciplinary approaches such as garden and food programmes. The public sector faces increasing cutbacks and non-profits may be forced to offer only the bare bones of programmes and services. On the other hand, when health agencies include environmental initiatives it may allow them to access sources of funding that they wouldn't otherwise tap into.

The way forward is for more agencies in the health sector to value and promote gardening and food production as a means of achieving health outcomes, while the gardening community (Urban Ag Groups) should look to other sectors, such as Health organisations, as sources of support, new possibilities and venues for growing food.

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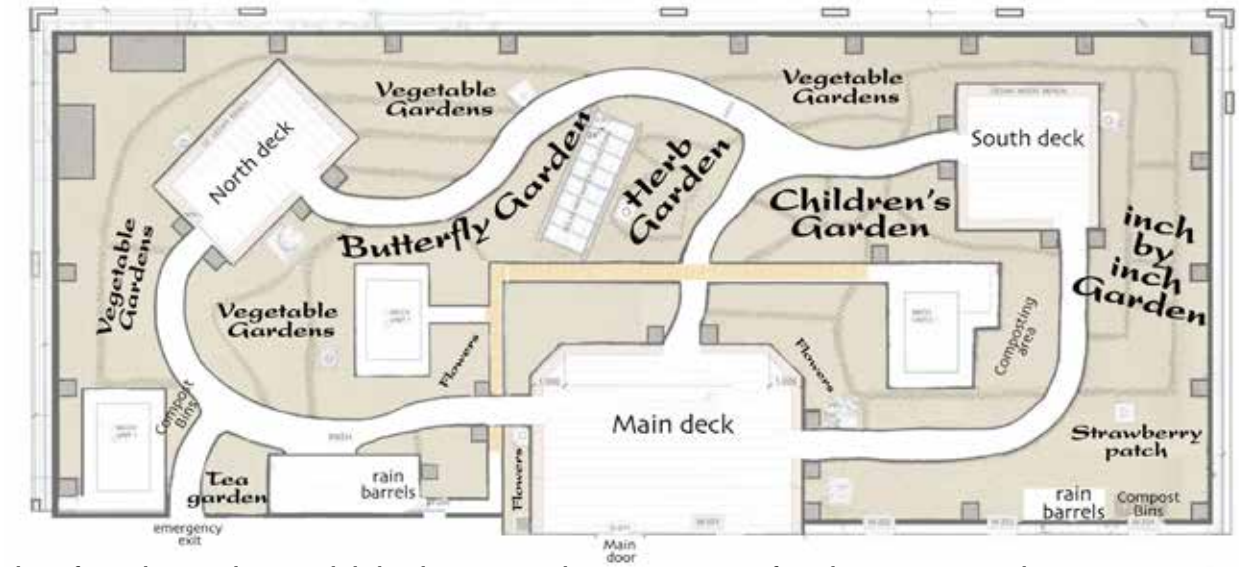


The rooftop is also a social space, with deck and seating areas that various groups use for gatherings, meetings and events. Photo: Lara Mrosovsky

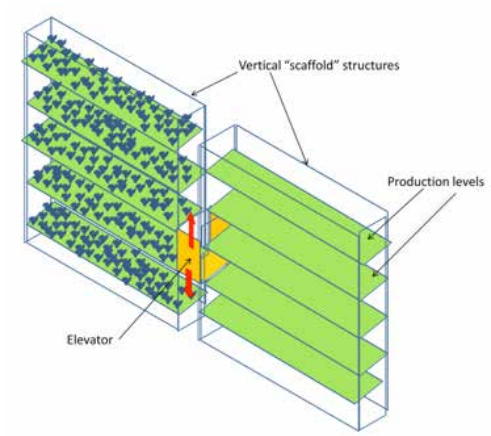
Re-Imagineering the Vertical Farm

a Novel Strategy in the Design and Development of Vertical Farms

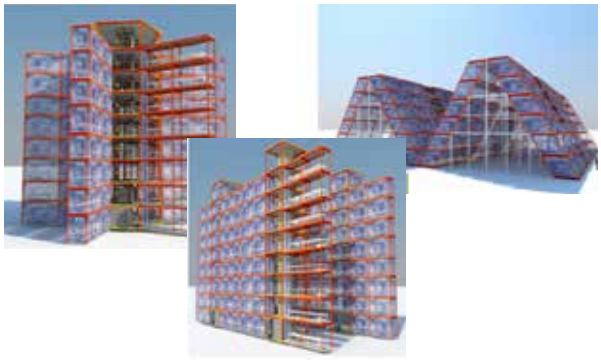
Joel L. Cuello
Xiang Liu

In 2010, for the first time in history, the proportion of the world's population living in cities exceeded 50 percent, despite the fact that the world's cities occupy only 3 to 4 percent of the planet's land area. This proportion is projected to rise further, to 60 percent by 2030 and to over 70 percent by the middle of the century. People the world over are drawn to live in cities because cities, quite simply, are the world's undisputed economic engine.

The biggest economic transformation the world has ever seen is occurring today, simultaneously with the population expansion of cities in emerging markets, generating millions of new consumers with rising incomes and with spending power that will change the way the world shops – including people living in cities buying more of their food locally.
Meeting the prodigious demand for food by the world's multiplying megacities will require various forms of urban agriculture, including vertical farms. The prospects for vertical farms, however, have recently been diminished by their projected high costs, particularly on account of the significant costs of the buildings needed to house the actual farms. Decoupling vertical farms from the conventional buildings in which the concept was originally conceived and developed constitutes a novel strategy in the design and development of vertical farms, and could make them economically feasible.
The Minimally Structured & Modular Vertical Farm (MSM-VF) is a vertical farm constructed without using a standard or conventional building, using instead minimally sufficient and modular vertical structures – or "scaffold" structures – that would be capable of supporting vertical agricultural operations (see figure). Walls made of transparent material (e.g., plastic) attached to the "scaffold" structure complete the outer shell. The relative narrow width of the "scaffold" structures would also be designed to maximize the transmission of sunlight indoors.



Basic modular "scaffold" structures of the Minimally Structured & Modular Vertical Farm (MSM-VF).



Geometric configurations using the basic modular "scaffold" structures for various farms: for the Cylinder Minimally Structured & Modular Vertical Farm (cMSM-VF) (left), Linear Minimally Structured & Modular Vertical Farm (lMSM-VF) (Middle) and Pyramidal Minimally Structured & Modular Vertical Farm (pMSM-VF) (Right).

For maximum cost reduction, each level of the MSM-VF would be designed to support the weight of the farm and associated hardware only, not the weight of human operators, who would not be stepping into or standing on the production levels. Operator access to each level would be achieved through elevators placed at strategic locations and using various forms of mechanical devices, such as conveyor belts, to gain convenient access to crops. Partial or full climate control within the production levels could be implemented as needed. Getting vertical farms out of conventional buildings and into minimally sufficient and modular vertical "scaffold" structures, would dramatically reduce the costs of vertical farms. The MSM-VF strategy could constitute a paradigmatic shift in the design and development of vertical farms and can potentially make vertical farms economically feasible for the burgeoning mega-cities around the planet, both at present and in future.
The scaled-up MSM-VF can adopt several geometric configurations using the basic modular "scaffold" structures, including a cylinder form, where the vertical scaffold structures radiate outward from a central core; a linear form, where vertical scaffold structures linked end-to-end are arranged parallel; or a pyramid form (see figures).

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Vertical Farming: From Concept to Reality

Maximilian Loessl

Inspired by the book "The Vertical Farm" (2008) by Dickson Despommier, and acknowledging the need for both a standard in terminology and a global reference point in order to map and connect businesses, institutes, projects, citizens and governments around vertical farming – in 2013, the author and eight other enthusiasts founded the non-profit Association for Vertical Farming (www.vertical-farming.net).

The basis of the Association for Vertical Farming (AVF) is the realisation that vertical farming is no longer just a utopian concept, but is actually becoming reality. Several commercial and non-commercial projects have been developed since "The Vertical Farm" was published. There are many different approaches to vertical farming, and questions regarding its economic feasibility, as well as its integration into cities, must be answered in the near future.

