The
Urban Agriculture Network
Incorporated in Washington DC, United States
Western Pacific:
• Australia / New Zealand
• South East Asia
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Why urban rooftop microfarms are needed for sustainable Australian cities

A submission by Geoff Wilson, President, Urban Agriculture Network- Western Pacific, to the Inquiry into Sustainable Cities 2025, on April 6, 2004.

Contents *Background on the Urban Agriculture Network.*

Background on the Urban Agriculture Network-Western Pacific.

The Urban Agriculture Network-Western Pacific was set up in the late 1990s as an offshoot of the Urban Agriculture Network Inc., in Washington DC, United States.

The US-based organisation was set up under the auspices of the United Nations Development Programme in 1992, to be a non-government organisation (NGO) which could help draw important threads together to help advance global food security.

So far the major work of the Urban Agriculture Network Inc in co-operation with the UNDP has been publication of the book: "Urban Agriculture – food, jobs and sustainable cities". The second edition of this book is now being prepared for publication.

The Urban Agriculture Network-Western Pacific operates in harmony with the US-based organisation, but is completely independent and autonomous. It's current major supporter is Nettworx Publishing Pty Ltd., which provides it will free hosting on the "Urban Agriculture Online" website. (see www.urbanag.info).

Activities planned for 2004 include:

- "UrbanAg 2004", a conference in Brisbane, Australia, on June 25 and 26, for professionals with interests in the many facets of urban agriculture. The conference will try to better define urban agriculture in the western Pacific region, and look at the opportunity for urban agriculture in the sub-tropical city of Brisbane.
- Aquaponics Seminar at Bribie Island Aquaculture Research Centre north of Brisbane, on Saturday, June 19. It will better define aquaponic technology for rural and urban projects.

"UrbanAg-2006 is planned to be held in Singapore in mid 2006 and ""UrbanAg-2008" in Brisbane again.

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Abbreviations and terms:

- *Aeroponics* is the growing of plants by spraying a nutrient mist over roots in a light-proof container.
- *Air-Dynaponics* – and advanced form of aeroponics.
- *Agrotechnology parks* are dedicated urban agriculture areas within cities.
- *Aquaponics* is the combination of hydroponics with aquaculture. The wastes from aquaculture are treated to produce plant food, often leading to no waste residues, but two saleable crops using the same infrastructure.
- *A chinampa* is the ancient central American concept of urban agriculture practiced by the Aztecs. It entails concertina-style canals carrying sewage from which fish are harvested, and from which silt and sludge is dredged to fertilise gardens on banks between the canals. It is a system still in use in Mexico City.
- *Macrofarming:* Traditional broad-acre and small-holder farming.
- *Microfarming:* Growing food in small spaces, especially when recycling urban organic wastes.
- *Organic hydroponics.* Hydroponics in which nutrient derived from vermiculture and composting are used instead of inorganic fertilisers.
- *Urban agriculture* is food production within cities, either by hobbyists in home gardens or by professionals in fully commercial enterprises.
- *Vermiculture:* Use of earthworms to break down organic matter into soluble nutrients – particularly important for organic hydroponics.

1. Introduction

On the next visit to a local shopping centre, take a good look at commercial rooftops. Imagine them covered with organic hydroponic microfarms providing substantial quantities of fresh vegetables and fruit for local food stores and restaurants.

But do not, whatever you do, dismiss the idea as something too new and untested to be considered seriously. The concept was pioneered in Babylon about 2,600 years ago. It has taken that long for humankind to both rediscover the technique, and to be reduced to it by over-exploitive mining of natural resources such as soil nutrients and water.

In the view of many, the famed Hanging Gardens of Babylon were likely to have been the world's urban rooftop farming project. Little is reliably recorded about these gardens because most writings were hundreds of years after Babylon was destroyed, and these writings were often at least third or fourth hand -- and fanciful. Indeed, that the Hanging Gardens of Babylon actually existed is not even certain.

John and Elizabeth Romer, in their book "The Seven Wonders of the World" well summed it up: "Like the legends surrounding Alexander (The Great), these Hanging Gardens are the strangest, the most intangible, the most wonderful wonder of them all. Of all the Seven Wonders they are the one that everyone first names, but they are also the one that is most insubstantial".

No Babylonian record of the Hanging Gardens has been found in the clay tablets that formed the recording media of the time. Notwithstanding, the story of rooftop gardens persists.

