Farming South Africa's Rooftops: An explorative study of Cape Town, Johannesburg and Durban

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Abstract

As a newly trending Urban Agricultural activity, Rooftop Farming is a developing industry that comes at a time in which cities are becoming the most populous places on this planet. As global populations are set to continue to grow to 12 billion inhabitants by the end of this century, much of this growth is expected to occur from within developing countries. Cities within sub-Saharan Africa are currently the fastest growing in which much of their demographic exists under the breadline. Associated with such urbanization of poverty are challenges related to food security. Rooftop Farming is thus an activity which may serve to alleviate these mounting challenges, where it may occupy the vacant spaces above a city's skyline. It is however still under-researched, in which there is a dearth of literature internationally, and even more so for South Africa. This dissertation thus sets out to create a baseline narrative of the budding industry in the country, in which it assesses the policy context which may serve to support the industry as well as to gain insight of challenges and perspectives of those involved in the practice.

List of Acronyms

100RC - 100 Resilient Cities

AFHCO - Africa Housing Company

ANC - African National Congress

AES - Agricultural Economic Services

AETS - Agricultural Education and Training Strategy

ABM - Area Based Management

BIA - Building Intergrated Agriculture

BEE - Broad-based Black Economic Empowerment

CEA - Controlled Environment Agriculture

CoCT - City of Cape Town

CoJ - City of Johannesburg

CSI - Corporate Social Investment

CSR - Corporate Social Responsibility

DARD - Department of Agriculture and Rural Devolvement

DAFF - Department of Agriculture Fisheries and Forestry

DERM - Department of Environmental Resource Management

DOH - Department of Health

DSD - Department of Social Development

DTI – Department of Trade and Industry

DAC - Durban Adaptation Charter

DCCS - Durban Climate Change Strategy

EGS - Economic Growth Strategy

EDP - Edamame Development Programme

EMM – eThekwini Metropolitan Municipality

ECPD - Environmental Planning and Climate Protection Department

EPWP - Expanded Public Works Programme

ESP - Expanded Social Package

FMPZ - Facilities Management Priority Zone

FAO - Food and Agriculture Organization

FSD - Farmers Support and Development

GDARD - Gauteng Department of Agriculture and Rural Development

GDED - Gauteng Department of Economic Development

GRPP - Green Roof Pilot Programme

IPAP - Industrial Policy Action Plan

IDMS - Infrastructure Delivery Management System

iTrump - Inner City Thekwini Regeneration and Urban Management Programme

IFSS - Integrated Food Security Strategy

IGDP - Integrated Growth and Development Plan

IDP - Integrated Development Plan

JDA - Johannesburg Development Agency

JFPM - Johannesburg Fresh Produce Market

JHC - Johannesburg Housing Company

JICP - Johannesburg Inner City Partnership

JOSHCO - Johannesburg Social Housing Company

JSE - Johannesburg Stock Exchange

JFF - Jozi Food Farmers

KZN - KwaZulu-Natal

LED - light emitting diodes

MTSF - Medium-Term Strategic Framework

MDG - Millennium Development Goal

MCPP - Municipal Climate Protection Program

NDP - National Development Plan

NIPF - National Industrial Policy Framework

NO - National Outcomes

NGP - New Growth Path

NFT – Nutrient Film Technique

PERO - Provincial Economic Review and Outlook

PGDS - Provincial Growth and Development Strategy

PSG - Provincial Strategic Goal

PV – Photovoltaic

RDP - Reconstruction and Development Programme

RTDS - Research and Technological Development Services

RF – Rooftop Farm

RTG – Rooftop Greenhouse

STC - Shukela Training Centre

SEDA - Small Enterprise Development Agency

SMME - Small Micro and Medium Enterprise

SAB - South African Breweries

SAET - Structured Agricultural Education and Training

SSA - Sub-Saharan Africa

SDG - Sustainable Development Goals

SRM - Sustainable Resource Management

TEL - Touching the Earth Lightly

UA - Urban Agriculture

UHI - urban heat island

UK - United Kingdom

UN - United Nations

VF - Vertical Farm

WCDA - Western Cape Department of Agriculture

WCG - Western Cape Government

WSI - Wits Siyakhana Initiative

WIBC - Wouldn't It Be Cool

ZFarm – Zero-acreage Farm

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Chapter One

1) Introduction

