URBAN AGRICULTURE

IS THERE NOW AN OPPORTUNITY FOR A VIABLE SMALL-SCALE SUSTAINABLE AGRICULTURE TO EMERGE IN BRISBANE, AUSTRALIA?

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A dissertation submitted in partial fulfilment of the requirements for the degree of Master of Sustainable Agriculture.

Charles Sturt University

June 2008

ABSTRACT

The world is encountering a time where there is a strong convergence of influences that have the potential to change the way urban agriculture is practiced and more importantly, perceived, particularly in more developed countries. These influences centre on the three key notions: (i) a greater community interest in local foods, manifested through the rapid increase in farmers markets; (ii) the ecological pressures and economic opportunities of urbanisation; and (iii) the continuing rise of energy costs. This dissertation examines these influences in detail and investigates how urban agriculture is becoming more relevant and economically viable, through these influences. Urban agriculture can be economically viable under circumstances which require the reasonable targeting of revenue from specific high value crops and the marketing of produce through direct markets. A gross margin analysis shows that even with conservative assumptions, a small-scale model of agriculture growing a combination of high-value and longer-season crops can deliver an immediate positive return on investment.

DECLARATION

I certify that this dissertation does not incorporate, without acknowledgement, any material previously submitted for a degree or diploma in any university. It does not contain any material previously published or written by another person except where due reference is made in the text.

This dissertation does not exceed 15000 words.

Signed: Stuart Brown

Acknowledgements

I gratefully acknowledge the wise counsel of Dr Kevin Parton, my supervisor for the six month duration of this dissertation and for the many and varied conversations we had over morning tea during his sabbatical with the CSIRO Sustainable Ecosystems in 2007. This dissertation represents my small contribution to the emerging field of urban agriculture research. Urban agriculture and urban ecology are two areas that are greatly under-researched and yet have great significance as the world increasingly becomes urbanised. Finally I thank my family for their patience while I tried to combine work, study and family life with varying degrees of success or otherwise, primarily over the last six months but also throughout the duration of my Master’s program.

Table of contents

1. Introduction

Urban agriculture can be described as any form of food and non-food growing or processing of produce that is sold to consumers both within and on the margins of an urban area (Mougeot 2006). Urban agriculture takes many forms though and exists as backyard gardens supplying one or more families, community gardens, small-scale commercial growing on vacant allotments, commercial hydroponic vegetable or flower operations on a large scale, or aquaculture and livestock raising, common in less developed countries, and many more. With such a wide variety of activities the term 'urban agriculture' is simply an umbrella term describing a wide range of agricultural activities of such diversity that a survey commissioned by the United Nations Development Programme (UNDP 1996) found over 40 different urban farming systems.

Urban agriculture is nothing new and the origins of cities and agriculture are inextricably linked. Agriculture was the basis upon which urbanisation emerged and has been fundamental to the rise and success of urban centres (Bryant and Johnston 1992). Pre-industrial cities arose and relied upon agriculture within and surrounding the city to ensure a reliable and minimum supply of food (Mougeot 1994). Rome partially relied on food raised along the Tiber River, and the Inca city of Machu Picchu relied on a sophisticated system of intensive agriculture, irrigated by the city's wastewater (Halweil 2004). Brisbane, Australia, which is the focus city within this dissertation, also relied to some extent on urban agriculture to provide food and fibre to the growing city and colony. The inner city suburb of New Farm was so called to distinguish it from other farming areas to the north and south of the city and had dairying and small cropping activities during the formative years of the colony until rapid urban development in the late 19th century encouraged non-agricultural land uses (Oxley Memorial Library and State Archives 1972). In early Brisbane, the Chinese community played a significant role in urban agriculture within the inner city, with many growers concentrating on the alluvial soils alongside Ithaca and Enoggera creeks and tributaries until as late as the 1950's (Drevins 2007). Urban growth pressures eventually determined that alternative non-agricultural land uses would prevail. Other significant drivers that saw a disjuncture emerge between agriculture and the urban environment in Brisbane and most other cities in the developed world, were the effects of industrialisation.

The availability of refrigeration, fast and efficient transport driven by the cheap availability of oil, good quality road and rail networks, and the combination of industrial and organic wastes within a single waste disposal system, combined to put pressure on urban farming as an anachronistic practice (Halweil 2004). The detachment that emerged between what was perceived as urban activities and rural activities particularly after World War II has been a backdrop to the transport-focussed development of many cities.

This detachment in Australia is still evident. By focussing on vegetable production alone, a picture of the detachment of cities from food production can be seen. A survey by the Australian Bureau of Statistics has shown that home production of vegetables totalled 153,000 tonnes out of a total vegetable production for the country of 2,725,000 tonnes, representing just over 5% of production (ABS 1992). Only 2% of the total vegetable production was grown within the capital cities with Brisbane only producing 6,954 tonnes of vegetables (ABS 1992). While these figures account for home production and not commercial production within the city it is still a clear indication that food production has been divorced from most households in Brisbane. The urban and rural detachment has over time seemed a natural disjuncture simply because transport was cheap and other presumed high value activities predominated. However some of the traditional drivers that drove this disjuncture are now beginning to diminish.

The world is increasing coming under significant pressures. The key pressures, described as influences in this dissertation because some are as a result of positive changes in people's awareness, are converging at this key time in history to contribute to a new appreciation of the merits of urban agriculture. Three key influences that are driving this resurgence include: (i) a growing awareness of local foods and the benefits it conveys to health and the local economy; (ii) the emergence of urbanisation and the inherent ecological issues associated with a concentrated population; and (iii) the rising cost of energy and the implications this has for the current conventional approach to agriculture. These influences also have a significant impact on the potential economic viability of an urban agricultural enterprise.

Urban agriculture is by its very nature, small-scale. Small-scale enterprises face challenges from larger enterprises when trying to compete in the conventional market. Govindasamy *et al.* (2003) suggest that the best opportunity for small enterprises is to serve market niches that offer price premiums. The rise of farmers markets[1] and the embodied local foods sentiments encapsulated with these markets are a positive influence on the development of urban agriculture. As too are the influences of rising fuel costs and the pressures of urbanisation. Production closer to markets will have a production cost advantage if energy prices continue to climb and remain high. Urban agriculture may also help ameliorate the effects of urbanisation by helping to go some way towards ‘closing the nutrient loop’ that is significantly disrupted by urban infrastructure and processes.

This dissertation examines more closely current forms of urban agriculture and the inherent benefits and challenges surrounding food production within cities. The key influences outlined above, are addressed in greater detail to examine their implications for society and for the ‘conventional’ approach to agriculture. Finally this dissertation presents an analysis of the potential economic viability of a model of urban agriculture as it might exist in Brisbane, Queensland. If urban agriculture is to re-emerge in developed cities such as Brisbane, then it will need to be economically viable. An opportunity may now exist for urban agriculture, arising from a convergence of profound influences and the unique environmental conditions of Brisbane that are favourable to intensive, small-scale and high value agriculture.

[1] Throughout this dissertation the term farmers market will appear without an apostrophe. It is common to see the apostrophe before and after the letter s in the word farmers; an apostrophe would indicate possession. Lyons (2008) suggests that to use farmer’s market would indicate a single farmer owning the market, whereas to use farmers’ market would indicate the market is owned by the farmers at the market which is generally not the case. Using the term farmers market correctly portrays a market with many farmers.

2. Urban agriculture

2.1 Current manifestations

In more developed countries urban agriculture often takes the form of a community garden or 'city farm'. Community gardens are places where food is grown but they also tend to have a social element associated with them. While fruit, vegetables and often livestock such as chickens and ducks are raised within a community garden they primarily serve to educate urban people about food production, and provide agricultural and environmental awareness (Lyson 2004) and facilitate opportunities for social interaction. Community gardens are numerous worldwide, but appear to be a phenomenon closely associated with countries of higher economic development (Gelsi 1999). Sommers and Smit (1994) state that New York City has over 1,000 community gardens and Boston has over 400. According to Australian Community Foods (2007), Brisbane has nine community gardens. One of the oldest and most developed in an organisational and educational sense is Northey Street City Farm located in the inner city suburb of Windsor. Community gardens also exist in Europe, but there the more common practice of urban agriculture is within allotments or privately rented plots. Community gardens tend to be managed for, and by, local community groups whereas allotments, a common form of urban agriculture in the United Kingdom, tend not to be managed by the community but rather by individuals or families.

In England the system of allotment gardening where people rent a small area of land for the purposes of food and recreation, number approximately 296,900 individual plots across 7,800 sites (Cook *et al.* 2005). Allotments have a long-standing history in Britain in particular. Their origins can be traced back to the early 18^{th} century as a rudimentary form of compensation for the landless rural poor as a result of the enclosure of common land. Allotments began to emerge in large numbers during the late 19^{th} century as the rural poor started to move in great numbers to the cities as part of the social changes brought on in the early years of industrialisation in Britain (Howe *et al.* 2005). Urban agriculture in Britain peaked in times of conflict though, with the 'Dig for Victory' campaign during the Second World War which saw the utilisation of wastelands, parks and lawns, and produced around half of Britain's fruit and vegetables (Garnett 1996). While allotments have served as emergency sources of food in times of conflict, they have otherwise been considered to be primarily gardens for recreation and food supplementation for households and not for the primary means of income.