Vertical farming is a relatively new, high-tech part of urban agriculture. It makes use of existing methods of Controlled Environment Agriculture (CEA) using artificial lighting in multi-levelled systems. Vertical Farms are set up irrespective of climate, sunlight and region, providing an optimal climate to produce the highest yields of highly nutritious, organic and safe food, locally and 24-7-365 (year-round).

Cultivating food in multi-levelled systems within or around cities has many potential advantages, one of which is the reduced need for transport, and therefore reduced greenhouse gas emissions. Other potential advantages of Vertical Farming include:

- increased production per square meter
- increased growth rates

Agrilution Scenario's

Agrilution Scenario's

Aeroponics Indoor Harvest images

Aeroponics Indoor Harvest images

Plantagon: Multifunctional Greenhouse Buildings

Plantagon designs resilient food systems that aim to minimise the need for land, water, energy and pesticides, with low environmental impact and transportation costs. Plantagon is active in Europe, Asia and North America, and is planning realisation in places including Linköping, Sweden and Singapore. In cooperation with several partners, Plantagon develops integrated solutions aimed at reutilising energy, excess heat, waste, CO_2 and water, by integrating buildings on site and adapting them to site-specific conditions which vary from location to location. Their "Multifunctional Greenhouse Building" has a characteristic transportation helix (also referred to as the spiral or the ramp). The helix has been developed on the basis of three main optimisation factors: maximise the footprint usage ratio of land; minimise the use of water; and minimise the demand for artificial lighting while gaining the most homogeneous light levels possible. The basic idea is to plant vegetable seeds to germinate and being transferred from germination area for transplantation in pots; the plants then are transported down the helix where the cultivation and growing process takes its complete turn. The crops keep growing during the slow transport (approximately two to three weeks) down the helix and will be ready for harvesting when they reach the end of the helix at the basement level. A different solution that Plantagon offers is the "PlantaWall facade system" which is designed to be installed on existing building. The system has a depth of three to six meters and consists of parallel conveyors, carrying the vegetable pots. The structure and the conveyors provide the building with sufficient daylight input for regular activities. Not only the greenhouse facade is not interfering with the normal activities at an office or other types of buildings but also, the building could benefit from a mutual symbiotic system with the greenhouse area. For example in case of exchange of CO_2-reached air generated by individuals with O2-reached air from the production area. The Multifunctional Greenhouse Building or Facade system both could be fit to different types of real estate projects, from tall skyscrapers to smaller and medium size buildings.

An image of a greenhouse building. Photo: Plantagon

- increased nutritional values
- decreased water use due to recycling water system
- decreased fertiliser use due to recycling system
- decreased land use (no arable land needed)
- decreased pesticide use due to controlled environment
- elimination of agricultural runoff
- elimination of seasonal, regional and climatic restrictions

To date, Japan is the epicentre of vertical farming. Ever since the Fukushima disaster, the demand for organic and safe food has dramatically increased and people have been willing to pay a premium for these products. There are already 370 operational vertical farms in Japan, called "plant factories". The vertical farms in Japan grow mainly leafy green vegetables, and they can be found in old or new warehouses, universities, restaurants and even grocery stores. Recently, *Sharp, Fujitsu, Toshiba* and *Panasonic* – some of Japan's biggest tech-companies – entered the vertical farming business, both to make use of their idle semiconductor production facilities and to create new revenue streams.

The largest vertical farm in Japan, a collaboration between *Mirai* and *General Electric*, produces roughly one ton of fresh lettuce per day on 18 levels of stacked, environmentally controlled systems. This highly nutritious and clean lettuce is sold in supermarkets at double the price of conventional products. Already the demand for these products is surpassing supply and more vertical farms are under construction.

In the Western hemisphere, start-ups in the United States are entering the spotlights. The first commercial vertical farms in the United States began operating in 2012. *Farmed Here*, in Chicago, makes use of aquaponics (a symbiotic system of fish and plants) producing and selling basil, lettuce and tilapia fish to local supermarkets. *Green Spirit Farms* is the newest entry; it began production in 2014 and was established in collaboration with *Philips* (the world's largest supplier of horticultural LED grow lights).

The European hotspot for vertical farming activities lies in the Netherlands, where horticultural expertise and know-how are of huge importance to the economy (see box on PlantLab). Another ambitious enterprise in Europe is Sweden-based Plantagon (see box).

A number of new business trends developing in the vertical farming sector are helping it to spread rapidly throughout a

PlantLab

PlantLab is an internationally operating company, founded in the Netherlands in 2010 and sponsored by Syngenta, focused on growing plants in a controlled environment, without daylight, using a unique and patented combination of climate control and LED systems. Plantlab's approach seeks to optimise crop production and grow fruits and vegetables on a fraction of the land required for conventional farming. PlantLab conducts proprietary research for each crop, location and customer before designing and starting the growing process, specifying the conditions required for each stage of plant growth. Plants have very specific requirements for every stage of their development regarding light, temperature, airflow, humidity, CO_2, water and nutrients. The key issue here is seeking to control key parameters of crops, so that the plant can develop more biomass from a much smaller amount of energy. Through its research and technology development, PlantLab seeks to improve crop taste and nutritional value, reducing the amount of water needed, eliminating the use of pesticides, and eliminating the need for transportation.

PlantLab thus created a completely closed growing environment where all growth conditions can be optimised and controlled, entirely independent from one another: the PPU (Plant Production Unit). Implementation of the PPU would allow for food to be grown locally, close to consumers, at a scale that matches local demand and reduces the time between harvesting and consumption, and also limits the waste and environmental pollution caused by food-related transportation.

At its location in the Netherlands, PlantLab is already growing crops in buildings without any natural sunlight, and using substantially less water than conventional practices. PlantLab claims that a PPU can produce crop yields that are 2 to 3 times higher than the best greenhouse, and 30 to 40 times higher than an open crop field. PlantLab further claims that an investment can be expected to be earned back within 3 to 5 years.

It remains to be seen whether the closed proprietary approach of PlantLab or an open-source approach as that of MITCityFarm will be the success model of the future.

multitude of industries around the world. Among these trends are OEM (original equipment manufacturer), big data, low-cost sensors, efficient LEDs, new substrates and facade farming. Even automated home-farming will soon become a reality: a German start-up company named *Agrilution* is developing the first intelligent high-tech appliances enabling anyone to grow fresh, clean nutritious vegetables at home year-round, seeking to reconnect people with what they eat.

Indoor Harvest [1] is the first original equipment manufacturer (OEM) focused solely on vertical farming, providing license-free, low-cost, commercial grade equipment. The *MITCityFarm* project, a facade farm in Boston's world-renowned MIT Media Lab, wants to make vertical farming data and sensor technology open-source with their "Open Ag" project. Big data[2] will play a major role in vertical farming: it will be used to optimise inputs and increase production output while improving quality.

The industry is in the making, and the challenge lies in tackling some of the remaining questions:

- How can we make sure the rapid development and introduction of technology in vertical farming does not leave social inclusion behind?
- How can we make vertical farming economically feasible for a wider variety of plants?
- How long will it take for the first vertical farms to be built in developing countries?
- How can we integrate vertical farms into the energy and water grids of existing cities?

There are many exciting opportunities and challenges in this emerging industry; a map, interactive infographic, and glossary as developed by the AVF, can truly help to unite growers and inventors across the globe and improve food security in a way that has never before been achieved. To join the community, get access to these products and more information on vertical farming, please visit www.vertical-farming.net

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1) Indoor Harvest, Corp., through its brand name Indoor Harvest™, is a manufacturer of commercial aeroponic system fixtures and components also offering custom design build services and consulting for indoor vertical farm construction
2) Big data is an all-encompassing term for any collection of data sets so large and complex that it becomes difficult to process using traditional data processing applications. The challenges include analysis, capture, curation, search, sharing, storage, transfer, visualization, and privacy violations. The trend to larger data sets is due to the additional information derivable from analysis of a single large set of related data, as compared to separate smaller sets with the same total amount of data, allowing correlations to be found to "spot business trends, prevent diseases, combat crime and so on."

