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Urban rooftop microfarms for Australian commercial buildings

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Glossary/Abbreviations:

- Aeroponics is the growing of plants by spraying a nutrient mist over roots in a light-proof container.
- 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.
- A chinampa is the ancient central American concept of urban agriculture prqcticed 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 (worm farming) and composting are used instead of inorganic fertilisers.
- Probiotics: The use of useful micro-organisms to either suppress disease organisms, or to break down organic wastes into simpler compounds that become plant food.
- 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 for plant food.

EXECUTIVE SUMMARY:

Australia has an opportunity to be a world leader in urban rooftop microfarming, using its significant expertise in vermiculture (worm farming), organic hydroponics, light transference into buildings, aquaponics and aquaculture.

Such world leadership will, however, require pilot sites that test and demonstrate all systems and business plans that are currently based on "off-the-shelf" technology the Southside Chamber of Commerce Inc. proposes to be put together in a superior way.

But the outcomes can be expected to be significant in:

1. Recycling organic nutrients within cities, instead of disposing them into waterways.
2. Reducing the use of diesel fuel that produces harmful particulates when burned -- particulates that are implicated in cancer, asthma and emphysema.
3. Reducing emissions of the "greenhouse gas", methane, which is 21 times worse in its effects than carbon dioxide.
4. Providing fresh food close to where it is needed.
5. Developing food-production employment close to where employees reside.

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 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.

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 submission, is perhaps one of the first steps towards a new destiny for humankind's food production.

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's nutrients, 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 something 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.
- Reduced water needs -- to around 10% of that needed for field crops.

That latter point has big future implications for the dry continent of Australia, where efficient water use is fast becoming a significant political, economic and environmental problem.

But inherent in this improved control via hydroponic technology 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 rooftop 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.

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.

6. The Mt Gravatt project

One of the most innovative projects being considered is in Australia by the Southside Chamber of Commerce, which has a membership catchment that straddles the Federal Electorates of Moreton (the Hon Gary Hardgrave MP) and Griffith (Kevi Rudd MP).

The Southside Chamber's interest was triggered by the Silwood microfarm in Auckland, New Zealand. This led to the Southside Chamber's feasibility study in 2000.

The pilot project now envisaged by the Southside Chamber of Commerce in Mt Gravatt Central, 1o kilometres from the Brisbane CBD, will entail:

- 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.

Major differences between the Silwood microfarm and the 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 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 commercial microfarm concept they tested addressed these points:

- How waste food from southside restaurants, hospitals and clubs can be collected and put through a worm farm.
- How a microfarm situated on commercial rooftops or at ground level in Mt Gravatt Central can grow salad vegetables and herbs from the hydroponic liquor from the worm farm, and feed mature fin fish and crustaceans (bought from aquaculture farms) from the feeding of worms.
- How salad vegetables, herbs and fish can then be sold to the same restaurants, hospitals and clubs to create a new local business and new local employment.

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 or at ground level 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 Southside Chamber of Commerce's Urban Agriculture sub-committee is now considering how to fund a pilot project in Mt Gravatt Central to prove the feasibility study findings.

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

The study set out specifically to:

- Identify the project's technical platform components, cost and availability.
- Identify job and business opportunities and local target groups for those opportunities.
- Assess any support/concerns from the general and business community.
- Identify markets, supply sources, product acceptability.
- Determine commercial viability via a business plan outline.
- Examine benefits for the built and natural environments and identify issues of concerns to authorities.
- Provide a skills audit.
- Specify potential support for funding.
- Review training needs.
- Examine effects on current suppliers (eg farmers).

Briefly described, the concept studied the use of vermiculture, organic hydroponics, aquaculture, and containerised growing of fruit and herbs to facilitate the systematic production and delivery of very fresh food products in a way that contributes to environmental improvement and waste management in a suburban shopping centre.

While there are conventional farms in the outer urban areas of Brisbane, these remain under threat from urban expansion, environmental concerns about the use of fertiliser and pesticides/fungicides close to homes, and rising production costs related to land value.