Two examples of urban agriculture from the United States highlight the innovation required by urban agriculturalists and the potential financial rewards to be made through farmers tapping into the local community and using locally generated organic matter.

Fairview Gardens in Santa Barbara, California is a 4.8 hectare working farm solely remaining as an example of what was once common in this formerly market gardening and orchard district. It is now surrounded by housing, freeways and commercial development. This farm, now protected from development, has become the Center for Urban Agriculture employing over 20 people and feeding 500 local families (Ableman 1998). Fairview Gardens has an educational and advocacy function through its research centre, much like that of some community gardens, but has approached this through a commercial model rather than through the public funding model of most community gardens. In 2005 Fairview Gardens made over US$700,000 (approximately $920,000 Australian dollars) in revenue (Ableman 2005).

Another urban farmer in Chicago utilises vacant lots throughout the city to grow tomatoes on waste that has been sourced from restaurants and other food sources throughout the city and specially composted through his recycling facility, thereby using some of the city's waste that would otherwise have been lost from the nutrient cycle (Ableman 2005). The use of vacant lots means that there is no certainty of tenure, but this use is an example of the innovation required of urban agriculture if it is to be successful. In order to make agriculture, including urban agriculture, more attractive it is necessary to show that it can also be economically viable (Ableman 2005).

In more developed countries, farmers markets in particular have created a resurgence in the direct contact between farmers and producers. At a farmers market, the grower can sell directly to the consumer and retain more of the profit from the transaction than is the case in conventional produce marketing. Direct marketing of produce is increasingly becoming important to the economic development of urban and rural communities (Feenstra *et al.* 2003). Business viability will ultimately be at the forefront of any renewed interest in urban agriculture in more developed countries.

The viability of urban agriculture particularly after World War II began to diminish due increasingly to land pressures in burgeoning cities. In virtually every industrially advanced country, food growing in urban areas made way for housing, community facilities or industry, and the associated rising wages after World War II meant there was less incentive to grow food in the city (Garnett 1996).

While a similar path to industrial development is being sought in less developed countries, many countries particularly in Africa have embarked upon urban agriculture as a response to crisis. Many African cities suffer from inadequate or unreliable access to fresh food; and inadequate opportunities for employment due to issues ranging from deteriorating national economies, urbanisation pressures or natural disasters and conflict (Drescher *et al.* 2000). Research into urban and peri-urban agriculture in African societies began in a small way in the 1970s and 1980s, and did not receive academic acceptance until the 1990s when the research and extension activities focussed on economic activities (Mbiba 2005). Ellis and Sumberg (1998) summarised the reasons for urban agriculture in Africa as: a means of survival; a personal strategy of women in times of economic uncertainty; food security; as a substitute for cash allowing bartering; as a means of income supplementation; and as a commercial activity taking advantage of growing markets for high value produce. African cities have turned to urban agriculture for a number of reasons, but most notably as a survival mechanism by urban residents. One of the more significant embraces of urban agriculture as a response to crisis has been the organisation of widespread urban agriculture in Cuba.

Upon the collapse of the socialist political and economic system in Eastern Europe in 1989, the Cuban economy dramatically declined. Over 85% of Cuba's trade was with the former socialist group and between 1989 and 1993, gross domestic product declined by 35% (Rosset and Benjamin 1994, cited in Altieri *et al.* 1999). Food security quickly became a major problem in Cuba, which resulted in a popular response to the crisis. Initially thousands of people took it upon themselves to grow food in any available location in the cities, especially Havana, which resulted in a movement that emerged into a sophisticated state-sanctioned and massively supported food production system (Altieri *et al.* 1999). While urban agriculture in Cuba originally appeared in response to a crisis it has now matured to a system that offers genuine income opportunities through the private sale of produce (Chaplowe 1998), as well as nutritional and community benefits (Peña Díaz and Harris 2005).

Not all less developed countries have instituted urban agriculture as a response to crisis. For centuries, cities in Asia have integrated agriculture into the urban landscape. Even today as urbanisation rapidly increases in many Asian cities, urban agriculture continues to serve as an important source of fresh produce. For example, Hanoi sources 80% of its daily fresh vegetables from within urban and peri-urban areas and Shanghai up to 60% (Halweil 2004). Far from being a response to crisis or considered an anachronistic practice, urban agriculture is often considered an intrinsic part of a city. In Beijing for instance, city planners have incorporated urban agriculture into long-term planning decisions (Halweil and Nierenberg 2007).

The discussion so far has highlighted that urban agriculture can exist in many forms and serve many purposes such as food security, income opportunities or even community and social interaction. Growing food in urban areas can bring many benefits to people in a city, but it can also encounter many challenges.

2.2 Benefits of urban agriculture

An exhaustive list of both benefits and challenges has been covered by many researchers (Sommers and Smit 1994; Garnett 1996; Nelson 1996; Halweil and Nierenberg 2007) and will not be recreated in full for this dissertation. Many studies have also particularly highlighted the positive community and social benefits of urban agriculture through such forms as community gardens and allotments (Garnett 1996; Gelsi 1999; Iles 2005; Cook *et al.* 2005). The benefits and challenges that are addressed briefly here specifically relate to issues relevant to commercially focussed urban agriculture in Brisbane and many other similar developed cities in the world. Some of the benefits of urban agriculture are summarised below.

Land regeneration: In many cities worldwide there are parks and open spaces that are vastly under-utilised. The successful Chicago urban farmer discussed earlier is one example of what is possible in spaces waiting to be developed or abandoned or even in under-utilised sections of public space. Urban agriculture could create positive activity within these spaces and contribute to reduced maintenance expense and has implications for the reduction of crime and increased personal safety (Garnett 1996).

Urban agriculture also has the potential to promote biodiversity and contribute positively to the urban ecology of a city (Viljoen and Bohn 2005).

Income generation: A major factor that will be addressed in detail in a later section is the income generation potential of urban agriculture. Many less developed countries have well developed urban agriculture as an integral part of their cities, but as the earlier discussion has suggested, for quite different reasons commercial urban agriculture remains under-developed in “western” cities. This may not be due to economic reasons. The issues may be more cultural. For example, Singapore and Hong Kong are two economically advanced and highly urbanised cities in Asia with income levels amongst the highest in the world and yet are estimated to be 30-50% self-reliant in fresh produce provided by urban farmers (Sommers and Smit 1994). The potential of urban agriculture is evident in a study by Heimlich and Barnard (1993 cited in Sommers and Smit 1994), which suggests that urban farms in the United States sell 13 times more per acre than non-urban farms. Somerton Tanks Farm in Philadelphia in the United States is a commercial example of the potential of small-scale intensive urban agriculture. On approximately 2,000m^2 and in its fourth-year of operation, the farm grossed US$68,000 (approximately $73,000 AUD) selling produce at farmers markets, through direct farm sales and a community supported agriculture (CSA) scheme (Innovations for Local Farming 2008).

Waste recycling: Most developed cities including Brisbane source the majority of their food from the surrounding countryside and more frequently from distant international sources. Effectively the soil nutrients are continuously exported from fields of rural regions to cities where they are converted to wastes and ultimately lost to the system (Nelson 1996). Urban agriculture could help reduce this lost organic matter by tapping into the urban organic waste stream to use as an input to the farming system in the form of compost and fertiliser additions. Much of the current organic material in cities is lost by being combined with other waste streams in the sewage system or deposited as household rubbish in landfills. Brisbane city has a partial organic recycling system in place that provides a free green waste kerbside pickup and deposit through waste transfer stations that will compost green waste (Brisbane City Council 2008). However other organic waste such as food is lost through the general waste system.

2.3 Challenges associated with urban agriculture

There are many challenges with urban agriculture worldwide. Some of the more common ones encountered in less developed countries include: resistance and even open hostility from councils and authorities in many African cities (Chaplowe 1998) and crime, vandalism and theft of equipment and crops close to harvest time (Ellis and Sumberg 1998). The more pressing challenges for urban agriculture in cities like Brisbane can be summarised in the following issues.

Conflicting demands for water: Urban agriculture will impose new demands for water and could exacerbate existing demands from domestic, commercial and industrial users. The challenge of water availability is highly relevant to Brisbane. Since 2000, there has been a significant reduction in catchment rainfall for Brisbane with 24% less rainfall than the historical average over equivalent 70-month periods (Department of Natural Resources and Water 2007). The current water use restrictions in Brisbane make this challenge quite significant and bring into focus the potential use of wastewater or grey water to irrigate urban agriculture. While it is estimated that there are 3.5 to 4.5 million hectares irrigated with wastewater worldwide, there is still a significant public health risk from pathogens in untreated wastewater (Halweil and Nierenberg 2007). Wastewater is not considered to be a viable option at this stage for urban agriculture in Brisbane. However, innovative, clean and safe solutions to a possible future of reduced rainfall may need to be sought. Rain water tanks and drip irrigation combined with the domestic supply may be part of the answer.