The most romantic (and perhaps most likely) story is that of the Assyrian King Nebuchadrezzar II (also spelled Nebuchadnezzar). He reigned over Babylonia (now southern Irak) nearly 600 years before the birth of Christ. A number of stories suggest he built the Hanging Gardens of Babylon (the capital city) to please his Medean wife, Amytis. She was from the mountains, and pined for them in the hot, dry plains next to the Euphrates River, close to where the Iraki city of Baghdad now stands.

Nebuchadrezzar, so the story goes, created a building to resemble a mountain slope, down which trees and other plants were raised on terraces. A bucket pump inside the building brought water for streams down the terraces. Administrative offices and store rooms were underneath.

No certain traces have been found of these Hanging Gardens, but in the late 1800s a German archaeologist, Robert Koldeway, did find an unusual series of foundation chambers and vaults in what had been the north-eastern corner of King Nebuchadrezzar's palace at Babylon. Koldeway believed he had found the remains of the Hanging Gardens.

He and others working from the sparse records from more than 2,000 years ago, have estimated that the arched vaults were probably about 23 metres (75 feet) high, and covered a square with sides of about 120 metres (400 feet).

Because stone was rare in Babylonia, the construction was likely to be bricks made of mud and straw. The rooftop microfarm they supported was probably waterproofed with bitumen, so that irrigation and ponded water could not destroy the sun-baked bricks underneath.

The early Greek historian Diodorus Siculus, drawing on the works of others written several hundred years before, reported that the terraces were piled with fertile earth, and grew an abundance of trees.

Babylon's urban citizens were well versed in growing of vegetables and fruit under irrigation, and often had fish ponds next their homes. Therefore, it can be argued that, if they did exist, the Hanging Gardens of Babylon could have been a source of fresh fruit and vegetables and fish as well as a visual pleasure for Queen Amitys. No doubt water plants for food could have been grown in ponds and water channels from top to bottom tiers.

If this was so, then the Hanging Gardens of Babylon were also the world's first aquaponics – the raising of food plants and food fish in the same water where fish excreta is the organic source of nutrients for the plants.

Whatever the truth (and it is unlikely it will ever be known), we of the 21st Century will find a resonance in what King Nebuchadrezzar II achieved in the fifth century BC.

The next serious rooftop microfarmers were probably the Aztecs, although we know this only from the observations of the Spanish conquistadores, who marvelled at highly productive chinampas and other sophisticated urban agriculture in which waste management was a key element – before they laid waste to it..

Alas, the details about both Babylonian and Aztec pioneering efforts have been lost .

However, rooftop microfarming is now more than an embryonic reality in North America, Europe and Asia.

2. Microfarming – what is it ?

The term "microfarming" was coined by the author in the early 1980s after studying emerging food production systems in agribusiness in Asia and North America, and after making observations about such faiths as "Permaculture", "Ecofarming" and "Community Supported Agriculture". The new word was necessary to distinguish small-scale (often very small scale) food production from large-scale food production ("macrofarming"). It is a term most appropriate for the food production that can take place in cities – or urban agriculture.

But, whereas much urban agriculture can be classified as microfarming, the definition goes well beyond towns and cities. It can include operations underground (in mines, or in shelters from natural disasters), at sea (in ships or islands of floating housing condominiums), undersea (in nuclear-powered submarines), and in space. As humankind reaches to the planets to explore and

colonize, and then to the stars, perhaps microfarming in a spore form will be for survival for our species and others.

Microfarming on urban rooftops, the focus of this report, is perhaps one of the first steps towards a new destiny..

However. microfarming is not new in concept. It has been practised in various parts of the world for centuries as people have grown food in small spaces – such as around their homes or within enclosures within cities (particularly when under seige). During two world wars in Europe microfarming around homes with food gardens was the way to survival for many people. Often there was an integration of vegetables, fruit and small animals – the latter feeding off wastes or specially-grown fodder.

In Asia, microfarming around homes was, and still is, integrated with the cultivation of fish, and the reuse of nutrient-rich fish pond or fish tank water for irrigation of plants in containers. There is evidence that such microfarming could have occurred in China as long as 3,000 years ago – half a millenium before the Hanging Gardens of Babylon..

Then there's the microfarming systems reported to have been widespread in Central and South America. These were well-integrated horticulture, aquaculture and small animal husbandry in small spaces.

Therefore, microfarming has been a part of humankind's food security for a long time. Indeed, it could be well argued that the first farming that emerged was microfarming, because it probably occurred in small spaces around caves or dwellings.

Much of our macrofarming, on the other hand, is more of a creation of the 19th and 20th centuries.

The importance of microfarming never really declined in those parts of the world that were less affected by industrialisation, especially the industrialisation of food production in the gamut of activities in agribusiness – where the inter-dependent elements are the farm input sector, the farm output sector and the farm services sector (which includes government).