Low-tech Innovations in Vertical Farming: Nairobi, Kenya

Randall Coleman

This article describes the further development of small-scale, "low-tech" vertical farms at the individual and neighbourhood level in informal settlements. These vertical farms are adapted to suit small urban spaces. They increase the density at which food can be produced and keep the growing medium independent of potentially contaminated ground. They require little maintenance and are more easily accessible to the elderly and the disabled by virtue of their vertical nature.

Can YA Love (CYL) is an American NGO that works globally on sustainable agriculture, with a focus on environmental reclamation, aerobic composting and vertical farming methods to spur economic development. CYL works primarily with orphanages, schools, women's groups and youth groups, because these reside in the community and contribute to its long-term improvement. In Kenya, CYL has worked on an urban agriculture project in Nairobi.

The vertical garden

The vertical growing systems used by Can YA Love were inspired by practices in the slum of Kibera, in Nairobi, Kenya. Women were taking burlap sacks, filling them with soil, puncturing holes across the entire three-dimensional surface of the sacks, and growing leafy greens from those holes. Bearing in mind the lack of sanitation services in this environment, the "sack garden" was a crucial innovation because it was independent of the contaminated ground. Several organisations have reported working with these sacks (see UAM 21). Many also credit this innovation with saving lives during the period of post-election violence Kenya experienced in 2007-2008, when the community suffered massive food shortages.

However, the "regular" sack garden is limited in terms of what can be grown, due to soil depth and the amount of growing surface: only half a square metre. CYL's intention was to use a similar concept, but to increase the size and solidify the structure in order to realise the additional benefits detailed below and to grow enough food to support an organisation or family.

Innovation

CYL's extensive R&D coalesced into two main types of vertical garden, the "Growing Pillar" (GP) and the "Growing Wall" (GW). Both utilise simple welded-wire fencing for the structure, fabric for the inner lining, and high-quality compost or some combination involving soil as the growing medium. Like the sack garden, the entire surface can be used to grow food. In its most common form, the GP is a cylinder that takes up about half a square metre of ground space. It stands just under two metres tall and provides a minimum of nearly five square metres of growing surface, which makes the growing surface ten times greater than the occupied ground area. The growing surface can be further maximised by using trellises up which vining plants can climb from the surface of the GP. The GW uses many of the same principles and stands as an elongated rectangular prism. In its most common form, it measures 50 cm in depth and 1 metre in height while the length may vary.

Crop production in dense urban spaces as part of the CYL project in Nairobi. Photo: Can Ya Love

CYL works with orphanages, schools, women's groups and youth groups. Photo: Can Ya Love

The vertical growing systems with a solidified structure by CYL. Photo: Can Ya Love

A growing pillar for household production. Photo: Can Ya Love

In addition to saving space, these vertical gardens have the following advantages:

- They can be built on nearly any surface (e.g., pavement or contaminated ground) or in areas with low-level flooding;
- The design can be adapted to suit people with a range of physical limitations (e.g., the elderly and physically disabled);
- They require much less maintenance than a conventional garden or farm, involving no tillage and virtually no weeding;
- A water-capture system at the base of the garden collects for reuse any water not absorbed by plants or soil;
- The centre of the structure is insulated to reduce evaporation, thereby increasing water efficiency as roots penetrate deeper into the structure;
- The materials are inexpensive and readily available in most parts of the world;

And, of course, these systems increase food availability, which contributes to food security in urban food deserts. In addition to food production, the GPs may also be used to recycle food waste into a usable growing medium. To facilitate this usage, a vermicomposting component is added to the design. Worms are placed in the bottom of the GP and fed three days' worth of food. Once the worms have eaten the food scraps, a layer of growing medium is placed in the garden along with another three-day helping of food. This process is repeated until the garden is full of a rich, fertile growing medium. By this time, the worms will have multiplied about two or three times and can be easily extracted to start the vermicomposting method in other GPs, creating more growing medium . This method creates a self-perpetuating system.

Experience in Nairobi

In conjunction with Can YA Love Kenya (CYL-K), CYL hosted a three-day seminar at which the leaders of many community-based organisations were invited to learn essential sustainable agriculture methodologies such as the construction and utilisation of the vertical farms; ecological practices and understanding; aerobic composting; safe food handling; and soil microbiology. This was achieved using a combination of lectures and the hands-on experience of building a vertical farm for a primary school. During the seminar, together with the Kawangware Urumwe Youth Group (KUYG), the Parents of Children with Special Needs Association (PCSNA), and the Kabiro Primary School (KPS), CYL started a vertical urban farm at KPS. The small urban farm provides food for consumption by pupils at KPS, and also serves as an educational tool for them to learn about composting and agriculture. The implementation concluded with a GW and seven GPs, two of which used the vermicomposting method discussed above. Kale, spinach and chard were the three primary foods grown, as decided by the community members.

Challenges

The project team faced several challenges. The first was the availability and quality of compost. The GP vertical garden requires a significant amount of soil but structurally does

not support the weight of heavy clay, which in addition is difficult for roots to penetrate and does not absorb or distribute water sufficiently. Compost-rich soil is far more preferable. This emphasised the need for compost creation at the farm site. In view of this, of the seven GPs that were built at KPS, two were dedicated to compost production using CYL's vermicomposting method. However, the red wiggler worms used are expensive and difficult to source in Kenya, and temperature monitoring during composting was difficult for the community members. Other challenges faced in food production were water access, and organising the sale of any surplus.

Impacts and future plans

Members of CYL-K report that the gardens are still producing food for consumption and sale. The more exciting impact, however, has been the spread of the vertical gardens throughout Kenya following the seminar, which has happened *without direct implementation by CYL*.

CYL and CYL-K will develop a central farm with medium-scale aerobic composting as well as an education centre that will offer two new courses: best practices in community gardening, and simple data collection practices. Any CBO wishing to have CYL fund a garden for their organisation will be required to file a proposal that includes a written plan for allocating profits, and to file progress reports at certain intervals with CYL. Of course, any CBO wishing to build a garden on its own may do so without any such proposal and can ask CYL-K for technical support. CYL continues to be engaged in research and development at CYL headquarters near Washington, DC in the United States. It is working in areas that support its mission, such as filtration systems for salt and contaminated water.

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One member of CYL-K built a GP at his home in Nairobi for the purpose of feeding his family. Within three months, the food that the garden produced had covered the cost of building the GP.

Production of *Fortifer* Pellets: Boosting agriculture in and around urban areas

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Olufunke Cofie
Robert Impraim
Surendra K. Pradhan

Excreta are rich sources of essential plant nutrients and organic matter that can be recycled and used as fertiliser or soil conditioner, thus improving soil structure, increasing water-holding capacity, reducing pests and diseases, and neutralising soil toxins and heavy metals. Since 2001, IWMI has been working to understand the principles underlying the use of excreta in agriculture. In so doing, IWMI aims to optimise the removal of pathogens as well as the recovery of nutrients, and enhance the business potential of reuse in agriculture.

Fortifer pellets, a faecal sludge-based fertiliser developed by IWMI, addresses many of the challenges, such as cost of transportation, handling and negative perceptions. This is expected to have a positive impact on the adoption of this new fertiliser product. Faecal sludge (FS) is the waste extracted from on-site sanitation facilities, i.e., latrines, aqua privies and septic tanks. These are the main options for capturing human excreta in Ghana (> 85 % coverage) as well as in many developing countries. On-site installations must be emptied periodically, preferably mechanically, and FS, which is the mixture of human excreta more or less diluted with flush water, toilet paper, and sometimes other waste types, must be treated before disposal. Unfortunately, mismanagement of FS from on-site sanitation systems constitutes a serious threat to the environment and health, especially in and around highly populated zones in urban areas.