Pollution concerns: The risk of soil, atmospheric and water contamination of urban farming sites can be a real concern to the urban agriculturalist. The use of vacant development lots or public open spaces may contain contaminants that require expensive amelioration. In certain circumstances this may be rectified by bringing in soil, using compost and implementing raised beds (Garnett 1996). An innovative example from Fiji suggests that non-edible crops such as flowers, grown on sites that have soil chemical contaminate problems can be a valid and valuable form of urban agriculture when little other options exist for growers (Sommers and Smit 1994). Urban agriculture also runs the risk of atmospheric pollution due to the potential to be located near busy roads or within industrial precincts. The use of composted organic waste may also risk bacterial pollution and attract rodent pests if not prepared properly (Nelson 1996). These risks and the innovative solutions required are part of the pitfalls and possibilities with which an urban farmer may have to contend, and reflects the dynamic and flexible nature of farming in the city.

With a background now established regarding the form and function of urban agriculture it is important to understand the drivers of change that may encourage greater utilisation of urban agriculture in more developed cities like Brisbane. While there are many issues that help and hinder the development of urban agriculture throughout the world, there are a number of key converging influences that may drive the expanded development and acceptance of urban agriculture.

3. Converging Influences

3.1 Introduction

The key influences that may impact upon an increased interest in and development of an accepted form of urban agriculture have been building over the last few decades. The three key influences considered here are: (i) a growing awareness of local foods and the benefits they can provide for local economies and health and social interactions in communities; (ii) the growth of urbanisation and the associated ‘ecological footprints’ of cities throughout the world; and (iii) the rise of energy costs and the questioning of the ‘food miles’ associated with conventional agriculture.

3.2 Food localism

Much of the developed world is entrenched within an industrial or commodity-based approach to agricultural production. For instance, agriculture in the United States has become highly capitalised, highly commodity specialised and more regionally concentrated (Lyson 2004). Agriculture in Australia has followed a similar trend. ABS (1970) statistics show that the total number of rural holdings used for an agricultural purpose in the 1967-68 recording period was just over 256,000. Statistics for 2002-03[2] show a significant decline in farm numbers to 133,000 (ABS 2004).

Many researchers (Halweil 2004; Lyson 2004; Ableman 2005) have suggested that food consolidation is so strong in many developed countries that small farm viability is at risk by operating under the current model of marketing produce through wholesalers. An increasingly successful and alternative approach that many small farms have embraced, in an effort to maintain viability, is marketing produce directly to local consumers and food related businesses (Stephenson and Lev 2004). There are a number of means through which a farmer can market directly to consumers and retain the greatest share of the income from the produce. Two methods of direct marketing are farmers markets and subscription agriculture, otherwise known as community supported agriculture (CSA).

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[2] Data from 2002-03 were used because later ABS agricultural survey references have different survey parameters and are based on data from the Australian Business Register (ABR) and therefore preclude direct comparison between earlier periods.

A farmers market is simply a market where farmers directly sell their produce to the end consumer. They create a direct link between producer and consumer that can enable relationships to be built, and they provide a forum within which the specific needs of each can be fulfilled. Consumers attracted to farmers markets are often seeking an experience beyond just price and convenience (Weatherall *et al.* 2003), while concurrently farmers are seeking a fair return for their productive effort. Small farms are particularly disadvantaged in the more conventional market system because of the emphasis on the production of a single commodity. Traditionally, small-scale agriculture has formed cooperatives in an effort to gain economies of scale, but these efforts still position the farmer at the lowest end of the food system (Halweil 2004). A farmers market can present an opportunity particularly for small farms to retain more of the profits from production by removing the other layers of transaction evident in the conventional marketing system. Small-scale agriculture faces many hurdles in the traditional food marketing system, so the ability to serve market niches that offer high prices, while remaining flexible to changing preferences and needs of consumers within that niche is critical (Govindasamy *et al.* 2003). Another form of produce marketing that helps retain most of the profit with the farmer is a CSA.

A CSA is a system where consumers who are members pay a farmer or group of farmers for a share of the produce and throughout the growing season receive regular deliveries of produce (Lyson 2004). Lyson (2004) adds further to this definition by suggesting four models of a CSA: (i) farmer directed where the farmer manages the system; (ii) consumer directed where the consumers organise the system and seek farmers to supply produce; (iii) farmer coordinated in which a group of farmers that specialise in certain lines of produce join together; and (iv) a farmer, consumer cooperative in which both groups engage in joint decision-making about produce and farming practices. This arrangement, in any of its forms, promotes local production and consumption of food. The seasons will dictate what produce is supplied to consumers within a CSA and the environmental risk associated with farming is shared by the group rather than the farmer individually (Friends of the Earth 2002). For example if a farmer in a CSA suffers a crop loss due to a hail storm then they are not put into a position of economic hardship because the economic risk is shared by all the members of the CSA. The CSA absorbs the inconvenience of a reduced supply of certain produce until production returns. The shared risks and benefits are key elements of a CSA. The farmers have early and consistent cash flow to use towards production and the consumer gets local produce throughout the seasons.

Interest in local foods particularly from consumers, has been growing and is evident by the expanding number of farmers markets internationally and in Australia. The number of farmers markets in the United States has risen from 1,755 in 1994 to 4,385 in 2006 (Lyons 2008). The Australian Farmers Market Association (2003) has 99 farmers markets registered with their association throughout Australia. This list does not count the innumerable local markets run by churches, community groups and councils where individuals and businesses sell local food. The interest shown in local foods by patrons of farmers markets in particular is a result of a complex spectrum of issues ranging from socio-economic backgrounds, health concerns, sustainable farming and support for local economies, just to name a few.

Peters (1997) considers the issue of local food through a health and economic framework when she suggests that in a globalised food system the connection between food, health and the environment are not clear; the consumer cannot easily observe them. A local food system can have explicit observable benefits to a consumer through the preservation of farmland, the fostering of local economic viability, less transportation of produce, and fresher food. Local food systems manifested in farmers markets, can have distinct benefits to the local economy primarily through the economic benefits it can provide to small farms, including those involved in urban agriculture. Lyson *et al.* (1995) suggests that small farms specialising in niche products can take advantage of the price premiums available through consumers who are willing to seek out specialised products and experiences. However the concept of niche markets suggests that only a limited consumer base is willing to purchase specialised local produce.

Surveys with individuals from a diverse range of backgrounds from rural and urban locations in the north-east and north-west of England showed that 74% of urban and 82% of rural respondents were inclined to choose locally produced food (Weatherall *et al.* 2003). Another survey of local foods throughout the United Kingdom corroborated these findings by showing that the majority of consumers were interested in the notions of local food, but that only approximately 10% actively sought local foods when purchasing produce (IGD 2002, cited in Weatherall *et al.* 2003). This represents a small but potentially growing group of consumers who are willing to specifically purchase local foods. It is important to understand some of the reasons these consumers actively seek local foods when shopping.

A particularly important component to local food selection is the environmental awareness of the consumer and notions of sustainable agriculture as a counter to an industrialised and commodity-focussed agriculture (Winter 2003). Other reasons are social in that some people are seeking greater interaction with their food producer as a matter of trust and for reciprocal interaction that brings producers and consumers together in a way that cannot be achieved through modern supermarkets or through farmers selling to wholesale markets (Hinrichs 2000). The sociological underpinnings of direct markets may help explain why these markets do not rely entirely on price to be successful and they may give greater insight into the types of consumers who are willing to seek local foods.

Weatherall *et al.* (2003) proposes that the interest shown by consumers in local foods and subsequently direct markets such as farmers markets is associated with what is known as abstract benefits that are played-off against typical food choice benefits such as price, colour, texture, convenience and the retail environment. These abstract benefits may include things such as environmental awareness, notions of sustainability, and ideals of health and welfare. Abstract benefits do not enter the choice decisions of all consumers and tend to be associated more with those of higher incomes who have a greater ability or flexibility to afford the trade-off (Weatherall *et al.* 2003). Hinrichs (2000) analyses the economic transactions at farmers markets within a framework that represents a continuum of ‘marketness’, which identifies high marketness transactions as ones in which price is the prime concern; and low marketness transactions in which non-price considerations are important. Farmers markets are at the lower end of the marketness continuum because economics is combined with a more complex structure of social relationships (Hinrichs 2000). Such an economic transaction can be described as ‘embedded’, whereby the transactions are processed within an atmosphere of trust between producer and consumer (Hinrichs 2000; Winter 2003). Producers and consumers both have individual goals in the transaction. Producers are seeking good prices for their produce and consumers are seeking good non-price experiences. Like all market transactions though, it is a mix of social embeddedness, marketness (prices) and other individual aspirations (Hinrichs 2000).