Agribusiness was less able to make money from microfarming, so it was much less promoted. That is now changing, because industrial agribusiness is being revealed as being inadequate in the totality of world food security. Perhaps the first to really realise this were the Chinese. They looked at their recorded history and observable pre-history and saw very clearly that the important fundamental was the shift of nutrients from soil.

In macrofarming and its mining of the soil there tends to be a one-way ticket for nutrients; they mostly go from farm to city to sea. In microfarming there is a greater chance of the nutrients being given a return ticket, through recycling of organic wastes. Microfarming offers a more sustainable system of food production that well complements the world's macrofarming systems that have developed worrying unsustainability. It is best based on organic waste management.

3. Why organic hydroponics?

Organic hydroponics is a relatively undeveloped technology that has the promise of significant benefit to humankind in the 21st century and beyond.

To understand this contention we must first know about inorganic hydroponics.

The word "hydroponics" is constructed of language roots that mean "working with water". The term was coined during the 1930's when scientists were studying nutrient deficiencies in crop plants. By juggling the balance of nutrients in water scientists were able to demonstrate the varying nutritional needs of plants, and what crop plants looked like when they had nutrient deficiencies.

It did not take much of a mental leap to see that crop production systems could be developed based on hydroponics, and in the last 60 years a significant industrialisation of plant crop production has taken place as a result.

Hydroponic growing in structures offered agribusiness operators all-important controls that gave:

- Higher yields in less space.
- Quicker growth.
- Less risk of diseases and pests.
- Elimination of weeding, and much of the use of harmful chemicals.
- Improved quality of produce.

But inherent in this improved control has been the use of inorganic nutrients made by fertiliser companies. A hydroponic grower has recipes created by chemists.

Not so the organic hydroponic grower.

Organic hydroponic growers create their nutrients from organic wastes put through worm farms, or by extracting nutrients from plants (especially comfrey). As a result there is a lack of precision in the nutrients obtained.

Indeed, organically-produced hydroponic nutrient mixes can be extremely variable, depending on the organic waste input. This is certainly so with the organic wastes from restaurants, which can vary with the season as well as the type of cooking (eg a Chinese restaurant's wastes will be significantly different from those of an Italian restaurant).

To best utilise these differing organic wastes in a hydroponic system, it is necessary to blend from diverse sources in order to obtain some basic standardisation of organic input. It is also necessary to have a judicious input of minerals to assure the best balance of macro and micro-nutrients available from an organic "brew" of nutrients. This is usually done by adding appropriate rock dusts with known macro or micro components.

Offer this blend to worms in a "farm" capable of being sprayed with water (which is recycled through the worm beds to pick up soluble nutrients as worms excrete them), and a viable nutrient solution for organic hydroponics is obtained.

It may not be as precise as inorganic nutrient solutions made up from industrial fertilisers, but organic hydroponic solutions can be highly productive. The reasons why organic hydroponic nutrient solutions are not widely used are:

- They take more trouble to create, and it is much easier to make up inorganic solutions.
- They can provide variable results, whereas inorganic nutrient solutions have reliability.
- Up until now there has been little demand for organic hydroponic technology.

A world-wide desire to better utilise organic wastes within cities can be expected to change this. The flow of nutrients from farm to sea must be intercepted as much as possible, either to return the nutrients to soil, or to better utilise them within cities.

Probably the world's leading organic hydroponics researchers are New Zealand's horticultural scientists Dr Lynette Morgan and her husband, Simon Lennard. They have found that selected organic wastes from human food processing and from urban, domestic and food-service sources, can be recycled well via vermiculture. They are now producing an organic nutrient solution that can be as good as inorganic hydroponic nutrients made from so-called "artificial fertilisers".

4. Some current projects

Foodshare (formerly Annex Organics) has rooftop microfarming in downtown Toronto, Canada, where an old warehouse has notable urban food production inside the building as well. This project involves both rooftop growing of vegetables plus the raising of fish and edible fungi to service a retail outlet on the ground floor.

Foodshare has been joined by urban rooftop microfarming projects in New York and Chicago, in the United States – where the motivation is environmental aesthetics, a desire to reduce air pollution and the reduction of the "heat island" effect of buildings and pavements unshaded by green foliage.