Typically, raw liquid FS contains 8–25 g/l of nitrogen (N), 1–2 g/l of phosphorus (P), 2–8 g/l of potassium (K) and 21 g/l of organic carbon (C), while dried FS contains 27–41 mg/g of N, 12–29 mg/g of P, 2–6 mg/g of K and 115–427 mg/g of organic C (Asare et al., 2003; Nikiema et al., 2014). This explains why many farmers in periurban areas of several developing countries are keen to use this readily available material for agriculture. But the sludge (liquid or dewatered) is highly contaminated with pathogens, which limits its marketing potential. IWMI has developed a simple technology enabling the production of a sanitised and easy-to-handle fertiliser material (*Fortifer* pellets) by means of a controlled process.

Production of *Fortifer* pellets

The characteristics of FS are highly variable from one country to another and within a single country, as they depend on the type and origin of the sanitation facility being used. A novel aspect of the recycling technology is that it enables, at an affordable cost, the safe processing of the liquid faecal sludge, i.e., containing 10 % or less total solids.

The recycling process (see Figure 1) was developed, tested and optimised in Ghana (Adamtey et al., 2009; Nikiema et al., 2014). To address the issue of the high water content of the raw FS, it is dried. When this is done using drying beds, it has been established that a mixture ratio of 1:2 for public toilets and household FS is sufficient. Then, the dewatered FS can be composted with other organic waste (market waste, sawdust, etc.). The composting process sanitises the FS and makes it suitable for farm application.

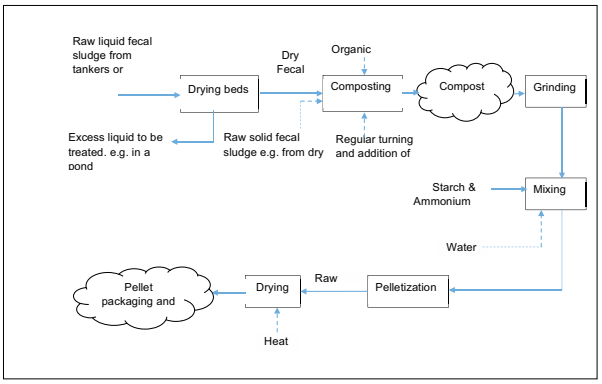

Figure 1. Fortifer pellet production process

Subsequently, the compost is ground and mixed with ammonium sulphate, cassava starch and, typically, water at a certain proportion depending on the required product quality. This process has been described fully in Nikiema et al. (2013). The enrichment of composts is designed to tailor the *Fortifer* nutrient content to the plant/soil nutrient demand. For example, the addition of ammonium sulphate increases the nitrogen level of the compost (see Adamtey, 2010 for tests on types of fertiliser additions). The addition of the binder to composts allows for strong pellet formation, i.e., their ability to maintain their shape when some mechanical pressure is exerted on them during, for example, transportation and storage. Key parameters to be considered when selecting a suitable binder include total available amounts especially in the production area, ease of use during pelletisation,

handling and storage requirements, binding ability, binding strength and costs. In Ghana, cassava starch was selected and its concentration was set at 3 % after optimisation. This binder requires a pretreatment that increases its binding properties before it can be added to the feedstock in the mixer. Optimal moisture content of feedstock, which is a key pelletisation factor, is affected by the binder type and concentration.

The pelletisation of composts involves the use of mechanical pressure to increase the density of the compost when converting it into pellets. Consequently, *Fortifer* pellets require 20–50 % less packaging volume than powdered composts. Pelletisation also facilitates broadcasting by making it a more uniform and dust-free process.

The photos show the pilot equipment used for *Fortifer* production. It was produced locally in Ghana, allowing minimal capital cost. Details can be obtained from the author.

Application of *Fortifer* in urban agriculture

Compared to traditional non-pelletised composts, pellets release nutrients at a steadier rate and are more effective in decreasing nutrient losses from agricultural fields. Consequently, the effect of *Fortifer* pellets on residual nutrient levels after a cropping season should be more significant than with the use of powders.

The agronomic effects of *Fortifer* pellets have been compared with inorganic fertiliser use (ammonium nitrate supplemented with muriate of potash and triple super phosphate) in a greenhouse. Open-field application was also conducted and validated the observations in the greenhouse. Overall, the results show that yields of maize, cabbages and other tested crops obtained using *Fortifer* pellets are comparable to or up to 50 % higher than those achieved with inorganic fertiliser, at similar application rates.

Grinder

Capacity: 450 kg/hr
Power requirement: 3-phase, 4 kW motor

Exterior dimensions:
- Length: 1 m
- Width: 0.5 m
- Height: 1.2 m

Mixer

Capacity: 20 kg per batch (up to 240 kg/hr).
Power requirements: 3-phase, 1.5 kW motor

Exterior dimensions:
- Length: 1.56 m
- Width: 0.5 m
- Height: 0.95 m

Pelletiser

Capacity: 100 kg/hr
Power requirements: 3-phase, 1.5–4 kW motor
Pellet diameter: 8–12 mm

Exterior dimension:
- Length: 1.2 m
- Width: 0.5 m
- Height: 1.35 m






Components of the batch and pilot pelletising unit. Photo: Nikiema et al., 2013

Power Requirements and Costs of *Fortifer* Pellets

In *Fortifer* production in Ghana, electricity is required for compost grinding, mixing and pelletisation using the locally produced machines, but not required for drying (solar energy) or composting (manual labour). The electricity used to produce each metric ton of dry pellets is between 36 and 57 kWh, depending on the raw materials used for composting. Owing to their physical properties, enriched products required 12–14 % less energy than non-enriched composts during processing while a co-compost of sawdust was revealed to have the highest energy consumption during pelletisation.

In the present operating scenario in Ghana, the production cost per metric ton of *Fortifer* pellets is below USD 200 (with about 30 % of the cost being for composting, 40 % for enrichment and 30 % for pelletisation and packaging). The energy cost represents 15–25% of the pellet production cost while other utilities (such as water, ammonium sulphate for enrichment, cassava starch) constitute some 40 % of the total cost (Nikiema et al., 2013). These costs could be reduced by securing contracts for the bulk purchase of supplies or by opting for more energy-efficient machines.

In 2013, the selling price per metric ton of conventional composts in Ghana varied between USD 120 and USD 200. Comparatively, costs per metric ton of inorganic fertilisers during the same year were about USD 632 (USD 392–USD 408 when subsidised – however these subsidies will be stopped in Ghana) for NPK or UREA and USD 424 (USD 392–USD 408 when subsidised) for ammonium sulphate. Nevertheless, the use of *Fortifer* pellets could remain more expensive than the use of inorganic fertilisers given that application rates required to achieve the same N content are typically 5–10 times higher (in the first years at least) than when applying inorganic fertilisers alone.

Exploratory market research showed that many farmers in Ghana appreciate the look of the *Fortifer* pellets and are willing to use them on their fields. Some farmers still prefer to use other forms of compost that they are already used to. *Fortifer* is being tried out with farmers in selected locations in the country. A *Fortifer* plant with a capacity of up to 500 metric tons/year for various FS-based fertilisers is being established in Ghana.

Conclusion

The IWMI technology enables the production of safe FS *Fortifer* pellets that can be used as an organo-mineral fertiliser for growing crops. It has been established that the production of *Fortifer* pellets provides a suitable way to:

1) remove pathogens and reduce the risks associated with the current practice of FS recycling;
2) reduce the bulkiness of composts, and therefore facilitate transportation and handling; and
3) contribute to addressing perception issues.

The use of a binder such as cassava starch serves two purposes: it increases the strength of the *Fortifer* pellets, which prevents them from being crushed during transportation; and it regulates the decomposition of the *Fortifer* pellets following application on the farm. Ideally, the selection of the appropriate binder concentration should take market behaviour into account (e.g., whether users are willing to purchase the product even with a certain percentage of fine particles), but such information may not be readily available. The decision to fix the starch concentration at the level of 3 % was supported by our pilot research findings.

The application of *Fortifer* pellets increases yields, improves soil structure and increases water-holding capacity. It is expected to reduce pests and diseases, and neutralise soil toxins and heavy metals. This could contribute to enhancing food security and reducing environmental and health risks due to waste in urban and periurban areas.