This part of the discussion has focussed on the sociological underpinnings of transactions within local food systems such as farmers markets and it is important for farmers seeking to produce for direct markets to understand the issues that drive consumers to seek out local foods. There are a number of challenges to this direct style of transaction that impede the potentially valuable two-way interaction. Farmers for their part will be required to provide more of the non-price aspect that will make local foods attractive to more consumers. This will require an entrepreneurial emphasis that many farmers within the conventional marketing system may not possess or be comfortable developing.

A British government commission on the future of farming in England highlighted that a challenge for the development of local food systems was the lack of technical knowledge by farmers (Halweil 2004). This lack of knowledge can be as diverse as suitable cropping regimes, new crops, post-production techniques or even appropriate business and marketing skills for local direct market opportunities. The lack of knowledge about how to address and develop local food systems is likely to be similar in Australia. Another challenge to expanding the appeal of local foods to a wider group of consumers is the question of convenience.

Consumer surveys from the United States highlight that while most consumers are amenable to purchasing local foods, the convenience factor of farmers markets as compared to supermarkets was rated lowly by the wider community (Wolf 1997, cited in Brown 2003; Stephenson and Lev 2004). This may be a significant challenge to small-scale producers trying to appeal to a wider section of the community as the direct market matures. Local foods may only begin to appeal to the wider community as their first choice of food purchase if their normal, food-intrinsic and convenience needs are met (Weatherall *et al.* 2003). This may mean that producers seek other marketing ventures that address the issue of convenience while still protecting their access to a greater percentage of the profits from production. It may also require innovations to the direct marketing system to extend the hours of local farmers markets to cater for consumer convenience (Brown 2003). Small-scale local farmers may also seek to join together to promote their produce through a conventional shop front to appeal to the intrinsic food choice habits of consumers (Halweil 2004). Local foods produced by flexible, small-scale farming operations that are sensitive to changing consumer preferences and tastes, hold great potential to be viable and financially and socially rewarding ventures.

The second influence that may contribute to a greater interest and development of urban agriculture is the rise of urbanisation worldwide and the maintenance of high levels of urbanisation in developed countries.

3.3 Urbanisation and ecological footprints

Urbanisation is now a worldwide phenomenon, with the world about to reach a point where over half the planet's population exists in cities (Lee 2007). Formerly, high rates of urban living were most common in more developed nations. Australia for example rates as one of the most highly urbanised populations in the world with over 66% of the population residing close to a capital city and over 87% of the population living within an urban environment (ABS 2007). Specifically, Brisbane city has been the fastest growing major city in Australia in recent times with an average annual population growth rate of 2.2% and an estimated population in 2006 of over 1.8 million (ABS 2008a). Brisbane's urban growth is well above the average of 0.4% in cities of the developed world and is more in line with the developing world's urbanisation growth rate of 2.3% (Mougeot 2006). The developing world is witnessing the greatest growth to the number of urban residents in part due to historically low numbers of urban residents.

China is a developing country experiencing the greatest movement of rural people to urban areas of any country. The urban population rose from 18% in 1978 to 31% in 1999 and represents a rise of 222 million people living in urban areas (Zhang and Song 2003). This equates to an average of over 10 million people every year between 1978 and 1999. These numbers are significant when the food needs of those urban residents are considered. It has been estimated that the cities of Beijing and Shanghai are growing so fast that by 2010 they will require an additional 8300 tonnes and 9850 tonnes of food per day respectively (FAO 2001). The additional food requirements will bring challenges to each city's infrastructure as the rapid growth contributes to rising land prices, high rates of land use change and increasing pollution (Nelson 1996).

While there are many costs to urbanisation, such as pollution, greater traffic congestion and social problems such as crime in certain circumstances, there are also many perceived benefits that draw people to cities in increasing numbers. Two key factors include greater employment opportunities and access to better education. The income disparity between rural and urban populations is high and persistent and the educational standards and attainment tend to be higher in cities than in rural regions (Bertinelli and Black 2004). This is magnified in less developed countries. Urbanisation can also be a key factor in the development process of a country. Bertinelli and Black (2004) suggest that urbanisation accumulates human capital and that cities are one of the key drivers of economic growth particularly in developed countries. The World Bank (2000) noted that areas classified as urban contributed on average up to 85% of the gross national product (GNP) in developed countries compared to 55% in developing counties. The growth of cities can often provide urban residents with more opportunities be they economic, educational, or social, than those that exist for rural residents. However, the growth and opportunities are often at the expense of the surrounding environment which suffers decline of the natural environment and farmlands surrounding cities.

In most circumstances as urban areas grow they tend to expand outwards and overwhelm the natural environment by modifying land uses such as farmland, resulting in a loss of a renewable resource (Bryant and Johnston 1992; Mougeot 2006). This loss may sometimes be compensated by an intensification of the remaining farmland. Often the productive capacity of the land is lost and the city's expansion requires the importation of food from increasingly further distances. Brisbane's expansion over the last 40 years has seen the urbanisation of formerly highly productive farmland to the east of the city. Beckmann (1967, p.55) foresaw the decline in agriculture in the administrative area adjoining the eastern boundary of Brisbane, now called Redland City, by stating that 'Cleveland and Beenleigh are in effect already satellite townships [of Brisbane]. It is therefore likely that prosperous agricultural areas such as…the Redlands district will eventually go completely out of production.' The 2006 population within Redland City was 131,332 which is 1.9% greater than the 2001 population (Department of Infrastructure and Planning 2006), and farming has been displaced by housing throughout most of the region. The demise of farming close to Brisbane highlights the demands placed on regions within commuting distance to the city. It also points to the need for Brisbane and most other developed cities in the world to rely on larger and more distant regions for food as the population expands. This has ecological implications for the city and the surrounding landscape.

Ecological function within an urban environment is dependent upon the importation of energy and matter and the expulsion of waste. Kaye *et al.* (2006) views the flow of imports and exports of energy and matter through cities as a study in urban ecology where the biogeochemical cycles are levied by the interactions between society and the environment. While the principles that govern the biogeochemical cycles, including nutrient, water and climatic cycles, are the same everywhere, they are modified in urban areas by human infrastructure. Three altered cycles in urban areas identified by Kaye *et al.* (2006) include: (i) an altered hydrological flow due to hard and impervious surfaces which increases runoff, reduces infiltration and directs water according to infrastructure rather than natural flows; (ii) a distinct temperature increase due to the impervious surfaces absorbing daytime warmth and releasing it during the evenings; and (iii) a modified nutrient cycle where the food that is imported to the urban system is used and then directed through the engineered waste systems rather than being returned to the nutrient cycle within which it was produced. This latter point is a significant issue in terms of the ecology of urban areas.

Odum (1971) notes that a developed city expends 10-100 times more energy compared to most unmanaged ecosystems and that the system is dependent on external inputs to satisfy functions within the system. The urban economy which includes the infrastructure of a city, the machines of industrialisation, the tools of human enterprise, and human capital, have what can be considered to be an ‘industrial metabolism’. This metabolism requires a continuous inward flow of energy and material in order to produce the goods and services required by urban residents. The natural resource inputs to this metabolism have been described as ‘natural capital’ and can be considered to be the accumulated total of ecological functioning that supports life and due to its complexity cannot be adequately reproduced by human activity (Hawkens *et al.* 1999). The continued supply of ‘natural capital’ without sufficient recycling of nutrients is an inherently unsustainable system. One way to analyse the impacts and to critically appraise the long-term sustainability of an urban system is through an ‘ecological footprint’ analysis.

Rees and Wackernagel (1996) proposed the term ‘ecological footprint’ as a measure of the productive land and water required to produce the resources consumed by the city and to be able to dispose or assimilate the wastes produced. The measure provides an illustrative impact of the area in hectares required for the current consumption patterns of an average individual. It has also served to be informative on the impact of human economic activity on natural capital (White 2007). An ecological footprint is calculated by taking available data for the production and consumption of various items in an economy such as food, energy or consumer goods, and estimating the land area per capita for each item by dividing the annual consumption of that item by the average annual yield of the same item (Rees and Wackernagel 1996). The ecological footprint of Queensland and Brisbane has been calculated for 2007 and identifies that Queensland and, significantly, Brisbane are well above the critical world supply of productive land.

Speirs *et al.* (2007) have reported that on average a Queensland resident has an ecological footprint of 7.19 global hectares which is up to three and a half times higher than the average world resident. The ecological footprint is even higher in the Brisbane city statistical area with some suburbs showing a footprint above 8.5 global hectares. A report prepared by WWF International (2006) estimates that the world's supply of productive land in 2003 was 1.8 global hectares per capita. The high ecological footprint for Brisbane suggests that the city is well above the sustainable threshold highlighted in the WWF International (2006) report. An ecological footprint can be viewed as an indicator of sustainability in a global context.