Singapore's rooftop farming is currently inorganic hydroponics, although moves are now under way to introduce vermiculture and urban organic waste management into the nutrient equation. The most impressive Singaporean projects are:

- The Changi General Hospital rooftop microfarm aimed at (a) ameliorating heat and glare from a concrete atrium at a level below hospital wards (b) providing cherry tomatoes for patient meals and (c) providing staff and patient recreation and, perhaps, (d) horticultural therapy. It was a project conceived and made practical by Gregory Chow, lecturer in hydroponics at Singapore's Ngee Ann Polytechnic.
- An expanding number of rooftop hydroponic gardens by groups of high-rise apartment dwellers who are utilising off-the-shelf technology from a local commercial hydroponic grower – Oh Chin Huat Hydroponic Farms Pte Ltd.

Singapore's Agri-food and Veterinary Authority is active in promoting urban agriculture in partnership with private enterprise over some 1,500 hectares of land in six agrotechnology parks. This includes world-leading application of aeroponic technology in which plant roots are sprayed with a mist of nutrient solution.

Aeroponic technology ideas led by Professor Lee Sing Kong of the Nanyang Technological University, are now being considered for "sky farms" on both high-rise rooftops, and on sun-trapping bridges between high-rise buildings. It will take only a small step to develop "organic sky farms" that recycle an apartment block's organic wastes..

Malaysian architects across the Singapore Straits are studying the concept of "bioclimatic skyscrapers" with "skycourts" of amenity and food plants -- and balconies and tiers of hanging gardens. Leading exponent of the idea is Ken Yeang, who believes it could save as much as 40 percent of a building's energy costs. He also believes the increased greenery will prove the building's inhabitants with oxygen-rich air.

But other innovative rooftop farming and gardening projects are emerging.

In Singapore Gregory Chow, and Australian-trained hydroponic lecturer at the Ngee Ann Polytechnic, has developed an exciting advance on aeroponics that he calls Air-Dynoponics. Its major advantages are that is reduces the nutrient solution temperature more economically than occurs in aeroponics, so that a wider range of temperate-climate vegetables can now be grown in microfarms in the sub-tropics and tropics.

The new technique is foreseen by the author to be one of the important new technologies for rooftop farming in climates that have been adversely affected by upward changes in temperature and reduced water precipitation caused by global warming.

Another important new technology is both freshwater and saltwater aquaponics, especially in areas of the world where water is scarce and expensive..

An Israeli rooftop farming project in Jerusalem is integrating recirculation aquaponics (growing fish and plants using the same water) with worm farming, and grey-water reuse.

Another project at Israel's National Centre for Mariculture at Eilat, is currently developing commercial saltwater aquaponics to a point where the technology could become a major part of urban food production and organic nutrient recycling.

It takes little imagination to see the Israeli (and some Australian) research into aquaponics leading to rooftop applications – not only in coastal cities and towns, but also at sea as the floating city concept becomes more attractive from many points of view.

In Europe, rooftop farming has mostly been preceded by ornamental horticulture in which grasses, shrubs and trees provide both aesthetic benefit and a reduction in the summer heat load. Reports are increasing of rooftop

growing of food and amenity plants on both office buildings and apartment high-rises.

A number of drivers are involved. While an important driver might be reducing a building's energy cost, commercial building owners are beginning to realise that bare high-rise rooftops are literally "a waste of space".

They could be earning rental from recreational amenities (when ornamentals are planted) or from urban rooftop microfarms that are now well-proven in concept, especially in Singapore.

Suburban shopping centre rooftops are the next logical step. Indeed, I believe they are about to become an important frontier for new world food production that slashes transport costs -- and the consequent pollution of our air by diesel trucks that often haul salad vegetables thousands of kilometres. Sometimes up to 40 percent of the cost a fresh lettuce in a supermarket can be in its transport cost.

World food security must now be a driver, also. Food production dispersed over suburban rooftops is close to where it is needed by suburban dwellers. In a terrorist-afflicted world that can be expected to mean something, especially if ordinary farming and food security is put at great risk by disease-toting terrorists aiming to inflict economic damage to livestock and cropping industries and disruption to the developed world's food distribution web.

What these points show is that some excellent pioneering is being undertaken to expand urban rooftop microfarming from the romantic and often fuzzy ideas associated with ancient Babylonians and the Aztecs, into an "off-the-shelf" technology reality for the world's current and future food needs.

The only really new concept being introduced is higher technology vermiculture (worm farming) to recycle organic nutrients within cities, via organic hydroponics.

A number of organic farming enthusiasts are anchored to the "soil-only" concept of their faith, and regard organic hydroponics as an oxymoron. They are being left floundering with legalities as organic hydroponics is being brought to commercial applications thanks to private research and development, especially in New Zealand and in California.

5. The Silwood Suburban Microfarm

The Silwood suburban microfarm on a suburban building block in Auckland, New Zealand, has been an important well-spring for rooftop enthusiasts in many countries.