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Co-composting to Recover Phosphorus from Waste in Tamale

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The use of organic waste for agriculture in Tamale Metropolis, in Northern Ghana, has a history of more than 30 years. Due to a combination of factors, farmers have been using faecal sludge in the cultivation of cereals, and drainage water and wastewater for vegetable production. The high cost of inorganic fertiliser and the poor soils which are low in organic matter, for example, have led to the use of readily available, cheap soil amendments. The production of high-quality organic fertiliser for sale to farmers has high potential in Tamale.

Co-composting is controlled aerobic degradation of organic materials using more than one material – usually different types of organic mixes. The combination of organic waste results in the optimisation of benefits and improvement of the final product. Various combinations co-composted in a ratio of 2:1 are suitable for Tamale Metropolis. Co-composting is a developed and accepted technology, but it is not yet mainstream. In Tamale, DeCo! has developed an innovative social business making compost without faecal sludge, and RUAF partner IWMI has developed various experiences in Ghana *(see UAM 26)*.

University for Development Studies, supported by RUAF, and a member of the Tamale Urban Water and Sanitation Consortium conducted research on waste nutrient recovery for urban agriculture. Local NGOs and small-scale farmers collaborated in participatory experimentation and up-scaling of various types of co-compost with organic waste available in the Metropolis. Easily obtainable components were used: faecal sludge, shea butter slurry, municipal waste and rice straw. The windrow method, which is less labour-intensive, was adapted. A survey was conducted on organic waste generation in the Metropolis. Stakeholder interviews were conducted. Farmers in the Metropolis were trained in co-composting at the research site, and participatory field experiments were carried out. Chemical analysis of the co-composts was conducted in laboratory.

Testing different co-compost heaps with farmers. Photo: UDS

Combinations of faecal sludge, municipal waste and shea butter slurry contain a considerable percentage of phosphorus and organic carbon and are thus suitable for cereal cultivation in Tamale Metropolis, while rice straw combinations are suitable for vegetables. During dry periods, crops on co-compost fields perform about 85% better than inorganic fertilizer fields. Weed control is easier and yields are comparative to faecal sludge fields. Additional benefits are improved urban sanitation, reduced waste disposal costs, and development of business and employment opportunities for the urban poor. Co-composting contributes substantially to greening of the municipality and urban food production.

Public and private financial mixes are required for small-scale co-composting initiatives and interest and finance are improving. The challenge is to sustain further up-scaling of these options. Not all of these practices will prove to be sustainable in the long run, although they do fulfil a role in the development process, piloting and raising awareness.

Rapid urbanisation in Africa has posed challenging options for processing waste and producing food in urban and peri-urban environments. Recycling and reuse of urban waste provides much-needed soil nutrients for poor soils as well as ways of solving municipal waste accumulation problems. Tamale Metropolitan area provides some examples of current thinking and options that can be applied to many other growing towns in sub-Saharan Africa.

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Promoting Periurban Agriculture in Flood-Prone Areas of Gorakhpur, India

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Flood resistant varieties. Photo: Gorakhpur Environmental Action Group

In Gorakhpur, India, periurban agriculture represents a practical mechanism for diversifying urban livelihoods and ensuring availability of local food supplies while maintaining open areas that can serve as flood buffers. The land-use pattern and ecosystem services in these areas are maintained, promoting climate-resilient periurban agriculture that uses innovative methods.

Gorakhpur, a secondary city located at the confluence of the Rapti and Rohin rivers in eastern Uttar Pradesh, India, is one of the fastest-growing cities in the mid-Gangetic plains. Its proximity to the Himalayas makes it vulnerable to floods, which impacts the livelihoods of poor and marginalised communities.

The periurban areas of Gorakhpur are particularly prone to recurring floods and waterlogging for two to three months every year, as a result of which small and marginal farmers suffer from crop losses. Climate change is likely to increase the intensity of similar rainfall events by 10 to 20 % in the future. Projections have indicated that the intensity of extreme rainfall in Gorakhpur is likely to increase in the coming years, which will cause significant flooding in the city. Flooding occurs in the low-lying areas of Gorakhpur,

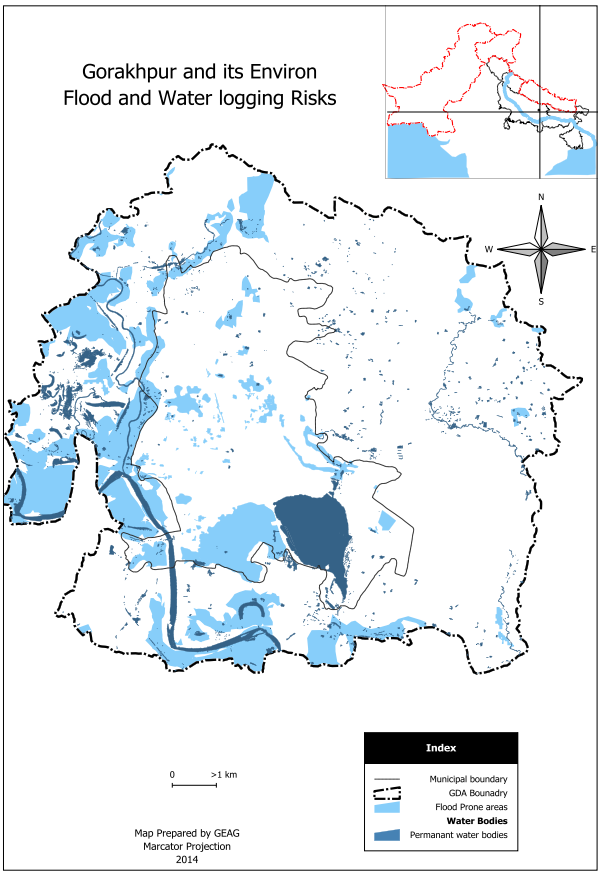
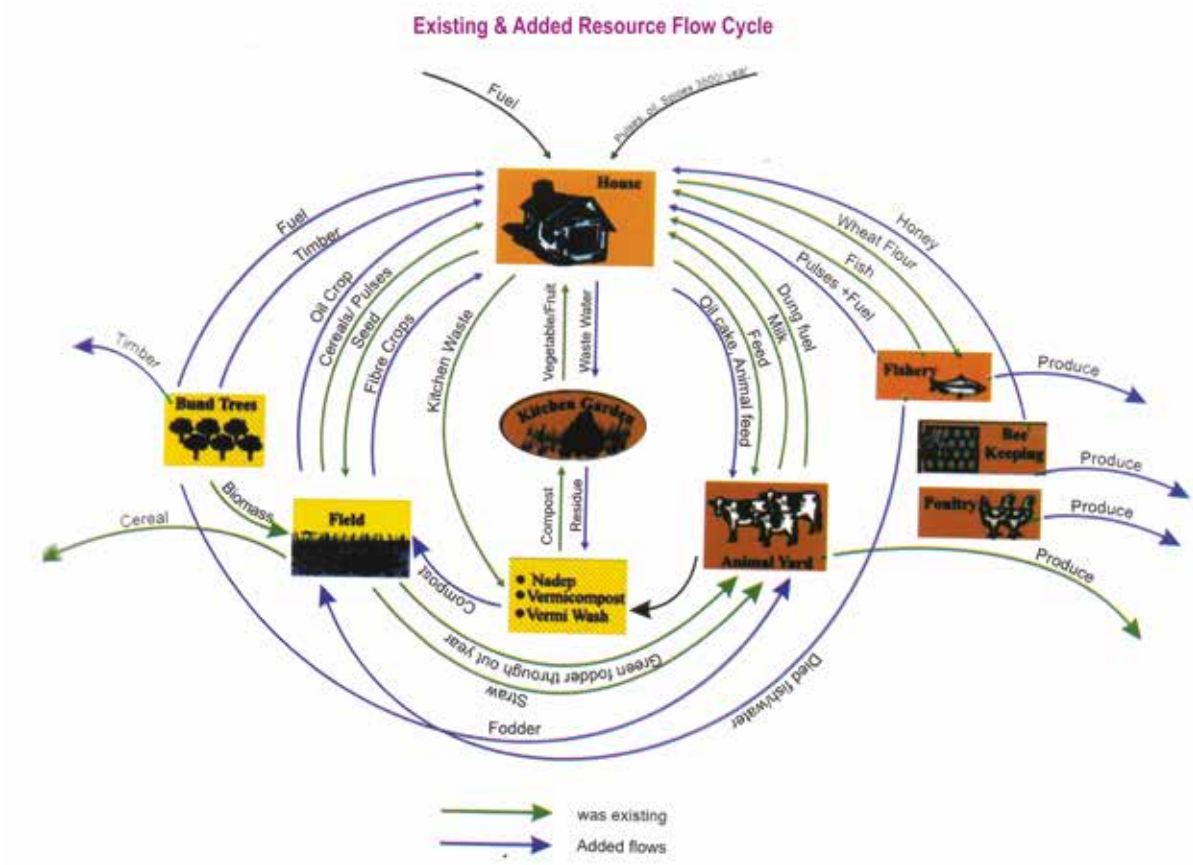