Some research has expressed doubts about the methodology underpinning the calculation of the ecological footprint by suggesting it does not account for biophysical setting, population size and per capita consumption rates (Kaye *et al*. 2006) or that it is unrealistic to convert energy use into land area to estimate the required land to absorb carbon dioxide emissions (Ayers 2000; McDonald and Patterson 2004). For the purposes of this dissertation, an ecological footprint adequately highlights the impact of people's consumption on the planet in a simple, widely used and accepted format. This dissertation does not critically examine the merits or otherwise of the ecological footprint in detail, suffice to say that it has been widely used in research and is a useful measure to help examine the impact of human activities in a comprehendible manner (White 2007). A city such as Brisbane is overextending its impact on biophysical resources locally and globally according to its ecological footprint and if it is to bring this down towards a more sustainable level then locally based production of some of the products consumed may contribute to a smaller footprint.

If the world is on a path towards a more urban future then urban ecology will need to be a focus if we are to see a sustainable future where living in cities will be the norm. Urban agriculture can contribute in a small way towards stemming the cycle of cities as consumers of resources and emitters of waste. If the organic waste was used to add value to soils in urban and peri-urban regions in cities and utilised to produce food for urban consumption, then it would help to reduce the ecological footprint of a city and help contribute to a more sustainable pattern of consumption (Nelson 1996).

A final influence to be discussed, is the notion of 'food miles' associated with the provision of produce in conventional agriculture and the rising cost of energy and what this may mean for the development of local food systems in urban areas.

3.4 'Food miles' and rising energy costs

Much of the food consumed in the developed world travels great distances every day to markets and final consumption. 'Food miles' is an acknowledgement that food is often transported over vast distances, to markets in which the food being consumed is often not available due to seasonal variations or ineffectual growing conditions. Supermarkets in developed countries have a wide variety of produce on display and will usually be selling produce that is not in season locally (Peters 1997). These products require transportation over vast distances in order to satisfy consumer demand for regular product purchases of particular types of produce throughout the year. Paxton (2005) points to two types of food miles that include: (i) the transportation of food within a country due to an organised distribution system by large-scale retailers and agribusiness; and (ii) the transport of food internationally. The freedom of international trade can also often result in the importing and exporting of the same food products. For instance in 1997 the UK imported up to 126 million litres of milk while at the same time exporting 270 million litres (Paxton 2005). While this process allows great variety and choice for consumers it also carries hidden and not so hidden costs.

There are many implications of 'food miles' ranging from environmental, social and economic. The large national and international trade in food products relies on a sophisticated network of road, rail and increasingly airfreight transport. This reliance on transport produces air pollutants, notably carbon dioxide emissions; is linked to biodiversity decline through farm specialisation and consolidation; and means that money is often lost to local economies due to distant production (Peters 1997; Paxton 2005). The expansion in the transport of food worldwide can be related back to the continued growth in urbanisation worldwide.

The discussion earlier on urbanisation highlighted that in developed countries it is common for the city to expand and push agriculture to the margins. It becomes increasingly necessary to transport food in from these distant sources and as wealth accumulates in expanding cities of the developed world so does the demand for a wider variety of produce. The world trade in food expanded three fold between 1961 and 2002 with 898 million tonnes shipped around the world compared to 200 million tonnes 40 years earlier (Halweil 2004). Improved technology and the industrialisation of agriculture driven by mechanisation, inorganic fertilisers and pesticides derived from oil products have created a more specialised and concentrated agriculture particularly in more developed countries. Specialisation and the need for fewer farm workers, means that fewer people are living near places of production. This combined with the improvements in food technology such as refrigeration and cheap and reliable transport involving containerisation has significantly reduced costs and created a system of agriculture in developed countries that is highly specialised and reliant on distant, often international, markets (Halweil 2004).

The high-energy use in conventional agriculture has brought high yields but this high dependence on fossil fuel energy inputs can leave modern food production vulnerable to the price and supply of that fossil fuel. If the future strategy for meeting the food demands of a growing urban population depends on the transportation and production of distant foods then significant supply and price problems may arise if fuel costs continue to rise (Gliessman 2000). In terms of energy employed to produce food, it has been estimated that the United States uses ten times as much fossil fuel in producing food as is returned in the food energy of the produce (Hawkens *et al.* 1999). Energy use is critical in not just agriculture but also importantly in transport. The popular media and the research community have postulated a future of reduced energy production, particularly oil, which has become known as ‘peak oil’.

‘Peak oil’ is the point at which the production from known reserves has reached the halfway point, signalling an inevitable future of declining oil production (Campbell

2005). One of the earliest proponents of 'peak oil' was M. King Hubbert, while working for the Shell research laboratory predicted that US oil production would peak in the 1970s (Deffeyes 2001) which subsequently proved correct. Utilising similar methods to Hubbert, other researchers have looked at the reserves of world oil and the majority agree that the peak in world oil is imminent. The results are varied but most point towards a peak sometime within the first quarter of the 21st century (Bentley 2005). If oil production is approaching a peak then the inevitable decline may begin to reveal itself through higher prices for oil.

The current estimates for the West Texas Intermediate crude oil spot prices is expected to average US$110 per barrel in 2008 which is significantly higher than the 2007 average of US$72 and again nearly double the 2006 average price of US$66 (EIA 2008). This may be an indication that peak oil is already apparent. The impact of declining oil production on Australia could be quite severe. Australia imports about 85% of its oil, balanced by its export of oil, and being a highly urbanised country with large sprawling cities that are dependent on this oil means that supply shortages will likely have an economic and social impact on Australia (Robinson *et al.* 2005). The issue of reduced energy supplies is a critical challenge facing the world and may bring rapid changes to the way societies in developed countries in particular are managed.

Holmgren (2002) suggests that the industrial culture of high fossil fuel use will eventually have to change due to emerging energy decline, which may then signal a transitional period in which the principles of conservation and recycling may come to the fore. This is one of the more positive interpretations of the future of energy decline. Heinberg (2005) has a more pessimistic view of the impact of energy decline on American society in particular. He suggests the United States and by association the rest of the world, will suffer profound economic impacts and societal problems through energy decline. The future may likely be somewhere in between if alternative energy sources or further significant efficiency gains are not achieved.

However there is evidence that in response to the rapid increases in energy price in 1973-1974, technical and behavioural changes reduced energy use and contributed to an increase in energy productivity particularly in agriculture (Cleveland 1995). This trend was also observed in Europe where a study by Bonny (1993) into energy use in French agriculture found that in response to higher energy prices, farm energy use productivity increased significantly due to changes in technology and managerial practices.

While changes in agricultural management and practices have shown a reduced or even more efficient use of energy, the changes in prices in 1973-74 were politically driven with prices easing when the crisis abated. The contemporary price changes are for the most part due to rising demand in emerging economies such as China and consumption growth generally, outstripping production growth (EIA 2008). This suggests that higher prices may now be the norm. If this is the case then conventional agriculture that derives much of its viability from oil based energy, may be challenged. The cost of transport is a large component of the energy used throughout the world. In 2003 the world's largest consumer, the United States, consumed approximately 20 million barrels per day of which two-thirds was for transport (Hirsch 2005). Significantly higher transport costs may alter the landuse patterns that have emerged through past periods of cheaper oil and cheap transport.

The previous discussion of urbanisation highlighted that as urban centres expand, agricultural land close to the city is often subsumed by alternative land uses. Due to the relatively cheap transportation costs and technological enhancements such as refrigeration, agriculture has been seen as a non-urban activity and has been pushed to the periphery. Johann Heinrich von Thünen developed an economic land use model that examined the relationship between transportation costs and agricultural activity in the 18th century. This land-use model sought to explain that with increasing distance from the market or town centre, agricultural land-use will change from high value, perishable crops, to produce and animal products that are cheaper to transport and have lower value (O'Kelly and Bryan 1996). Traditionally, highly valued and perishable agricultural products such as salad crops, vegetables and milk would be located close to markets because the cost of transport from distant areas would be too high or they may not reach market in a suitable condition. In many circumstances von Thünen's model appears to adequately explain the spatial pattern of agricultural production surrounding urban areas. Ewald (1977, cited in O'Kelly and Bryan 1996) found that agricultural zones in colonial Mexico accorded closely with von Thünen's principles such that the spatial arrangements of crops were dictated by the distance to markets. As transportation costs decrease though, the adequacy of the model begins to diminish.

The agricultural pattern surrounding many developed cities including Brisbane is one that has arisen as a result of cheap transportation and technological improvements (Halweil 2004). The question could be posed that if energy costs continue to rise according to the arguments outlined in this discussion, might agriculture become more acceptable or even viable closer to the city? The following section will outline the opportunities available to the urban farmer in a growing, highly urbanised city like Brisbane within the backdrop of a future of rising energy costs and evolving food sentiments.

4. Opportunities for Urban Agriculture in Brisbane

The influences discussed in detail have stated the philosophical case for urban agriculture. The convergence of the three issues: that is, rising interest in local foods; increasing urbanisation; and the rising cost of transportation, may start providing opportunities for an alternative approach to emerge. There may also be a practical case for an urban agriculture that is flexible and dynamic and takes advantage of the benefits, and mitigates the challenges outlined previously. Many conventional cropping guides point to high start-up costs, high variable costs and a minimum land base in order to establish an enterprise that may be profitable in the medium to long-term (Fullelove *et al.* 2004; Napier 2004; Wright *et al.* 2005). This approach to farming is conventional in the sense that production is focussed towards high inputs, using mechanisation and is reliant on high output yields to compensate for the prices received in the wholesale produce markets. Evidence from current urban farming practitioners suggests that this high cost path to enterprise development is not necessary for the urban agriculturalist and a more accessible low cost, low technology approach can be successful (Coleman 1995; Ableman 1998; Satzewich and Christensen c.2005a; Ableman 2005). A key function of success for the small-scale farmer is the marketing of produce through direct markets. Direct marketing through farmers markets for instance, is a place where new producers can perfect growing skills and get a sense of consumer preferences in a financially low-risk setting (Bachmann 2002).