The late Dave Silwood, was an inorganic hydroponic microfarm grower of "gourmet" lettuce and herbs, an operation now continuing under the guidance of his wife, Patricia and his son, Greg. His pioneering made others see that a most productive farm could be located in any part of a city.

This is because his 1,000 square metre microfarm could be transported to a rooftop and be operated in exactly the same way, and be almost the same size for a profitable business.

Significant points about the Silwood hydroponic farm are:

- It is contained on a mere 1,000 square metres (the old quarter acre) and has a hydroponic growing area of about 700 square metres.
- It produces hydroponic produce worth nearly NZ$600 per square metre of these 700 square metres (total revenue in 1997-98 was NZ$415,000).
- Its produce is marketed only within a five kilometre radius – to six supermarkets and 30 restaurants. The nearest customer is 2.6 kilometres away.
- It has daily deliveries of ultra-fresh food, mostly within half an hour of picking the produce. The record for a delivery from picking to supermarket customer sale was 10 minutes on a special occasion when a supermarket ran short.
- It offers whole lettuces and boxes of lettuce leaf (mesclun), plus some herbs and edible flowers.
- It employs roughly one person for every 100 square metres of hydroponic growing area and one person for every NZ$60,000 of turnover.
- It produces 18 to 19 crops of hydroponic lettuce a year, compared with several crops a year from open-air soil farms in the Auckland district, and three to four crops in greenhouses.
- It's land rental cost is about NZ$20,000 a year (based on 10% of the value of a suburban building block in that part of Auckland).
- To re-create the ground-level hydroponic microfarm on a rooftop site would cost about NZ$200,000,

Financial productivity of the Silwood microfarm is probably the best (for a legal crop), in the world. However, it must be recognised that this was achieved as a result of applying a unique combination of skills and technologies. The late Dave Silwood's previous background as a commercial airlines air traffic controller and scheduler well suited him to the detailed planning and operation of a high-technology hydroponic microfarm.

He also was an early adopter of technology that boosted growth in his geographic circumstances, such as added carbon dioxide in the air, extra heating, extra lighting for extended growth, tiered hydroponic channels, computer controlled air movement, use of probiotics in nutrient solutions, and use of ozone and hydrogen peroxide as sterilants. All these points added up to a lettuce and herb growing productivity not matched elsewhere.

The market was different also. Prices obtained for "gourmet" lettuce in New Zealand are well in advance of those obtainable in Australia.

The accompanying photos show the Slwood farm on a building blocl in surburban Auckland.

6. The Mt Gravatt rooftop microfarm project

One of the most innovative projects being considered is in Australia. It was triggered by a visit by the author to the the Silwood microfarm in Auckland, New Zealand.

A feasibility study was initiated by the author, under the auspices of the Southside Chamber of Commerce. The study looked at setting up an urban rooftop microfarm in Brisbane's Mt Gravatt Central, Queensland.

The feasibility study considered:

- Collecting food wastes from restaurants within half a kilometre
- Pulverising and heat-sterilising these wastes, and perhaps adding supplementary organics or minerals for nutrient balance.
- .Feeding the pulverised food wastes to an innovative worm farm that provides a continuous flow (rather than a batch process).
- Harvesting of three products from the worm farm: (a) a liquid nutrient for organic hydroponics focused on salad vegetables and herbs (b) worm castings for containerised growing of fruits and (c) surplus worms to be frozen and subsequently fed to fish or crustaceans.
- Vegetables, herbs, fruit, fish and crustaceans being sold to the same restaurants.

But major differences between the Silwood microfarm and the proposed Mt Gravatt microfarm are expected to be:

1. Development of organic hydroponics for the Australian project -- based on utilisation of restaurant food wastes via vermiculture.
2. Integration of aquaculture with hydroponics ("aquaponics") to be able to also offer local restaurants fresh fish and crustaceans.

The urban microfarm project proposed at Mt Gravatt is a *nutrient capture system* that offers organic waste recycling as one important benefit, and reduction of the greenhouse gas, methane as another.

Importantly, food wastes that normally go to landfill to cause methane emissions are reduced by earthworms to their soluble nutrients so that these can be recycled via horticulture. It is a small but important approach to reducing world greenhouse gas emissions – methane being some 21 times worse than carbon dioxide.

A most important driving force (perhaps the most important to many) is whether a financial investment can make a profit commensurate with risk.

The Southside Chamber of Commerce in Brisbane, Australia, regarded this as so important to test, that it sought and obtained a A$20,000 grant from the Australian Federal Government for an Urban Microfarm Feasibility Study in Mt Gravatt Central.