Figure 1 India and Gorakhpur, illustrating the flood-affected and waterlogged areas.



often after only 100 mm of rain in 24 hours, an event that happens about every two years.

The rapid urbanisation occurring in Gorakhpur is putting a strain on the natural resources and is absorbing the existing agricultural land. Large-scale conversion of agriculture land for non-agricultural uses is exacerbating the risks of climate change. The Gorakhpur Environmental Action Group (GEAG: www.geagindia.org) is an NGO that seeks to mitigate the risks associated with flooding by maintaining the existing open spaces. A strategy being used to do this is that of strengthening livelihoods based on periurban agriculture.

Role of periurban agriculture

In these flood-prone areas of Gorakhpur, periurban agriculture is a means to keep areas that are vulnerable to flooding free from construction and to maintain their natural functions (such as enhancing water storage and infiltration, and in this way reducing run off). This reduces the vulnerability of the urban poor and enhances their capacity to cope with the impacts of floods. It also helps to enhance the sources of food and income available to periurban agricultural communities.

Since women members of the family do most of the agricultural activities, nutritional security is an important outcome. In addition, periurban agriculture diversifies food sources, thereby reducing energy footprints, as well as creating income opportunities. Preservation of local biodiversity and recycling of urban waste are other potential gains that periurban agriculture offers.

Challenges

Under the city's Master Plan-2021, about 54 % of the periurban area is designated for agricultural use. Of the 100,000 inhabitants a significant proportion are small and marginal farmers. These farmers are hit by several problems that make them socially and economically vulnerable. These include:

Floods and waterlogging: Approximately 25 % of the total periurban area in Gorakhpur is flood prone, and in most parts severe waterlogging takes place for two to three months every year. This results in decreased soil fertility and an increased incidence of pests and diseases in the crops. Increased inundation means farmers are unable to sow the summer crops *(Kharif)* and this has a knock-on effect creating a burden on the winter crops *(Rabi)*. This severely impacts the food security of the small and marginal farmers.

Sewage dumping: Periurban areas have become the city's waste and sewage dumping grounds. Improper management of solid waste and sewage is leading to health problems as well as deterioration of soil quality and contamination of groundwater.

Increasing cost of agricultural inputs: agriculture has become expensive for small and marginal farmers. The high cost of inputs such as seeds, fertiliser, irrigation and labour makes agriculture almost unaffordable for these farmers and the net gains are very low.

Inaccessibility to agricultural services: Periurban farmers do not have access to the agricultural schemes that are directed at rural farmers. They are not eligible for government subsidies on agricultural inputs nor do they have access to extension services. Hence, they lack knowledge and information on new farming techniques.

Changing land-use patterns: Land-use patterns are changing in the periurban areas of Gorakhpur, as farming has not remained remunerative enough for the farmers. This is also leading to distressed migration. Unplanned developments and non-compliance with the city Master Plan are leading to infrastructural developments on the agricultural lands.

Innovations to deal with flood conditions

The periurban area of Gorakhpur totals 7,000 hectares and most of this is demarcated by the Gorakhpur development Authority (GDA) as green and open areas. GEAG has been promoting periurban agriculture in Gorakhpur since 2012 on 200 hectares where a total of 18,000 people live, focusing on small and marginal (mostly women) farmers. The interventions of GEAG are aimed at reducing risks and vulnerabilities of the poor who are dependent on periurban agriculture and also of the city's population who are affected by flooding. The underlying strategy is to make periurban farming economically viable among the farmers and to demonstrate new techniques of climate-resilient farming.

Climate-resilient agriculture

This type of farming is based on the principle of integrating household, livestock and agriculture, and seeks to enhance diversity and recycling in the farming systems. Low use of external bio-inputs, appropriate crop varieties, space and time management, seed banking, land shaping and portable nursery systems are practices that are being promoted and taken up by the farmers. The farmers have adopted a number of innovative farming practices that are adapted to the geographical conditions of the area and the problem of frequent flood events. These are described below.

Integrated and diversified farming systems

Integrating and diversifying their farming systems has helped the farmers to increase the resilience of their farms because the chance of losses is reduced. Increasing diversity and complexity in agriculture means increasing the number and performance of functions. For example, if the function of fodder is performed by several elements, such as agricultural residues, fallen leaves and pruned branches of trees on the farm boundary, cattle residues and other such farm sources, the farmer's resilience will be greater than it would be by only relying on a single option such as cow dung. Similarly, increasing the number of crop varieties grown, the number of crops grown simultaneously, the number of crop cycles during the year on the farm, and the number of crops replaced over the years are other mechanisms of enhancing the diversity of a farm. Besides increasing the number of crops, increasing the number of subsystems on the farm to include, for example, a pond for aquaculture, orchards/a kitchen garden, livestock, poultry, will add to the *diversity* of farm systems. The number of functions performed by a single farm element increases the *complexity* of a farm system. For example, if the livestock in the farm system is utilized for its dung (for compost), milk, ploughing and other purposes, it increases the complexity of that particular farm element. Similarly, the trees can be used for wood, fuel, shadow, multiple cropping and other such functions. In this way the utility of elements is increased. *Recycling* is adopted by the farmers in and between various farm sub-systems to fulfil several needs of the farm and reduces the need for external inputs. The more recycle flows there are, the better the health of the farm, as this reduces the input costs of the farm without having a negative effect on outputs.

Diversity and multi-tier cropping.
Photo: Gorakhpur Environmental Action Group

Cultivation in jute bags.

Household and Farm Level	City Level	Ecosystem Level
- Establishment of sustainable and climate-resilient models of agriculture in marginal land holdings in periurban areas - Increase in farm productivity - Increase in crop diversity - Reduction in chemical inputs and increased use of organic inputs - Reduced inputs and enhanced net gains for small-scale marginal farmers - Increase in inter-linkages amongst different farm subsystems - Improvement in soil quality - Enhanced livelihood security of vulnerable groups in periurban areas and food security of urban poor - Increase in annual income - Food security ensured - Reduced dependency on markets for food	- Enhancement in food security of the city as periurban agriculture is providing fresh vegetables, fruits, milk, meat, eggs, etc. - Periurban agriculture conserves open and green spaces and has thus enhanced the buffering capacity of the city against flooding and waterlogging	- Conservation of agricultural land in periurban areas which has enhanced the flood buffering capacity of the city as a whole - Conservation of water bodies which has enhanced the water retention capacity - Soil conservation - Enhanced food security of the urban population - Reduced energy footprint as food is produced close to the consumers

Table: Outcomes at various levels

Time and space management
Altering the timing of cropping cycles through pre- or postponement of planting is a successful strategy that the farmers have adopted. Sowing varieties that can withstand water inundation has also been helpful in saving the crops from the effects of flooding. Traditional varieties and those developed by research institutions were identified through participatory exercises and adopted by the farmers. Multi-tier cropping is another effective practice that the farmers have adopted, as the layers of crops are able to deal with various water levels during flooding in this area.