The following section outlines the opportunities available to the urban farmer to develop a small-scale intensive form of agriculture which takes advantage of the inherent benefits of growing close to markets. The benefits primarily include cheaper transport costs and a greater retention of revenue from direct markets. An intensive production model is also proposed that directly addresses the converging influences driving the development of urban agriculture. The urban farmer in Brisbane is well placed to take advantage of these influences and opportunities due to its advantageous subtropical growing conditions.

4.1 Environmental advantages

Brisbane’s climate is humid sub-tropical which generally has a wet summer with associated high temperatures, and mild, dry winters. Climate data for 100 years from the Brisbane Regional Office weather station show that Brisbane’s average annual maximum temperature is 25.5^{o}C and the average annual minimum temperature is 15.7^{o}C (Bureau of Meteorology 2008). In terms of human comfort in relation to climatic conditions, studies by the American Society of Heating, Refrigerating and Air Conditioning Engineers (1960 cited in Bureau of Meteorology 1983) claim that people feel heat and cooling discomfort when effective temperature is above 27^{o}C or below 15^{o}C. Brisbane's average maximum and minimum temperatures compare favourably with this data. Brisbane's mild temperatures and high average annual rainfall of 1149 mm (Bureau of Meteorology 2008) also provide favourable conditions for plant growth. This is evident in past accounts of vegetation communities along and adjacent to the Brisbane River.

Originally, vegetation in the Brisbane region consisted of closed forest and rainforest communities along the river and tributaries with emergent hoop pine (*Araucaria cunninghamii*) and Moreton Bay figs (*Ficus macrophylla*) opening up to *Eucalyptus* communities further from the river (Young 1990). A great proportion of the native vegetation in Brisbane has been removed due to urban development with significant stands of remnant or modified vegetation only remaining on steep lands or in areas with poorer soils (Beckmann *et al.* 1987). The distribution of vegetation communities is closely related to soil differences, primarily soil structure and moisture retention characteristics. Brisbane's soils are closely related to the climatic influences of high rainfall and high summer temperatures which have promoted weathering and mineral leaching.

Beckmann *et al.* (1987) describes the most common soil types throughout Brisbane as red and yellow podzolic soils which are duplex soils consisting of a distinct loamy A horizon with a red or yellow-brown clay B horizon that is moderately to strongly acidic due to leaching. According to Isbell (1996) podzolic soils with these characteristics can be translated to Kurosol soils in the more recent standardised Australian soils classification. Northcote *et al.* (1975) notes that podzolic soil types are often used for horticultural pursuits including cultivation for vegetable cropping. Other soil types prevalent in Brisbane that have been considered suitable for cropping in the past include the alluvial soils surrounding creeks and the red earths and krasnozems particularly in the suburbs of Sunnybank and Runcorn (Beckmann *et al.* 1987). Brisbane has the advantage of favourable climatic and soil characteristics and when combined with the converging influences described earlier make a strong case for the development of urban agriculture.

4.2 Techniques and marketing opportunities

This section describes the opportunity that exists by growing high value crops for local direct markets. Growing techniques from an agronomic perspective are not considered in detail, rather the focus is on general principles. The urban grower has many and varied marketing and selling opportunities due to the fact that they are positioned within an urban environment. These opportunities include farmers markets, direct selling to restaurants, road side or farm site stalls, and community supported agriculture (CSA) to name a few of the more common methods. Two similar agricultural systems outlined below, describe a mode of agriculture whose techniques can be replicated in any city, although individual production of high value crops will be dependent on local preferences and growing conditions. Both systems involve intensive vegetable production where most of the benefits are derived from the quick turnover of high value crops and the proximity of the production to ready markets.

Coleman (1995) has sought to develop a vegetable production system based on four key areas which include: (i) simplified production techniques; (ii) using efficient small machinery and tools; (iii) a system that reduces expenses on external inputs; and (iv) marketing produce in a way that will bring the greatest return. Elliot Coleman intensively farms 6000m^2 in the state of Maine in the north east of the United States and grosses US$100,000 per year in an environment that has a limited growing season (Ableman 2005). A similar system on a smaller scale has a model that can be applied on a single site or over multiple sites, often in people's backyards or in available public open spaces depending on negotiated arrangements with local councils.

Satzewich and Christensen (c.2005a) have coined a term called 'SPIN farming' which stands for small plot intensive farming. This is a market gardening system that employs intensive farming techniques in a small area utilising organic growing methods that can include crop rotation, green manuring, compost and natural soil amendments. The key features of this type of 'management intensive' agriculture are: (i) an intensive relay cropping systems to get maximum yield throughout the growing season; (ii) a balance between high value and longer seasonal crops to ensure a variety of produce is available; (iii) revenue targeting for each cropping bed; (iv) direct marketing of produce through farmers markets using innovative pricing structures; (v) the use of hand labour and small machinery; and (vi) minimal capital equipment and operating overheads (Satzewich and Christensen c.2005a).

Both systems are focussed on producing from small areas with minimal capital outlays while seeking maximum returns through direct marketing. Each system also employs a bed layout system that measures approximately 3ft (<1 m) wide which includes a 1ft (~30cm) access path per plot. The systems differ with bed length. Coleman (1995) suggests using a 100ft (30m) bed, which would make up to 57 beds from a 2000m^2 plot measuring approximately 60 x 34 metres. Satzewich and Christensen (c.2005a) suggest using a bed measuring approximately 25ft (7.6m) which make approximately 240 beds possible in a 2000m^2 area. The urban farmer has to think creatively when considering which bed size to implement. A multi-site inner city operation such as that documented by Satzewich and Christensen (c.2005a) will benefit from the smaller bed sizes whereas a larger operation on the peri-urban fringe may be able to implement larger beds successfully. The premise behind smaller beds is a combination of an acknowledgement of the smaller more dynamic bed system needed for an urban farm and the targeting employed to ensure a revenue potential is reached (Satzewich and Christensen c.2005a).

Satzewich and Christensen (c.2005a) target a gross return of US$100 per bed per cycle, with total bed revenue of US$300 per growing season which represents three crops per marketing season. At the time of writing the Australian dollar was just below parity with the US dollar, which makes direct comparison plausible in this instance. The return highlighted for each bed is based on high value crops that are consistently in demand at farmers markets. These crops are often highly perishable and when produced locally with minimal transport and harvested close to the time of sale are often keenly sought by farmers' market patrons (Shores 2008). Other crops grown for consistent revenue over longer periods will have lower targeted revenue per season but form an important component of economic and biological diversity for the urban farmer.

Suitable high value crops for Brisbane are dependent on the specific climate requirements of the crop. Many of the leafy greens that are highly perishable but also in high demand require cool growing conditions. These include daytime temperatures less than 25^{o}C and night temperatures of 8^{o}C in order to germinate correctly, develop suitable leaf material before flowering, and prevent wilting during harvest (Dimsey and Vujovic 2005). Brisbane's average temperatures are suitable to leafy greens; particularly between March and November where the average maximum temperature is 24°C and average minimum temperature is 14°C (Bureau of Meteorology 2008).

Some of the more suitable high value leafy greens include; immature or 'baby' spinach (*Spinacia oleracea*), lettuce mixes (*Lactuca sativa*) and rocket (*Eruca sativa*). Other high value crops suitable to the small-scale market farmer include spring onions (*Allium fistulosum*), and herbs such as coriander (*Coriandrum sativum*) and basil (*Ocimum basilicum*). Other high demand but longer-seasoned crops include garlic (*Allium sativum*), carrots (*Daucus carota*), small cherry-sized tomatoes (*Lycopersicon esculentum*) and potatoes (*Solanum tuberosum*) if space permits. The inclusion of longer season crops is an important strategy for the small-scale farmer in terms of economic and ecological diversification.

A common problem with conventional agriculture is the loss of biodiversity. Agricultural systems can become vulnerable to significant costs and potential crop losses from insect pests when monocultures predominate. Establishing a diverse cropping system has a number of positive aspects that include: (i) a varied plant architecture that may support populations of natural predators; (ii) enhanced soil protective capacity through sound crop rotations; (iii) reduced dependence on soil ameliorations; and (iv) the stability of economic returns with crops producing over an expanded period (Altieri 1995). Satzewich and Christensen (c.2005b) suggest that market demand for a variety of produce and good farming practices require the growing of longer-season produce. This is also recognition that a limited variety of crops are vulnerable to weather, pest and disease problems. Both high-value and longer-season crops can work under a price targeting formula. However, in order to achieve worthwhile returns the high-value crops should form the greater component of the operation.

