The influence of rooftop agriculture on urban food security in South Africa

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Abstract

One out of two households in South Africa experience hunger, approximately one out of three are at risk of hunger, and only one out of five seem to be food secure (Drimie and McLachlan 2013). This paper analyses the influence of rooftop agriculture on urban food security using three case studies in three cities (Johannesburg, Cape Town and Durban) in South Africa. This research is important as it studies a variety of rooftop gardens and farms which will help to inform policy directives as well as promote rooftop farming within cities and aid food security. The methodology used for this paper was qualitative research, based on an extensive literature review which investigated four different rooftop gardens in cities around the world. Results of the research indicated that all three rooftop gardens contributed to food security and affordability, employment and business opportunities, environmental restoration and beautification into cities. In future therefore, cities need to pass legislation making rooftop agriculture a priority, or offer a tax rebate to building owners who do comply. Furthermore, studies testing roof garden capacity need to be carried out in all cities.

Keywords
Rooftop agriculture/gardens/farms, food security, food production, employment, South Africa.

1. Introduction
It is estimated that the world's food production will drop by more than 50% by 2050 due to climate change, and the population will increase to 9 billion people (Kumar et al. 2019). Furthermore, the world's urban population might rise to 60% by 2030, while cities only occupy 3% of the Earth's land. This calls for a sustainable source of food within cities, considering the lack of space (Manso et al. 2021). South Africa will also have to find a way to bring food production into her cities. While South Africa as a whole is currently food secure, this is not the case on a household and community level, with one out of two households experiencing hunger, approximately one out of three at risk of hunger, and only one out of five seeming to be food secure (Drimie and McLachlan 2013). Therefore, this study explores rooftop agriculture as an alternative source of food production and its impact on urban food security using three case studies within three cities of South Africa – Johannesburg, Cape Town and Durban. Other studies conducted on rooftop gardens within these cities have not solely focused on their ability to deal with urban food security.

1.1 Objectives

- To analyse the various types of rooftop farms/gardens around the world through a dense literature review.
- To gather information on rooftop gardens in three major cities in South Africa; Johannesburg, Cape Town and Durban.

2. Literature Review

Urban agriculture occurs within a city, or on its fringes, using materials found in its surroundings to produce food and non-food items (Stewart et al. 2013). The two main issues that such urban agriculture addresses are food security and income generation for those involved in food production. It is mostly aimed at helping the poor who could normally not afford to buy from supermarkets, as fresh produce is often expensive in cities. Although the food is not always cheaper, these street vendors are the main suppliers to the poor by providing a variety of fresh food which will be healthier and cheaper than their regular diets. This improves the food security of the city and gives people an opportunity to prosper in life (Stewart et al. 2013). Therefore, urban agriculture can be seen to alleviate the problem of cities not being able to respect their ecosystems because of the overuse of natural resources and the high production of waste. Through the practice of urban agriculture, these negative effects can be lessened, even though they extend far beyond city boundaries (Deelstra and Girardet 2000). Walters and Midden (2018) further concluded that rooftop farms have the opportunity to expand urban agriculture, as urban agriculture requires land usage, which rooftop farms solve by using an alternative type of space (Walters and Midden 2018).

There are three types of rooftop farms which form part of urban agriculture. First, hydroponic rooftop farms, which are grown in green houses through a liquid medium contain a high percentage of nutrients. This type of farming is in demand because of the growing interest of people in organic food (Proksch 2011; DiDomenica and Gordan 2016). Second are educational rooftop farms. These include pilot projects completed by the community itself to test or investigate the sustainability of the amount of food produced. This type of farming is also set up by educational institutions to teach students how to produce sustainable crops in cities where the lack of ground space is an issue (Proksch 2011). Third are commercial rooftop farms. These are primarily for the use of one person or a particular restaurant because of the need for fresh, locally grown produce. They are usually small scale production but are sufficient to sustain the restaurant usage. An example of a very new type of rooftop agriculture would be the HK farm in Hong Kong which not only provides fresh produce to city dwellers, but also uses it as a type of art form and brings a stylish feel to the city (de Boer 2012). Further examples follow below.