The study took the view that an Urban Rooftop Microfarm must avoid such problems by adopting a different approach -- using urban spaces not normally considered for farming.

It was clear that the expense of this approach (cost of urban land) can be offset by reduced costs in transport and energy use and by providing high quality produce for a premium price. Customers were prepared to pay more for organically-grown local fresh produce.

Needing to be as close as possible to markets, the Urban Rooftop Microfarm concept had certain requirements to be met by the technological approach chosen.

They included, for example, a maximum production output requiring little or no arable soil, minimal use of artificial fertiliser and water, little requirement for large machinery, portability, limited or no use of pesticides and ease of rapid harvesting and processing in hygienic conditions.

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.

8. Summary and Conclusion

Where is urban rooftop microfarming headed? A medium-term objective must be improved food security for expanding cities around the world, particularly to reduce the consequences of terrorist threats on food supplies based on fragile growing and distribution systems.

Supermarket systems in developed countries are vulnerable to many possible dislocations. At any one time there is only a few week's supply of food in supermarkets in most developed countries.

This makes a re-shaped slogan of the TV series "Star Trek" most appropriate for the 21st century 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 humankind's restless energy take microfarming beyond planet Earth, then the slogan is apt indeed.

But the new breed of urban rooftop farmers have most important environmental side benefits to what they do, including:

- ***Recycling organic nutrients within cities***, instead of disposing them into waterways to pollute creeks, rivers, lakes, estuaries and seas -- or precious groundwater. Serious degradation of Australian soils is occurring as a result of the constant drawdown of plant nutrients and the depletion of organic matter through over-cropping of fragile, duplex soils which account for around 60% of arable land in Australia.
- ***Reducing the use of diesel fuel that produces harmful particulates*** when burned -- particulates that are implicated in cancer, asthma and emphysema. Current frehs food production in Australia is mostly via supermarket logistic systems that use central warehousing, This means that fresh produce is often transported by heavy diesel trucks up to 1,000 kilometres -- sometimes travelling part or all of the same route to its ultimate destination as it travelled to the central warehouse. It has been estimated that, at many times of the year, the transport cost of a lettuce in a supermarket can be as high as 40% or its retail price!
- ***Reducing emissions of the "greenhouse gas", methane***, which is 21 times worse in its effects than carbon dioxide. Every Australian produces about 1.2 tonnes a year of organic matter. Much of it could be salvaged through vermiculture and urban rooftop microfarms -- or in home food decks. Instead, organic matter mostly goes to landfill where it can take up to 20 years to break down, all the time relaseing methan gas.
- ***Providing fresh food close to where it is needed***. Urban rooftop microfarms can grow fresh produce just above where it is sold. The only transport energy needed is a hand trolley and a goods lift.