This feasibility study showed that urban microfarming based on recycling food wastes can be made into a most profitable business that provides new employment in a city and its suburbs.

The study was funded by the Australia's Federal Department of Employment Workplace Relations and Small Business, after being recommended by the department's Southside (Brisbane) Area Consultative Committee. Initiated by the Microfarm Group of the Southside Chamber, the study was undertaken by Integrated Skills Consulting Pty Ltd., of Brisbane, led by business consultants Peter Weightman and Paul Sawtell.

The author provided technical input.

The project studied how a microfarm could be a business serving a market within a small radius of a shopping centre – perhaps only half a kilometre from the microfarm site.

Integrated Skills Consulting concluded that with a total funding of $212,000, a microfarm on a Mt Gravatt commercial rooftop (or equivalent urban space) could be profitable after 17 months of operation. It could then provide a return of around 20 percent per annum on invested capital. It could provide three to four new jobs for each microfarm, possibly jobs suited to people with a disability.

Key factors identified in making a success of an urban microfarm on a rooftop were closeness to markets, consistent supply of high quality fresh produce and stable pricing. A further bonus was reduced food wastes going to land fill, and some reduction of methane produced.

The Urban Rooftop Microfarm concept of the Southside Chamber differs from many previous studies in that it involved an urban microfarm with three objectives:

- Production of food in a way that contributes actively to a better environment using minimal space
- Provision of employment opportunities for people disadvantaged in the labour market
- Achievement of self-sustenance through the profitable sale of farm product

Organic hydroponics via worm liquor emerged as the preferred growing method.

Such a natural product as worm liquor is less capable of precise specification than are inorganic chemical solutions, because the nutrient content varies according to the nutrient value derived from different worm food sources – in this case, food wastes from restaurants.

However, the nutrient balance of worm liquor can be adjusted by adding rock dust, a natural mineral-rich product, or specific organic materials (such as pineapple tops for extra magnesium). Some additional, simple heat processing

would be required to ensure pathogen-free and readily digested waste matter for the worms.

The study identified by-products of vermiculture as being important to the final mix of products to be offered back to restaurants. Worm castings could be used in containerised growing on rooftops, or sold as a valuable soil additive sought by gardeners. Also, surplus worms produced would be used as a food source in the second food production stage involving holding mature fish or crustaceans.

The proposal required maximum production from a minimal area "footprint". The site chosen for the study was 600 square metres. Of the various hydroponics systems reviewed in the feasibility study and experience of a number of commercial growers, it was considered that the locally-developed Boxsell "Ell-Grow" system of oval -channels most readily met the needs of this project (in a sub-tropical climate).

The proposed layout for the hydroponics occupied 450 of the 600 square metres, with six rows of eight 3 x 2 metre tables, all covered with hail mesh and insect screening. While the actual growing units formed the core of the system and represented the largest single cost element, other components were needed to complete the whole system. But it was all off-the-shelf technology that was not hydroponic specific (e.g. pumps, plastic pipe, GRP tanks for nutrient storage).

The ready availability of vermiculture technology made this aspect of the project practical. Several systems were considered and the simplest proved to be the most cost effective. Using commercial worm beds as a basis, a purpose-built system can be configured by stacking a number of them in a robust pallet frame in such a way that they can be rolled out and back for access like a series of filing drawers.

The other equipment was a shredding machine to reduce worm bed material and vegetable matter to a finely ground mulch, a boiler to heat the mulch to remove pathogens, small pumping systems to re-circulate the liquid passing through the worm beds, storage for the worm liquor and a worm/castings separator. An assortment of minor tools and equipment to assist in this process would also be required.

Aquaculture is an established technology and there are many examples of successful fish farms operating in Queensland, which could supply mature fish or crustaceans held ready for local restaurants to purchase. The fish species recommended was "Silver Perch" an Australian native freshwater fish which is ideal for the restaurant and retail markets. The use of aquaculture to grow silver perch thus completes the circle of this proposal. But "Jade Perch" would be an easier option.

The holding process uses simple equipment and avoids the need for complex facilities necessary to maintain fish in aquaculture tanks through their whole life cycle.

The feasibility study concluded:

"Our research suggests that the above systems combine to present a viable means of growing of a range of hydroponic vegetables, fruit, fish and worms. The system

components are either commercially available, incorporating proven technology, or where they need to be purpose built, they can use proven elements that offer reliable results".