The Brooklyn Grange in New York was constructed in 2012 and is currently still running (Harada 2017). It takes up three large rooftop areas and completely changes them into fully functioning farms (Proksch 2011; Ackerman et al. 2014). The aim of these rooftop farms is to provide their residents with fresh vegetables, to be able to supply to restaurants, to help the environment and provide jobs. It is done on a fairly large scale as it also helps to educate thousands of students, host workshops as well as serve as venue for a range of occasions. This farm yields 11000-13000 metric tons of food per year (Harada and Whitlow 2020). It may be thought that food security is not America's biggest priority because of their developed status, but they do have urban poor who need food (Ackerman et al. 2014). For example, New York currently has neighbourhoods which suffer from diet-related diseases, low access to retail food and a high availability of vacant land. The city has since created a new zoning code called "Zone Green" which enables buildings to be modified in order to boost urban sustainability such as the creating of rooftop gardens. The New York City Department of Environmental Projects also encourages green infrastructure projects through grant provisions (Harada and Whitlow 2020).

The city of Detroit, Michigan was once very populated as it was a motor production hub. However, it has since deindustrialised from a population of 1.8 million people in the mid-1900s to around 700000 people in 2010, leaving many vacant plots of publicly-owned land (Bluestone 2013). The community has since taken over these vacant plots and has started to create gardens which provide them with produce that they need, as many were left with no jobs after the deindustrialisation. This currently acts a source of food and also as a source of income (Colasanti and Hamm 2010). Detroit has also launched tax incentives for independent grocery stores opening in the city. In 2013, the city introduced a new zoning code which would consider seven types of agriculture as valid land uses to encourage farming (Taylor and Ard 2015).

Furthermore, in Rotterdam, Netherlands, architects created the city's first rooftop garden called Dakakker as a test site in 2012. The aim of this 1000 $\boldsymbol{m^2}$ rooftop garden was to provide alternative sources of food within a city by using old

buildings (Milanovic, Djuric-Mijovic and Savic 2018). It currently produces fruit and vegetables for selling to local restaurants and also farms bees (de Boer 2012).

Lufa Farms in Montreal began in 2011 with one 31000 square foot greenhouse but has since added another. These greenhouses collectively provide food to 0.2% of Montreal's population (Maughan 2015). The greenhouses enable crops to be grown throughout any season of the year and forms part of large-scale farming (de Boer 2012). They produce forty different crops throughout the year, using hydroponics which are highly cost effective. The Lufa Farm company estimates that they would only require greenhouses on fifteen shopping malls to be able to feed the whole of Montreal (Maughan 2015).

3. Methodology

The case study used secondary data from books, research papers, journals and articles and municipal websites presented in the form of a dense literature review to act as a source for the data collected on rooftop gardens in South Africa. The data were sourced from different types of rooftop gardens/farms around South Africa (three cities). The data was then analysed in terms of its foremost relationship to food security and thereafter additional benefits.

4. Results and Discussion

4.1 Johannesburg Housing Company owned Rooftop Farms: Johannesburg

The JHC owns the majority of rooftop farms in Johannesburg (Allen 2019). They have a total of 15 rooftop farms, with the first few projects which started in 2011 still running. The initiative stems from a Sesotho word, Makhulong A Matala which translates to "greener pastures". These rooftop farms were driven by the need to improve the lives of residents within the buildings as well as to create projects which residents could participate in. All JHC farms receive support from Jozi Food Farmers (JFF) for training of volunteers and their expertise in farming, as well as Food and Trees for Africa (FTFA) for training and capacity building. These workshops deal with the basics of how to grow agriculture products which not only help with maintenance of the existing rooftop farm but also assist in creating new farms. Tenants are then given an opportunity to attend these workshops. Unfortunately, only around 3-4 volunteers have remained. The rooftop farms nevertheless grow an assortment of vegetables, and shade nets reduce the prevalence of pests and birds. All of the rooftop farms use municipal water for irrigation, and none make use of grey water recycling or rainwater capture. These farms were designed to create income opportunities, improve food security and nutrition and enable tenants to purchase the produce grown. This directly improves the food security of residents (Allen 2019).