Loft farming
In waterlogged areas, loft farming is an innovative way of farming. Farmers fill old tyres or sacks with soil and manure and plant seeds of climber vegetable crops. Lofts or stilts are made from wooden sticks and these support the climber crops as they grow, thus saving the produce from spoiling in the waterlogged fields.

Raised low tunnel poly-houses
Raising crops in nurseries during summer for transplanting in winter used to be extremely difficult due to extensive waterlogging. Farmers have now been trained to prepare and use poly-houses for growing seedlings. First, the farmers prepared a raised seed bed (1 to 1.5 feet above the ground) in the field which was free from waterlogging. A 30 to 45 cm high mound with a sloppy drain was made around the seed bed to prevent rainwater from entering the seed bed and to allow excess water to drain away easily. This high raised bed was covered by a low tunnel poly-house supported with bamboo sticks. Vegetable seedlings of tomato, cauliflower, brinjal (eggplant), and chilli are to be prepared in these seed beds until they have become ready for early transplantation.

Climber crops
Farmers in the area grow vegetables that creep over the soil, such as sponge gourd and bottle gourd, but these crops do not survive due to excess water and humidity in the soil. Farmers have adopted an innovative practice of growing *dhaincha (Sesbania aculeata)* for green manure and also use it as a support for these creeping vegetables to climb up.

In the waterlogged fields, farmers also use *thermocol* boxes and jute bags to raise climber crops such as bottle gourd and ridge gourd. The boxes or bags are filled with soil and manure and the vegetable seeds are sown in them. The climbers are supported by wooden sticks as they grow.

Flood-resilient crop varieties
Flood-resilient crop varieties have been promoted among farmers. The *Swarna Sub-1* variety of paddy and the *PV-7* variety of lady's finger have shown successful results. These crop varieties even grow in flood and waterlogged conditions.

Climate information advice
Weather stations have been installed and mobile SMS-based climate information advisory services have been set up, providing the farmers with advance weather information. Information on temperature, rainfall, wind and humidity is sent to farmers through SMS, which acts as an early-warning system and helps the famers in scheduling their irrigation, harvesting or other crop activities.

Promoting Low External Input Sustainable Agriculture (LEISA)
The adoption of LEISA practices, such as local preparation of organic manure and pesticides, has significantly reduced the use of high-cost external inputs such as chemical pesticides and fertilisers, thereby increasing the net gains to small and marginal farming communities.

Outcomes and lessons learned

The introduction of sustainable and climate-resilient periurban agriculture has resulted in several outcomes at the household, farm, city and ecosystem levels shown in the table.

Agriculture in periurban areas should be seen as an activity undertaken by the entire community, as only then will its impacts be felt and sustainability achieved. Government schemes should also be formulated in such a way that they

Low Tunnel Polyhouse preparation. Photo: Gorakhpur Environmental Action Group

encourage promotion of periurban agriculture at the community level, since the problems that farmers face are not individual but affect the whole community (for example, discharge of sewage water or solid waste, digging out of soil, private land colonisers). Conservation of periurban villages is essential largely because of their role in providing a low-cost supply of food to the urban market. However, periurban land use could also be developed not just for the services it provides to urban areas but also for agro-based industries, such as seed production, processing of dairy products and meat, tanneries, laundry services, carpentry, etc.

Looking to the future, the experiences generated from this initiative will be used to develop and implement a policy framework in which the marginalised are empowered and periurban agriculture and farmers receive due recognition. Apart from promoting LEISA techniques and other farm practices as ways of adapting to flood situations, the focus will also be on organising communities so that they can compete in markets. Through advocacy initiatives with city authorities, efforts will be made to implement regulatory frameworks that preserve periurban agricultural space and discourage change in land-use patterns. Lastly, experiences will be disseminated and shared in other areas with potential for periurban agriculture.

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Cultivation in thermocol boxes.
Photo: Gorakhpur Environmental Action Group

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Unmanned Aerial Vehicles (UAVs) and Urban Agriculture; Potential for Research and Planning

Johannes Schlesinger

Mapping and quantifying areas of agricultural production within cities and in periurban areas remains a challenge, mostly due to the heterogeneity of land uses in urban settings and the small scale character of Urban and Periurban Agriculture (UPA). The development of small Unmanned Aerial Vehicles (UAVs), however, makes aerial photography and UPA analysis more efficient than previous in situ and satellite-based approaches. This article provides an overview of the manifold applications of UAVs in the context of urban agriculture and presents experience from a research project in Tamale, Ghana.

Integrating UPA in urban and periurban land-use plans can be difficult, as research and implementation projects have shown in the past. In many cases, the reason is the sheer lack of knowledge within municipal planning institutions about the current extent, locations and characteristics of agricultural sites within their area of authority rather than any unwillingness on their part. The quantification and mapping of UPA remains challenging as plots are often located in areas difficult to access, such as private backyards, temporarily flooded or moist river banks, and steep slopes. This makes conducting surveys and in situ mapping of agricultural sites costly and time intensive, and data tends to be outdated by the time it is actually used and published. Therefore, in the recent past, an increasing number of NGOs, researchers, and planning institutions have made use of satellite images to map agriculture in urban contexts. Satellite data becomes more accessible through services such as Google Earth or Bing Mapd, providing images for an increasing number of urban areas, not only in the Global North but also in Latin America, Asia and Africa. With spatial resolutions typically ranging from 0.5 to 6 metres, demarcating individual plots or even identifying different crops remains almost impossible. Due to the limited temporal resolution and restriction to cloud-free scenes, satellite imagery often falls short of the expectations of planners, NGOs and researchers alike.

A new era in aerial photography

Recent developments in the field of UAVs – commonly known as "drones" – create a wide range of opportunities and applications in the context of UPA mapping by overcoming most of the shortcomings of in situ surveys and satellite-based approaches. While generally having a bad reputation due to mostly military uses, an increasing number of devices are

An image of Tamale, Ghana. Photo: Johannes Schlesinger/University of Freiburg

The potential applications in the context of UPA are diverse. Photo: Johannes Schlesinger/University of Freiburg

used for civil purposes. UAVs have been significantly improved in terms of spatial resolution, payload and usability. Simultaneously, the price and size of these devices has decreased, making them more attractive for applications in urban and periurban settings. Prices for systems vary, starting at a few hundred euros, but can increase to EUR 20,000 for more elaborate devices. UAVs are particularly suitable for acquiring geodata, especially in cases where very high ground resolutions (+/- 5 cm) and up-to-date imagery is necessary. With cruising altitudes typically well below 300 metres, they can be operated in cloudy conditions, which is a particular advantage in tropical regions.

The variety of systems is wide, ranging from small electric multicopters to larger fixed-wing planes with combustion engines. While the former can typically cover areas of a few hundred square metres in a single flight, the latter manage to capture the data of a few square kilometres. Some of these systems can be equipped with digital photo cameras, others can carry infrared, hyperspectral, or thermographic cameras or laser scanners, depending on the application and budget of the operator. Easy-to-use software packages, which usually come with the devices, allow for automated processing and analysis of the raw data. While most software solutions are proprietary, there are also free solutions that can be downloaded. In some cases, digital surface models for 3D visualisations can be calculated in addition to mere photo mosaics. Usually, the outputs are georeferenced / orthorectified, making them instantly available for integration and further analysis in geographic information systems (GIS) or computer-aided design (CAD) software, often used by planners and scientists.

The biggest advantage of these data-acquisition systems is their flexibility. Little flight preparation is necessary; the devices can be quickly assembled and need little space for take-off and landing. A small patch of grass next to a UPA site is usually enough. Once the UAV is in the air, some can be operated manually and others automatically or semi-automatically, with an integrated GPS receiver making it follow a pre-defined flight route. Depending on the specifications of the respective device, flexible acquisition of up-to-date aerial images is possible, thereby closing the gap between costly satellite images and time-consuming in situ mapping.

Applications in the context of UPA

The potential applications in the context of UPA are as diverse as the technologies for data acquisition. The following examples showcase where the systems could be beneficial for planners, extension services, and eventually urban and periurban farmers themselves.