"It must be recognised that in the use of organic nutrient from vermiculture processes as described, there is a less precise degree of control of nutrient content than would be the case with inorganic fertilisers. This is not considered to be a problem as plants naturally take up what they require for growth from the available medium and the worm liquor analysis shows that such an organic nutrient is rich in their what they require. The main difference will be that all of the nutrient available may not be taken up and some will go to waste. Nevertheless there will be a requirement for experiment and adjustment in ensuring the nutrient offers the range of minerals required".

"On balance The Urban Rooftop Microfarm project appears to positively address all of the issues and should therefore be accordingly judged as a feasible venture".

The Southside Chamber's feasibility study also revealed a number of issues requiring resolution in setting up an Urban Rooftop Microfarm. They included:

- Zoning issues,
- Production facility operation issues such as noise; smell; traffic; effluent and waste & exhausted nutrient solution disposal; lighting impact and restrictions; signage and aesthetics
- Space and site management issues,
- Health, hygiene & sanitation regulations compliance,
- Food waste delivery and storage issues,
- Workplace health and safety issues,
- Benefits accruing to the built/natural environment,
- Compliance with municipal, state and federal regulations – particularly in food safety for consumers.

The current state of the project is that a group of investors, led by myself, is considering financing it as a pilot project that has the following commercial objectives:

(a) *Commercial Operation of a rooftop microfarm, as described, at 1420Logan Rd., Mt Gravatt Central, Qld.* The accompanying photos show this site. The rooftop will be the prime growing area for hydroponic produce, but both the walls and the basement are proposed to be used also. The feasibility study is now being used to check potential revenues from this profit centre.

(b) *Demonstration of various commercial ideas in hydroponics, vermiculture, aquaponics, aeroponics, air-dynaponics and light transference.* Most of these ideas have come from Australian inventors and developers, but the overall use of them in joint harness has never been done before. Site tours and lectures will be organised for various groups, and the modest charges made per person will be part of the revenue stream for the commercial success of the pilot project.

(c) *Writing of both operational and training manuals for urban rooftop microfarms.* These will be published for sale on the Internet when they are ready. The publisher will be one of the pilot project's shareholders, Nettworx Publishing Pty Ltd. It is considered that the wide availability of the manuals will trigger other investment around Australia in similar urban rooftop microfarms.

Inherent in these commercial objectives, however, is considerable community benefit, namely:

- Businesses in Mt Gravatt Central will have the benefit of an increased flow of people attracted to them for such things as food services (utilising the produce grown on the rooftop. Local employment will be enhanced well beyond the four or five new employees in the pilot project.
- Food nutrients that would normally be sent to landfill to cause unwanted methane gas production, will be recycled within half a kilometre of where these wastes are produced (the proposed pilot project has the potential to draw food wastes from 12 food service establishments in the Mt Gravatt Central shopping centre.
- Water harvesting from the commercial rooftop that will help reduce a local problem in flooding at times of peak rainfall.
- An educational facility for local high schools, and TAFE and university students and researchers.
- Publicity of one method of helping Australian cities become more sustainable.
- Reduction of the heat island effect of rooftops in cities, by introducing greenery that absorbs and utilises sunlight.
- Reduction of the need for imported energy for transport of many fresh foods from distant places, when the same foods can be grown directly above the stores that sell them, or the restaurants and cafes that can use them.
- Reduction of air particulate pollution from road transport devoted to moving fresh food around cities. Usually this is diesel particulate pollution that is a known cause of cancer, asthma and emphysema, especially in the very young and the very old. Urban rooftop farming can utilise re-chargeable electric vehicles, or non-polluting natural gas vehicles, for the very short distances transport is required.

The photographs on the next pages show the building chosen for the pilot protect Urban Rooftop Microfarm in Mt Gravatt Central.

8. Guarding against food terrorism

Recent expansion of global terrorism must trigger more focused development of increased food self-sufficiency in towns and cities of the world.

It makes such sense for other reasons too – especially climate change that appear to be inevitable. Changing patterns of rainfall, temperature and humidity can now be expected to disrupt current agribusiness systems relatively slowly over the next 50 years.

Not so food terrorism. It can strike at us at any time.

It is not in the public interest to list the many ways food terrorism can affect all of us adversely. That merely hands ammunition to the common enemy. It is much more sensible to take a positive look at how we can build as much resilience as possible into our food supply web -- especially though better urban organic waste management.

In the world's developed countries we are mostly dependent on a supermarket system of food supply. It is an efficient system, albeit one that is of concern about the way it harshly squeezes its suppliers, and is becoming concentrated economic power that may not always be in our best interests.

Key facts to now ponder about the increasing dependence on the supermarket food supply chain are:

- At any one time it has a mere 10 days to a fortnight's supply of food available – as cost-cutting "just-in-time" logistics hold sway.
- It is heavily dependent on efficient road transport, with fresh food being carted from 500 to 1,000 kilometres or more from farm to processing plant to food store, in many instances.