Figure 1: JHC rooftop garden (Greyling n.d)

Figure 1 is an image of one of the JHC rooftop gardens. It showcases a variety of plant and vegetable species being grown in a series of containers.

4.2 Two Oceans Aquarium: Cape Town

The rooftop farm at the Two Oceans Aquarium was started as small project by staff members and is currently still running. It consisted of succulents until 2017 when a conservational biologist who was a caretaker to sea turtles saw it as an opportunity to grow food for them (Allen 2019). The vegetables grown were produce that sea turtles could eat (spinach, chard, beans and so forth), and the farm acts as an educational tool to teach visitors about sustainability. The aquarium rooftop farm, unlike the JHC owned rooftop farms, uses rainwater as well as grey water recycling, however, as the farm is quite small it does not provide food for the turtles every day. The rooftop garden also provides seating for staff to use on their breaks. However, the rooftop garden experiences challenges with wind tunnel effects and extreme weather conditions which affect its production (Allen 2019).

Figure 2: Two Oceans Aquarium rooftop garden (Two Oceans Aquarium 2017)

Figure 2 shows part of the Two Oceans Aquarium rooftop garden where workers can spend their free time amongst plants.

4.3 Green Roof Pilot Project (GFPP): Durban

A local example within the city of Durban is the GRPP which was started in 2008 and is currently run by its Architecture Department (Van Niekerk et al. 2011). This initiative was designed for greening roofs and providing benefits for both the building, people and the environment. This initiative reduced the urban heat island effect, increased biodiversity in the area, reduced storm water run-off and finally increased food security. Local, indigenous plants were also used. As this was a pilot project, it was not constructed on a large scale. Instead, it has been used as a training tool so that when more rooftop gardens are set up, it will provide all the necessary guidelines which will be helpful to citizens who wish to start greening their own roofs.

Figure 3: The Green Roof Pilot Project rooftop garden (Greenroofs.com n.d)

Figure 3 is a picture of the Green Roof Pilot Project rooftop garden, where plants can be seen growing in separate containers on the actual rooftop after it has been waterproofed. Even though plants are being grown on the roof, there is still space provided for pathways.

Table 1: GRPP harvest list (Van Niekerk et al. 2011)

Vegetable	Weight (Kg)	Retail Cost (R/Kg)	Total Savings (R)
Spinach	14.6	10	146
Tomato	22.2	11	244
Green pepper	2	17	35
Chillies	1	25	25
Eggplant	2.2	20	44
Spring onion	1.4	50	70
Total			R564.00

The Table above was taken from the GRPP. It indicates the list of vegetables harvested from the $10m^2$ of the GRPP that were planted with vegetables between June 2010 and January 2011. The total savings (R564.00) were listed to point out how much households could save (Van Niekerk et al. 2011).

5. Conclusion and recommendations

There is extensive evidence of the benefits of rooftop agriculture/farms and the role that they have played in providing urban food security amongst many countries as well as in the three case studies in South Africa. Yet it is clear that this is an underutilized tool in the combat against urban food insecurity. Some of these benefits include employment and business opportunities, environmental restoration and beautification, not to mention the opportunity to bring an affordable food source into cities. The JHC for example, have proved that rooftop gardens at residences are quite beneficial as they not only act as a source of food to residents but also as a learning tool. The Two Oceans Aquarium can act as a template for other wildlife sanctuaries to produce their own food for animals. The Green Roof Pilot Project can act as a base for other businesses, schools and office buildings as they efficiently use space and informative techniques to produce food and plants that are indigenous. More studies need to be disseminated to the greater public so that building owners are made aware of the endless possibilities, and only then will huge changes be seen.

South African cities have the potential to create many more rooftop gardens to aid in food security, therefore, further studies should be carried out in cities based on inspection of roof weight capacity which can inform building owners

whether it is safe to construct rooftop gardens. However, once buildings are given the go-ahead, there should be legislation such as subsidies and tax rebates put into place to incentivize rooftop gardens.

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