Urbanisation is prevalent. The United Nations has reported that today, more than half of the world’s population lives in cities. By 2050, this proportion is expected to increase to 70 percent (Figure 1). As urbanization continually increases, so do associated problems accumulate. One of the most pertinent issues would be this – how will the world feed this ever-burgeoning urban population as agricultural land correspondingly declines to make way for the expanding urban areas? Some cities attempt to solve the problem of increasing food demand and decreasing food supply by importing, not realising that this in fact leads to other sustainability problems such as global warming. The global flow of food between cities is made possible through transportation that consumes energy resources and which emits carbon dioxide. With the strain that has been put on Gaia, the discourse on sustainability in cities has been on the rise. Apart from rethinking about how the existing system of food production and distribution can be revamped, there is also an urgent need to translate thought into action, quickly.

Singapore has seen 100 percent urbanisation since 1955. Coupled with the country’s problem of land scarcity, Singapore illustrates the dynamics of competing land use. According to statistics published by the Agri-Food and Veterinary Authority of Singapore (AVA),
Singapore has a total farming area of only 738 hectares and this constitutes only about one percent of the total land area. This tiny agricultural land area produces less than ten percent of the nation’s own food, forcing Singapore to be highly dependent on food imports. In the event of global food crises, Singapore’s food security will be a grave concern as exporting countries, under pressure to feed themselves, are likely to restrict or even stop exports. While diversification of suppliers is a current key strategy in allaying food shortages, and consequent price hikes, this approach may not be adequate in the long run because developed or developing countries all over the world are leasing or purchasing agricultural land in developing countries to ensure their own food security. Examples of this include South Korea which has agricultural land in Madagascar, as well as China in the Philippines and the United Arab Emirates in Pakistan, respectively. Singapore itself has initiated a feasibility study for the Jilin-Singapore Food Zone which covers 1,450 square kilometres, more than twice the area of Singapore, in Jilin, China. This thereby exacerbates the global trend of declining agricultural areas and correspondingly, food production. For its own security, Singapore needs to set its sights towards greater self-sufficiency in food supply for the long run.

Urban agriculture – the growing of food within the confines of the city – has recently gained prominence as a solution attempting to reverse the ills of urbanization. It is achieved through complementary land use where food production is situated within or alongside buildings to optimize the use of space. This reconciles the problem of competing land uses. The adoption of urban agriculture puts food production and consumption in closer proximity and thus allows cities to attain a higher degree of food self-sufficiency, as it offsets a substantial portion of food imports. There is a reduction of “food mileage” as it decreases energy consumption associated with the transport of food within and between cities. In turn, this reduces carbon emissions and helps mitigate climate change.

This concept of urban agriculture is especially relevant in Singapore’s context as the landscape is largely marked by buildings. The Housing Development Board (HDB) reports that about 80 percent of Singapore’s population live in high-rise public housing apartments. With these, there is a total rooftop area of approximately 1,000 hectares (based on various calculations from a preliminary study by the NUS School of Design and Environment). Ecopolis, a television documentary series on visionary, technology-driven solutions for megacities featured an episode on food and water. In this episode, Professor Lee Sing Kong from Nanyang Technological University (NTU), estimated that nine square miles (2,331 hectares) of cultivable space would be sufficient to grow almost all the fruit and vegetables Singapore needs. The total cultivable area measures up to Prof Lee’s calculated value if we take into account balcony and corridor spaces of high-rise HDB apartments, suitable rooftops and ground areas between apartment blocks. By engaging residents to grow food crops in these areas, Singapore may approach self-sufficiency in vegetable production and thereby decrease the country’s reliance on food imports.

Agriculture is commonly thought to be a land-intensive activity because, to achieve economies of scale, traditional agriculture requires large parcels of land situated away from cities. Urban agriculture however, rests on the concept of residents producing their own food within or adjacent to their household units. These plots may also be based at community farms at the rooftop or on ground levels. With urban agriculture, compact and portable micro-hydroponic or micro-garden kits (Figure 2) can be easily retrofitted along sun-exposed balconies or corridors for individual residents.

Alternatively, hydroponic or aeroponic vegetable cultivation systems and home gardens can be set-up for roofs of buildings or ground-level areas between buildings.
Hydroponics is a way of agriculture that contrasts the usual use of soil and organic substrates for micro-gardens. Instead of cultivating plants in soil, hydroponics employs the use of water and inorganic nutrients for cultivation. A variation of hydroponics, aeroponics is a method of cultivation where plant roots are suspended in the air and bathed with mists of nutrient solution. While both methods are suitable for urban agriculture, they are relatively expensive and are technically complex systems. In addition, plants cultivated in these ways may be susceptible to mass-disease outbreaks because of the connectivity of the plants, all of which are fed the same nutrient solution.

Micro-garden kits are a miniature version of the organopónicos approach which is a system of organic gardens, developed in Havana, Cuba as a solution to infertile ground in urban and peri-urban areas. It employs the use of container-beds filled with compost and soil for cultivation. Micro-gardens allow for the incorporation of biochar (Figure 3) as an alternative substrate which has been hailed as the next big thing by environmentalists and agronomists alike. Essentially, biochar is compositionally equivalent to charcoal which is made from wood. It is a carbonized product derived from thermochemical decomposition of organic matter. Additionally, the production of biochar is sophisticated and environmentally-friendly, making it a good alternative which effectively addresses concerns of sustainability. Studies have also shown that biochar helps to improve soil quality and crop yields. With this in mind, research should be conducted on the efficacy of biochar for growing food, especially commonly consumed local vegetables. The results can help Singapore improve food security.

With the above methods of cultivation, we can develop a sustainable and environmentally-friendly cycle with urban agriculture. Cultivation allows waste produce to be processed and recycled for use as substrates and nutrients for food production. These in turn, are converted into edible material – leafy vegetables. With such benefits, urban agriculture may be a multi-pronged solution to a myriad of problems. This proposed integrated system for an urban agricultural system incorporating waste disposal, net-energy production, and food crop production is seen in Figure 4. If it is actualised, Singapore will enjoy better food security while it demonstrates its commitment to being a green city beyond that of garden landscapes.

References
Van Zwieten et al., 2007; Chan et al., 2007; Steiner et al., 2007; Yamato et al., 2006; Iswaran et al., 1980