Satzewich and Christensen (c.2005a) outline a price targeting system that suggests setting the price at $3 per unit and $5 for two units of produce. However, each unit of produce will be different. For example, a standard unit for bagged produce such as leafy greens might be 120 grams and a standard unit for bunched produce such as spring onions, radishes or coriander might be bunches of eight individual plants. The marketing norms of each farmers market will ultimately determine the appropriate standard unit for each grower. These price-targeting formulas are important for the direct marketing of produce so that the urban grower may achieve a balance between high returns and an adequate throughput of produce.

In order to get a sense of the applicability of the price setting and targeting strategy employed by the SPIN farming approach, a survey of three representative farmers markets was undertaken over a period of three weeks in Brisbane. There are numerous markets selling produce provided by growers and resellers in Brisbane. Three markets located in the inner suburbs were chosen on the basis that they were a regular weekly format and sold a range of fresh produce. The three long established inner city markets visited were: the Northside Markets based at Nundah, seven kilometres from the centre of Brisbane; Hotel Broadway's Grower's Market located at Woolloongabba, less than two kilometres from the centre of Brisbane; and the Northey Street Organic Market, located in Windsor less than three kilometres from the centre of Brisbane.

The produce survey was informal and relied on price checks of commonly demanded produce including mixed bags of lettuce leaves, mixed bags of spinach and rocket, individual bags of spinach and rocket, bunched spring onions, and bunched coriander. These crops represent high value, highly perishable products suitable to the intensive urban farming systems described earlier. Table 1 shows the results of prices surveyed at the three markets.

Table 1. Survey showing average prices from three Brisbane markets 2008

Market	**Lettuce mixes (bagged)**	**Spinach & Rocket (variants)**	**Spring Onion bunches**	**Herb bunches**
Northside Markets	$2.00/120grams	-	$2.00/bunch	-
Broadway Grower's Market	$2.50/120grams	$2.50/120 grams	$2.00/bunch 8	$2.00/bunch 8[3]
Northey St Organic Market	$3.50/130grams	-	$3.00/bunch 10	$2.00/bunch[4]

Each producer was remarkably similar in terms of pricing at each market which according to Byczynski (2008) confirms that vendors are well aware of each others' prices but do not necessarily try to compete with each other by offering the lowest price. This is not a comprehensive survey and ignores many other sought-after produce such as carrots and tomatoes. The results from the survey do indicate though that the price targeting approach outlined earlier is a useful assumption upon which to base a detailed gross margins analysis to determine the profitability of a small-scale intensive cropping system catering to direct markets.

Based on the assumptions regarding price targeting, growing system and bed structure, further sensible assumptions can be employed to get a sense of the opportunities that may exist for an urban farmer. A gross margins analysis is a simple way to calculate the potential profitability of a low-input, small-scale agriculture focussing on high-value crops for niche markets.

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[3] Coriander (*Coriandrum sativum)*

[4] Basil (*Ocimum basilicum*)

5. Economic Viability of Urban Agriculture in Brisbane

Economic viability was highlighted earlier in this dissertation as an important element to the re-development of urban agriculture in cities such as Brisbane. A gross margins analysis is often a useful way to determine the economic viability of a potential enterprise. It is also a useful basis for comparing competing enterprises for that particular site. A gross margin is the difference between gross income and the variable costs of an enterprise.

In this particular scenario, the variable costs include all the costs associated with growing and bringing crops to market every growing season. The gross margins analysis in this section examines the costs and potential revenue of a small-scale farming operation that sells through one or more farmers markets and for customers through a dedicated CSA. Fixed costs are the start-up costs associated with the enterprise and can be considered to be the purchase of enterprise assets. This hypothetical scenario requires reasonable assumptions to be made regarding the available land base required and the resources needed to adhere to the targets set for the operation. The assumptions outlined below have been conservatively estimated and represent a starting figure through which a more detailed individual farm budget can be framed before implementation of the enterprise.

5.1 Land base and resource assumptions

Unlike conventional vegetable growing enterprises, the techniques outlined earlier can be implemented over a much smaller area due to the intensive systems used. Land and labour available to the urban grower will ultimately determine the eventual size of the land base. In the case of a multi-sited growing enterprise where the crops are spread over many sites of varying sizes, the grower will have to carefully negotiate access and water use with the owners of each site. This is where the creativity and dynamism of urban agriculture will come to the fore. For this gross margins analysis, a single site in a peri-urban location on Brisbane's periphery will be used to minimise the assumptions about site negotiations between grower and land holder. The key assumptions with respect to the land base for the gross margins analysis are:

Assumption 1) A single site with up to 2000m^2 available for growing. Coleman (1995) and Satzewich and Christensen (c.2005a) both suggest an intensive farm of 2000m^2 is approaching the upper limit for a full-time individual and may still require temporary labour at critical times in the harvesting and processing periods.

Assumption 2) Peri-urban location within 25 kilometres from markets.

Assumption 3) Access to water from a dam or underground source. Cost of water is not accounted for and is assumed to be unmetered.

Assumption 4) The 2000m^2 land base is assigned according to high-value and longer-season cropping. Satzewich and Christensen (c.2005c) suggest that a useful guide to segmenting high and longer-season crops on a small farm is to apply a 75/25 rule whereas larger areas can devote more land to bi-relay and single-season crops. For this gross margins analysis a land apportionment rule of two-third of the land to high-value crops and one-third towards longer-season crops will be implemented.

Assumption 5) Bed size is standardised to 10m long by 1m wide, a 30cm access path with 10 beds per plot. This creates 20 plots of 200 beds across the 2000m^2 land base. Based on assumption 4, the high-value crops will occupy 13 plots with 130 beds and long-season crops will occupy 7 plots with 70 beds.

5.2 Operational assumptions

Assumption 6) Marketing period of 35 weeks from March to November. This timeframe targets the most appropriate growing period for the high-value crops outlined earlier[5].

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[5] Other longer growing summer crops such as pumpkins (*Cucurbita* spp.), watermelons (*Citrullus vulgaris*), beans (*Phaseolus* spp.), or eggplant (*Solanum melongena*) can be grown in Brisbane and marketed during the summer period of December to February. This would extend the marketing season and potentially increase revenue. However, to simplify this analysis a summer crop scenario has been omitted.

Assumption 7) Farm labour is based on a single person working full-time. Extra labour for harvesting and processing may be required throughout the marketing period. Extra labour and calculations for labour costs have not been included in the initial gross margins calculation.

Note: Farming is not necessarily a 9am to 5pm, five-day working week. The time required to engage in activities such as bed preparation, planting, fertilising, weeding, irrigation, harvesting and processing produce for market require long hours. Satzewich and Christensen (c2005d) have noted that even a modest operation focussed towards a weekend farmers market will require up to 55 to 60 hours per week, not including time selling and other marketing activities. This equates to approximately 11 to 12 hours a day, five days a week with at least an extra half a day spent at the farmers market.

Assumption 8) Capital equipment depreciation is not included in the calculation. Forward estimates of inflation on variable costs are estimated at 4% and are based on the consumer price index (CPI) for March 2008 (ABS 2008b). Business enterprise taxation has also been excluded from the variable costs as inclusion would require unreasonable estimates of depreciation, and associated tax deductable business costs. Any loan repayment for capital equipment has also been excluded.

5.3 Fixed and variable costs

Using these assumptions, Table 2 shows the assumed fixed costs for the hypothetical enterprise. Considerations have been given to the acquisition of used equipment for some of the capital equipment purchases. Total fixed capital costs required to establish the enterprise ranges from $8450 to $29160 depending on the purchase of used or new equipment. The low start-up costs are a reflection of the small scale and, management rather than machine intensive production models developed by Coleman (1995) and Satzewich & Christensen (c2005a). Table 3 illustrates the estimated variable costs required to operate this small enterprise. Seasonal variable costs are contained below $7625. Keeping the variable cost so low is due to the labour intensity of the operation based on a sole operator model. Labour wage rates have not been accounted for in the gross margins analysis but are investigated in a separate analysis.