In the course of the integration of UPA in urban and periurban planning, UAV data can facilitate the assessment of the current state of agricultural production. It then allows for joint situation analysis, adjusted planning and land zoning measures that are based on the actual situation rather than either survey data or master plans that are likely to be outdated due to the dynamic nature of urbanisation and UPA, especially in the developing world. Furthermore, planning institutions can use digital surface models to identify areas that could be reserved for agriculture because they are unsuitable for urban expansion, such as flood-prone land or slopes. Based on high-resolution elevation data, irrigation schemes can be planned and implemented.

Very high-resolution and up-to-date aerial photos can be used to solve land-tenure disputes that often hinder agricultural activities; this is especially true in periurban areas, where different land-tenure systems collide. The data can be used as a basis for agreement on typologies and their importance, participatory mapping efforts eventually leading to increased understanding, a long-term demarcation of land and therefore more tenure security.

Extension officers can use the data for appropriate planning of support measures, such as distribution and subsidisation of fertilisers, based on the extent of agricultural land and the crops under cultivation. The analysis of crop health based on infrared images can support farmers in identifying areas where appropriate countermeasures have to be taken.

Experience from the field

In the course of the ongoing research project UrbanFood^{Plus} (funded by the German government; RUAF is a project partner), the University of Freiburg is currently using a fixed-wing UAV to analyse crop production in and around Tamale, a regional capital of about 500,000 inhabitants in northern Ghana. The aim is to bring together the spatial, temporal,

The fixed-wing UAV is used by the project to analyse crop production. Photo: Johannes Schlesinger/University of Freiburg

and socio-economic dimension of UPA in a rapidly growing urban setting. As a first step, all major production sites are identified in recent satellite images and then captured in RGB (red, green, blue) as well as NIR (near infrared) photos. The data helps in updating statistics and eventually leads to an inventory of current areas under cultivation. In a subsequent step, the spatial determinants of agricultural characteristics, such as crop diversity, plot sizes, and location, are analysed. This information can be used in multi-stakeholder meetings, and in making linkages, for instance with other sectors, such as WASH.

The flexible acquisition of aerial photos allows for the analysis of the temporal dimension of UPA on different scales. Long-term (> 1 year) changes in the area under cultivation are assessed by comparing UAV data to historic satellite images. This is supplemented by participatory GPS-mapping with elderly farmers in order to capture the local knowledge regarding where agricultural land was lost. Data from dry and wet seasons are compared to analyse the medium-term (+/- 1 year) changes in crop production. This increases the understanding of crop selection and rotation within a year. Lastly, short-term (< 1 month) patterns in crop rotation and harvests are analysed by repeatedly flying over the same sites in quick succession.

Socio-economic aspects of UPA are analysed by bringing together the information about plot sizes and cultivated crops with the respective households' characteristics, including income, household size, and tenure arrangements.

The experience from Tamale shows the comparative advantages of UAVs over other remote-sensing-based approaches and in situ methods in obtaining information about backyard gardens, an often neglected form of urban agriculture. Cultivated spots which are small or are located behind high walls can be easily identified and quantified based on aerial imagery.

The foundation has been laid for an intensified collaboration with the local municipal administrative bodies to ensure that this technology adds value to current approaches. Collecting and analysing geodata, however, requires a high level of capacity that needs to be built in most cases. Therefore, the application of such a new technology needs to be linked to capacity-building measures. Several members of the Town and Country Planning Department of Tamale have already been introduced to and trained in GIS. Other stakeholders, such as the Ministry of Food and Agriculture and the Ghana Health Service, will be included in future dialogues.

So far, the biggest challenge remains attaining a flight clearance from the respective authorities. In the case of Ghana, several ministries, the National Security Council, the Air Force, and the Civil Aviation Authority were involved in this process. Interest on the part of all stakeholders on the local level, including the farmers themselves, was overwhelming and showed the opportunities of UAVs in Tamale. So far, no major concerns were raised by farmers, even though some of them informally cultivate public land. However, one has to be aware of the potential consequences of informing administrative bodies about possibly illegal land uses. The value added generally depends on the policy support by the respective institutions on all levels. Otherwise, the data collected informs the scientific community, but does not have an impact on the situation on the ground.

Conclusions

UAVs bear a great potential for manifold applications in the context of agriculture in and around cities, particularly in data-scarce regions of the developing world. UPA research can benefit from the very high ground resolution as well as from the high flexibility in the field. Once the technology is appropriately incorporated in existing surveying and planning procedures, it can help to ensure the persistence of agricultural land use within the city. The experience from the pilot project outlined above shows how it can be applied as a tool to explain the different dimensions of UPA. Once the respective authorities are more used to its nature, UAVs can significantly help in understanding, planning and visualising urban agriculture.

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No. 29: City-Region Food Systems

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With SUPURBFOOD (Special Guest Editor Joy Carey)
Issue no. 29 will focus on:

1. the concept of city-region food systems that is emerging as a promising approach in international, national and regional policy agendas;
2. methods for the mapping and assessment of city-region food systems;
3. urban food policies and governance models for city-region food systems;
4. social and entrepreneurial business models in the context of city-region food systems.

In the last years, attention for regional approaches to the planning and development of sustainable food systems has greatly increased, as evidenced by, among other things, the growing number of cities worldwide which have developed their own urban food strategies and policies. Additionally, new political and administrative structures for such city-region food systems are increasingly being put into place, as is the case with the food policy councils which have spread from Canada and the United States to Europe, and multi-stakeholder policy processes that have been initiated in many other places.

SUPURBFOOD

City-region food systems, and policies and practices associated with these, have been the focus of the European Research project SUPURBFOOD. SUPURBFOOD, funded by the European Union, studied food systems in 7 European city-regions (Rotterdam, Rome, Ghent, Vigo, Bristol, Zürich, and Riga) focusing on various complementary thematic aspects such as short food chain initiatives, water and waste recycling, multifunctional land use, and related socio-institutional innovations. RUAF contributed to the project by analysing relevant experiences regarding these issues in cities in the Global South.

Call for Action: City-Region Food Systems

Another relevant development is the establishment of an international coalition, which calls for joint action to further develop and implement city-region food systems approaches as a promising strategy to contribute to food and nutrition security and sustainable urbanisation. Apart from RUAF, involved organisations include FAO Food for Cities initiative, Habitat International Coalition, ICLEI, ILO, IFAD, IUFN, UN-Habitat, UNCDF, and Prince of Wales' International Sustainability Unit. For more info, see www.cityregionfoodsystems.org/

Contributions

Contributions will come from SUPURBFOOD project partners and will highlight the main overall results, approaches and recommendations as well as those from different city-regions. Also, participants in the international Call for Action will give further details on the city-region food systems concept, as well as mapping and assessment tools and policies. Several cases from the Global North and the Global South will be highlighted from the perspective of city-region food systems.

We also invite you to submit information on recent publications, journals, videos, photographs, cartoons, letters, technology descriptions and assessments, workshops, training courses, conferences, networks, web links, etc., especially those relating to this theme. Of course, all other suggestions and comments concerning UA Magazine are also welcome. Please take a moment to voice your opinion by sending an e-mail to the editor of this issue at info@ruaf.org.

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Magazine

GROW the City
Innovations in Urban Agriculture

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The *Urban Agriculture Magazine (UA Magazine)* is produced by the RUAF Foundation (the International Network of Resource Centres on Urban Agriculture and Food Security), in close collaboration with strategic partners on particular topics addressed in each magazine.

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UA Magazine facilitates the sharing of information on the impacts of urban agriculture, promotes analysis and debate on critical issues for development of the sector, and publishes "good practices" in urban agriculture.

UA Magazine welcomes contributions on new initiatives at individual, neighbourhood, city and national levels. Attention is given to technical, socioeconomic, institutional and policy aspects of sustainable urban food production, marketing, processing and distribution systems. Although articles on any related issue are welcome and considered for publication, each UA Magazine focuses on a selected theme (for previous issues, visit: www.ruaf.org).

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