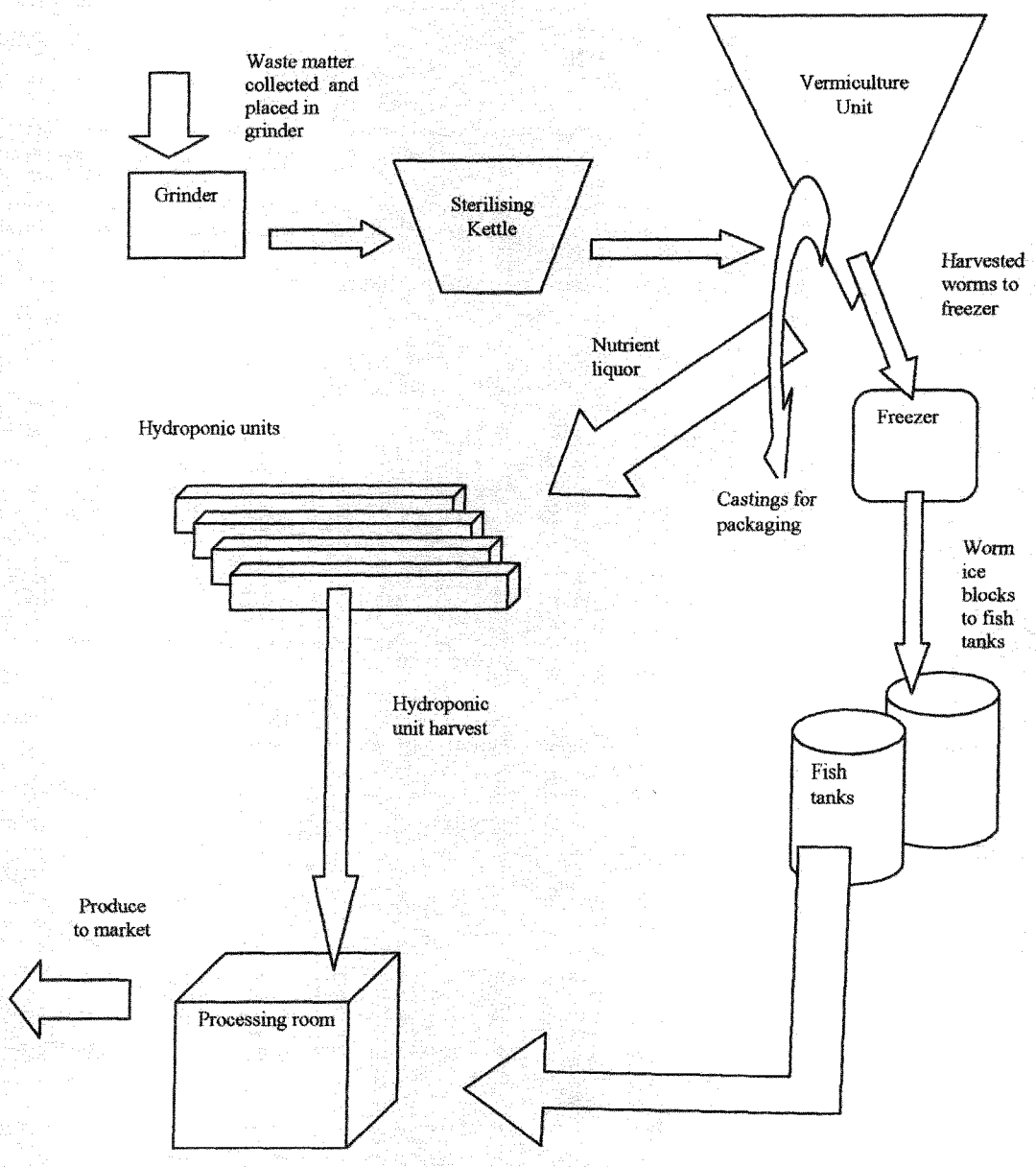
- ***Developing food-production employment close to where employees reside.*** The environmental benefit and energy cost savings of this point is important also. Reduced work travel means the potential of a better family life, and reduction of transport costs on family budgets.

What this submission adds up to is an opportunity for Australia to test and further develop the concept of urban rooftop farming as outlined. It is a food production technique that is well in tune with the times in which we live.

I hope the House of Representative Standing Committee on the Environment and Heritage will consider urban rooftop microfarming as a concept it can support in whatever ways government sees fit.

DIAGRAM NEXT PAGE:

A flow chart for the proposed urban rooftop farm pilot project at Mt Gravatt Central, about 10 kilometres south of the Brisbane CBD.


Waste matter collected and placed in grinder
Grinder
Sterilising Kettle
Vermiculture Unit
Harvested worms to freezer
Nutrient liquor
Freezer
Hydroponic units
Castings for packaging
Worm ice blocks to fish tanks
Hydroponic unit harvest
Fish tanks
Produce to market
Processing room

ADDITIONAL INFORMATION HELD BY THE COMMITTEE

ATTACHMENTS TO SUBMISSION NO. 119

ATTACHMENTS, APPENDICES AND PHOTOGRAPHS PROVIDED WITH SUBMISSIONS ARE HELD IN THE COMMITTEE OFFICE