The planet's total population, is currently estimated to have exceeded 7.5 billion people, and is expected to continue to grow to approxiamatly 9 – 10 billion people by the year 2050. (Ziervogel & Frayne, 2011, Ackerman, et al., 2014, Dawson, 2018). While the rate of this population growth is beginning to slow on a global scale, there is still much growth taking place within the developing countries in Africa and Asia. Wherein the cities of these developing countries are experiencing increased population as a result of rising birthrate and more prominently through to rural-urban migration (Dubbeling, et al., 2010, Ziervogel & Frayne, 2011, Ackerman, et al., 2014, Satterthwaite, 2016, Lanz, et al., 2017). As these cities continue to expand in order to accommodate their burgeoning populations, they permanently transform the surrounding terrestrial environment (Seto et al., 2011, Eigenbrod and Gruda, 2015). In the African context, cities in Sub-Saharan Africa are the fastest growing, in which studies show that many people living in these cities are living beneath the breadline. Issues surrounding food security are of great importance especially since 4 out of 5 urban households in southern Africa are food insecure (Dubbeling, et al., 2010, Satterthwaite, et al., 2010, Ziervogel & Frayne, 2011, Crush, et al., 2011, Ackerman, et al., 2014, Satterthwaite, 2016).

While availability of food forms part of being food secure, the ability to access food is just as pertinent. Access to food in the African sense is largely hindered by household income. In this then, cities in Sub-Saharan Africa are faced with rapidly urbanizing cities, whose inhabitants are – for the most part- poverty stricken (Dubbeling, et al., 2010, Battersby & Crush, 2014, Frayne, et al., 2014, Eigenbrod & Gruda, 2015). Their financial state thus acts as a barrier to receiving adequate nutrition, in which malnutrition is becoming a crisis unchecked (Ziervogel & Frayne, 2011, Ackerman, et al., 2014).

As climate change impacts begin to increase in severity, it is expected that the effects will be most acute on the poor (Ziervogel and Frayne, 2011, Inostroza et al., 2016). It is in this context of growing urban populations who are faced challenges such as food security and climate change that Urban Agriculture (UA) is presented. Urban Agriculture has often been cited as a solution towards poverty amelioration and increased food availability and access, in which it also has applications towards strengthening global and local food systems (Rogerson, 1998, Rogerson, 2010, Malan, 2015, Eigenbrod & Gruda, 2015). While there are many reasons why

Urban Agriculture should be encouraged to take place, various academics question the effectiveness of it in engendering the benefits that so many claim (Rogerson, 2010, Crush, et al., 2011, Webb, 2011, Frayne, et al., 2014).

While such debates continue, Urban Agriculture remains to be a growing activity worldwide, whereby Northern contexts view UA is seen as a form of food sovereignty and resilience building (Foley, et al., 2011, Block, et al., 2012). Whereas in the Southern view it is still largely developmental in application and used as a subsistence strategy (Specht et al., 2014, Frayne et al., 2014). While it is a popular activity in many African countries, the same cannot be said for South Africa. Various reasons may be attributed to this such as negative social perceptions of the practice, the receiving of social grants as well as a lack of policy support (Thornton, 2008, Crush, et al., 2011, Battersby & Marshak, 2013).

UA as a practice is not new and is quite prevalent internationally (Greenstone, 2009, Eigenbrod and Gruda, 2015). This dissertation however focuses on Rooftop Farming (RF). Rooftop Farming is the act of undertaking any agricultural activity on a rooftop, RF falls under the umbrella term called Zero-Acreage Farming, which includes all manner of agricultural activities that take place in, on and around buildings. Zero-Acreage refers to the non-use of actual land in order to conduct their farming activities (Ceron-Palma, et al., 2012, Thomaier, et al., 2014, Specht, et al., 2014, Ackerman, et al., 2014, Eigenbrod & Gruda, 2015, Sanye-Mengual, et al., 2015 b). Various types of Rooftop Farms exist, and are determined according to growth method used, function type as well as the intended motivation of the farm – whether for social benefits or for financial gain. RFs can grow produce in soil or soilless environments and can act to fulfil a variety of criteria in terms of social upliftment, commercial gain, promotion of a company's image or contributing to various sustainability goals (Thomaier, et al., 2014, Specht, et al., 2014, Thomaier, 2017).