It takes little imagination to foresee very real problems for developed countries resulting from terrorist disruption of efficient supply and transport of our food. So far food terrorism has not happened. But Murphy's Law applies: If it can happen, it will, and at the worst possible time.

Urban rooftop microfarming is one counter-measure to food terrorism that must now be considered and developed for sustainable cities to be a practical objective.

This was the undercurrent of concern the author observed at the Urban Agriculture Symposium at Dallas, Texas, USA, in May 2002. While the symposium's 34 papers well-emphasised all that is positive about urban agriculture, the questions and informal discussions revealed much concern by

agribusiness professionals in academia about potential terrorist threats to the existing global food supply chain.

Fortunately there is a convergence of new food production technology with the perceived problem of food terrorism. Advances in hydroponics, aeroponics, air-dynaponics, aquaculture, aquaponics, vermiculture, probiotics, rooftop farming, and a host of other relevant technologies mean that we can grow, economically, much more of our fresh food either in cities, or on urban fringes – so-called peri-urban agriculture.

Lack of space, soil fertility and rainfall are no longer limitations. We can grow healthy fresh food abundantly if we wish to, in relatively small urban spaces and with greater certainty because of controls we can apply, and structures we can use.

Importantly, we can grow an increasing volume of our food through innovative recycling of urban organic wastes -- which are really plant and animal food that has come from distant farms to towns and cities, and is currently passed through to waterways and the sea, to cause unwanted problems of pollution.

Good business people know that behind most threats lie opportunities. The threat of food terrorism is an opportunity in disguise for global urban and peri-urban agriculture.

9. Recommendation.

The recommendation of the Urban Agriculture Network-Western Pacific is that the inquiry into Sustainable Cities 2025, should seriously consider advocating further studies of the huge potential for food sustainability in cities that could occur if urban organic waste nutrients are recycled through urban rooftop microfarms on commercial buildings in shopping centres.

Approriate in this is a re-shaped slogan of the TV series "Star Trek" most appropriate for the 21st centu ry onwards. It was adopted several years ago by a British hydroponic supply company, as its mission statement: *"To boldly grow where none have grown before".*

Such a slogan could also suit a new breed of urban rooftop farmers around the world as they pioneer a new urban food frontier on both commercial and home rooftops. Should our restless energy take microfarming beyond planet Earth, then the slogan is apt indeed.

In the meantime it behoves us to develop sustainable food supplies from appropriate places and spaces in our outwardly expanding cities that demand better ways to handle polluting wastes, and better ways to assure our general food security.

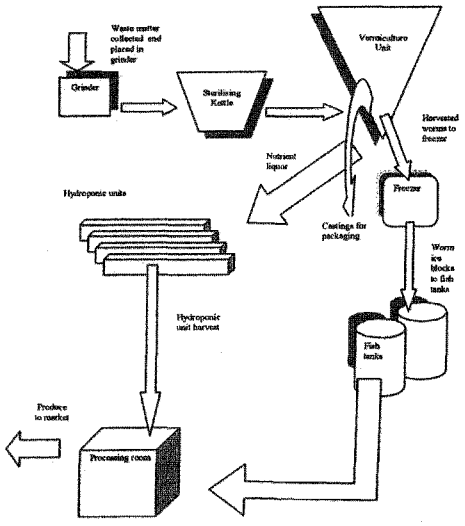
Geoff Wilson, April 6, 2004.

Acknowledgements:

- *Parts of this report first appeared in "The Growing Edge" (U.S) in December 2001, and in "Practical Hydroponics & Greenhouses" (Australia) in 1999 and 2000, in articles by Geoff Wilson..*
- *Much of this report is from an invited chapter of the UNESCO "Encyclopaedia of Life Support Systems" published online in September 2003 and written by Geoff Wilson.*
- *A major reference was "An Urban Rooftop Microfarm for Mt Gravatt", a 160-page feasibility study in 2000 for the Southside Chamber of Commerce, Brisbane, Australia, by Paul Sawtell and Peter Weightman.*
- *Historical details of the Hanging Gardens of Babylon are from "The seven wonders of the world", by John and Elizabeth Romer. Henry Holt & Company, New York. ISBN 0-8050-4122-2.*

DIAGRAM:

A flow chart for the proposed urban rooftop farm at Mt Gravatt Central that is expected to be an important catalyst project for the practical development of more sustainable cities.



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ATTACHMENTS TO SUBMISSION NO. 178

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