Table 2. Estimated fixed capital costs

Equipment	Assumptions	Estimate Price $ (used - new)
Walk-in cooler	Dimensions: 1800x1200x2100 .	1500 – 5000
Rotary hoe	Petrol 5.5HP, 600mm wide.	1500 – 3500
Irrigation equipment	Pump and hoses, fittings.	1500
Farmers market display – table, banner, information sheets	Metal framed folding tables plus stand shelter. All equipment purchased new.	1000
Garden seeder	Average used and new price.	150 – 360
Post-harvest area	Dedicated benches, sinks and storage room for equipment eg. digital scales.	1500
Harvest & processing equipment	Salad spinner $350 plus assorted bins for harvesting and sorting.	800
Farming tools (hoes, shovel, wheel barrow, soil blocker)	Used or new garden equipment plus soil blocker for seedling propagation.	500
Vehicle	Assumed available or purchase of a used utility.	Nil – 15000
Total fixed costs		**8450 to 29160**

Table 3. Estimated average variable costs for 35-week season

Item	Assumptions	Cost per season $
Farmers market fees	$75/week (averaged across two weekly markets).	2625
Public liability insurance	$10/week for $10,000,000 Farmers Market insurance.	350
Transportation costs (Petrol)	Petrol: 20ltr(for 150klm) x $1.60/ltr x 35 weeks.	~1200
Vehicle maintenance	2 services per year @ $250.	500
Seeds & plant sets	High value crop seeds of various amounts & lower value plant sets – approximate.	1200
Soil amendment (purchased compost, rock phosphate, plus other organic additions)	5 - 10 tonnes compost applied every year. Note: not necessary if soils tests indicate suitable fertility.	400[6]
Cooler utility costs	Electricity and maintenance.	300
Irrigation costs: pump and hoses maintenance and operation	Petrol and replacement parts and servicing.	250
Sales bags/containers	~ 9000 large zip lock bags @ $80/1000; plus ties for bunching crops.	800
Total variable costs		**7625**

[6] After year 1, composting and the use of locally sourced organic materials should significantly reduce the cost of soil amendments. An important way an urban farmer can reduce costs further is to 'tap into' the organic waste stream of a city. By using locally available organic material a farmer can contribute towards a more complete nutrient loop. However, for the simplification of this gross margins analysis the current variable cost will be used across all years.

5.4 Revenue and gross margin calculation

Each crop will yield differently according to management and the normal differential biomass produced by different crops. However an average estimate of unit numbers can be given for a bed. An example such as loose leaf lettuce grown at four rows per bed can expect to yield approximately 700 grams per linear metre (personal observation). This type of yield would allow for 50, 120 gram bags of lettuce leaf.

Assumption 9) Conservatively target an average yield of 40 units per bed, three times per season across the range of high-value produce. Based on assumptions 4 and 5, the high-value produce section of the farm should target 15600 units per season across 130 beds. The longer-season produce will produce fewer crops per season but averaged out over the season and over the range of produce types, can be estimated to produce 60 units per bed resulting in 4200 units per season.

Assumption 10) With consideration given to the market survey results, market price has been targeted at $2.50 per standard unit of produce. For simplicity, the subscription fee paid by customers in the CSA[7] has been included in the calculations of revenue.

Table 4 shows the total estimated units produced across the 2000m^2 land base for high-value and longer season crops. If all produce is sold based on the targeted yield/price formula then just under $50000 can be achieved.

Table 4. Expected unit/revenue combination based on $2.50 per unit.

Crop type	Units	Revenue ($)
High-value	15600	39000
Longer season	4200	10500
Total		**49500**

[7] An example CSA subscription could take the form of $15/week per subscription over a 35 week marketing period. If 30 members subscribe to the CSA, seasonal start-up revenue of $15750 could be achieved. These are conservative estimates of revenue from a CSA. Urban Partners (2007) provide evidence from a financial survey of Somerton Tanks Farm in Philadelphia that shows 2006 revenue from their CSA subscriptions amounted to US$24900 from 46 members over 22 weeks.

Any business takes time to implement efficient practices and build customer support and loyalty. To reflect the notion of ‘experience building’, an assumption has been made regarding the revenue generation capacity of the enterprise.

Assumption 11) The first year will encounter operational and marketing problems unforseen to the operator. To reflect this, it is assumed that revenue will require at least three years to achieve the potential returns outlined by revenue targets. Revenue is scaled back in the first two years to reflect the implied learning curve.

Note: Urban Partners (2007) have examined the income and expenses for Somerton Tanks Farm from 2004 to 2006. Their data shows a rise in revenue each year that has been attributed to on-farm learning and improved marketing skills attained over the three years.

Table 5 examines the gross margins based the previous assumptions. Inflation is assumed to be 4% per year in line with assumption 8. The data show that in the first year revenue has been limited to a capacity of 75% to reflect an estimated reduced working capacity while techniques are perfected. Production and revenue is ramped up to 90% in year 2 and finally 100% in year 3. These assumptions are based on the full productive use of $2000m^2$.

Table 5. Three-year gross margins scenario

	$/year 1 @ 75% capacity	**$/year 2 @ 90% capacity**	**$/year 3 @100% capacity**
Total revenue	37125	44550	49500
LESS			
Total variable costs	7625	7930 (4% CPI)	8247 (4% CPI)
GROSS MARGIN	**29500**	**36620**	**41253**

The favourable gross margins result in Table 5 has been calculated without accounting for labour costs. While assumption 7 outlined that the enterprise is sole operated, it is useful to get a sense of the business profit or loss when a wage payment is made for the 60-hour working week over the 35 week marketing period. The fruit and vegetable industry growing award wage is a useful benchmark for this enterprise. It classifies the rate of pay for farm labour work at $528.40 for a 40 hour period (Queensland Government 2006). This equates to an hourly rate of $13.21. Table 6 shows the profit results when a 60 hour working week over 35 weeks is multiplied by the hourly farm labour rate of $13.21, and calculated as a seasonal wage of $27741. After wages are accounted for, a profit is expected in each of the three years, assuming the standard award wage remains the same.

Table 6. Profit after accounting for wages

	Year 1 ($)	**Year 2 ($)**	**Year 3 ($)**
Gross margin	29500	36620	41253
Profit after wages	**1759**	**8879**	**13512**

The combined profit after three years is $24,150 and represents an annualised rate of return[8] for the three years of between 95% based on an investment of $8450 or 28% for an investment of $29160 (from Table 2).

The results from this gross margins and profit analysis shows a positive result over the three years. It has been a conservative yet realistic analysis of the productive capacity of a single operator working a land base of 2000m^2. The discussion throughout this dissertation has alluded to the need for urban farmers to be creative and dynamic to make full use of opportunities as they arise in an urban setting. A creative farming entrepreneur will be able to develop individually tailored solutions and find productivity gains in areas not addressed by this analysis. Over time an experienced farmer may also have access to more land to expand longer-season crops that are less labour intensive but provide balance to the high-value crops focussed upon above.

[8] Annualised rate of return% = Total return ÷ (Investment x Total Years)

6. Conclusion

If urban agriculture is to succeed and contribute positively to an urban ecosystem then it needs to be economically viable. Community gardens are an important manifestation of urban agriculture in developed countries and often serve as a platform to educate and inspire urban residents. However they are not necessarily vehicles for profit and may not be the appropriate model to promote the spread of urban agriculture as a viable economic activity. Innovative farmers that integrate themselves into the urban ecology of a city by tapping into the resources, materials and services that exist in urban areas and in turn provide resources, materials and services for that urban area (Mougeot 2000), are likely to be sustainable and economically viable.

An urban agriculturalist needs to be flexible and innovative in order to make full use of the resources available whilst simultaneously mitigating the challenges associated with an urban environment. Brisbane is an affluent city with a rapidly expanding population. Much like other cities in Australia and the rest of the developed world, it is also experiencing a rapid growth in the number of farmers markets. Direct marketing was identified in this dissertation as one of the key elements to the viability of small-scale farming. Entrepreneurial farmers will find significant success in niche markets, such as farmers markets, where direct contact between growers and customers is the norm. Direct contact provides farmers with instant feedback that can be used to enhance products and further enhance sales potential. A dynamic small-scale enterprise can quickly adapt to changing consumer sentiments and trends and position their enterprise in the marketplace to take advantage of these rapid changes in sentiment and tastes. Larger organisations have often invested heavily to produce larger quantities and are less likely to move quickly in the short term, to take advantage of changes in niche markets. Small-scale urban farms with low start-up costs and low operating costs can remain flexible to the market. They are also more likely to show resilience to the potential societal and economic threats posed by rapidly changing circumstances, such as rising energy costs.

The three converging influences discussed in this dissertation will have significant impact on society for the foreseeable future. The most significant of the three is the challenge of rising energy costs. These are still early days; however the maintenance of high oil prices is beginning to impact on societal habits and transportation networks. Agriculture in developed countries is dependent on oil for transport and the manufacture of agricultural chemicals and fertilisers. The maintenance of high oil prices is likely to translate to higher food prices. Urban agriculture is well positioned because of lower transport costs to get produce to markets, but it will also benefit from the higher prices in the marketplace. More importantly it may serve to augment these more traditional forms of agriculture during a transition period away from the current heavy reliance on fossil fuels. While this dissertation has looked at the economic viability of urban agriculture with particular reference to three key influences, there is still much critical research needed into urban agriculture, particularly in relation to its implementation in highly urbanised environments.

Future research may look to address key areas highly relevant to Brisbane. These include identifying available land in public open spaces under-utilised by the public and within close proximity to existing markets, transportation networks and water utilities. A geographic information system (GIS) could be used in a collaborative study with local councils to assess the availability of land and utilities, and to assess current zoning regulations. Other research might include addressing the policy framework and engaging with local councils to incorporate urban agriculture as a core issue within their sustainability charter, to position urban agriculture as an integral part of the urban ecology of the city.

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