Rooftop Farming on the whole is in its infancy as an industry, and so there are many challenges that must still be overcome. These challenges mostly relate to its 'newness' wherein perceptions surrounding its viability are skeptical, technologies and implements are still being trial proofed, and policy contexts have not yet caught up and in some instances hinder development (Ceron-Palma et al., 2012, Sanye-Mengueal et al., 2016, Specht et al., 2016, Thomaier, 2017).

There is very little academic research regarding rooftop farming at an international level and is also sparse for South Africa. With the budding development of new RF's in the country's

largest cities, it is perhaps important to begin gaining an understanding of their motivations, as well as the drivers behind the growing trend.

1.1) Problem Statement

Cities within developing countries are currently faced with rapid urbanization mostly due to rural in migration. Many of those moving to the cities do so for various reasons, many of these relate to a desire for better stability, whether in the form of job security, food security or also due to an inability to cope against climate change (Ziervogel & Frayne, 2011, Ackerman, et al., 2014, Lwasa, et al., 2014, Satterthwaite, 2016). These cities are currently faced with various challenges in the form of poverty and increasingly severe food insecurity (Dubbeling, et al., 2010, Satterthwaite, et al., 2010).

As cities begin to grow, much of the surrounding land and potentially arable soil is permanently transformed. As populations begin to coalesce, their host cities begin to generate greater demand on natural resources (Seto et al., 2011, Eigenbrod and Gruda, 2015). There is thus a need to become more efficient in land use, and the utilization of natural resources. In this then, Rooftop Farming is a novel industry in which niche environments within the urban landscape are made productive. In the years to come, it may be that this industry could play a larger role in the overall global system (Specht, et al., 2014, Thomaier, et al., 2014, Sanye-Mengual, et al., 2015 a).

Rooftop Farming is a trend that is taking hold within the Global North, as well as quite prevalently in South Africa. In this, however, research is still emerging regarding the international trend of rooftop farming, the same is true for the African and South African context (Thomaier et al., 2014, Specht et al., 2014). While there are a considerable amount of rooftop farms beginning to bud within the country's largest cities, there is not much narrative given as to what is spurring on their development. In this then, there is little understanding as to the motivations of RFs, as well as what the challenges are that they face. Furthermore, Urban Agriculture – let alone Rooftop Farming- is not very well supported in National and Provincial policy frameworks. Having said that, there are policy opportunities for RFs and UA activities to take place at a municipal level, in which cities recognize the benefits that exist through job creation and food security.

1.2) Aims and Objectives of the Research

With the scant research undertaken in understanding the Rooftop Farming trend in South Africa, the aim of this dissertation is to create a baseline narrative of the development of

Rooftop Farms in 3 of the country's most populous municipalities. The research focus is then on the following city municipalities: The City of Johannesburg, the City of Cape Town as well as the eThekwini Metropolitan Municipality.

The research sought to achieve the following:

- Gather literary context concerning Rooftop Farming, in terms of background, as well as the benefits and challenges of the industry.
- Critically assess the South African policy context that may be applicable to Rooftop Farming from the National, Provincial and Municipal levels for the selected municipalities.
- Locate as many Rooftop Farms operating within each selected municipality and categorize them accordingly to determine if comparative differences exist.
- Identify key stakeholders for each identifies Rooftop Farm and gain insight in terms of the challenges that they face, as well as their perceptions on the RF industry in the country.

1.3) Study Area Context

While this investigation is intended to reflect the trends in the country at large, the study is limited to the 3 most populous municipal districts in South Africa. In no particular order, the selected municipalities are the City of Johannesburg, the eThekwini Metropolitan Municipality and lastly the City of Cape Town – see Figure 1. While these municipalities were selected for investigation, the study had a strong focus on searching for results within the inner-city districts, which had the greatest population for each municipality.

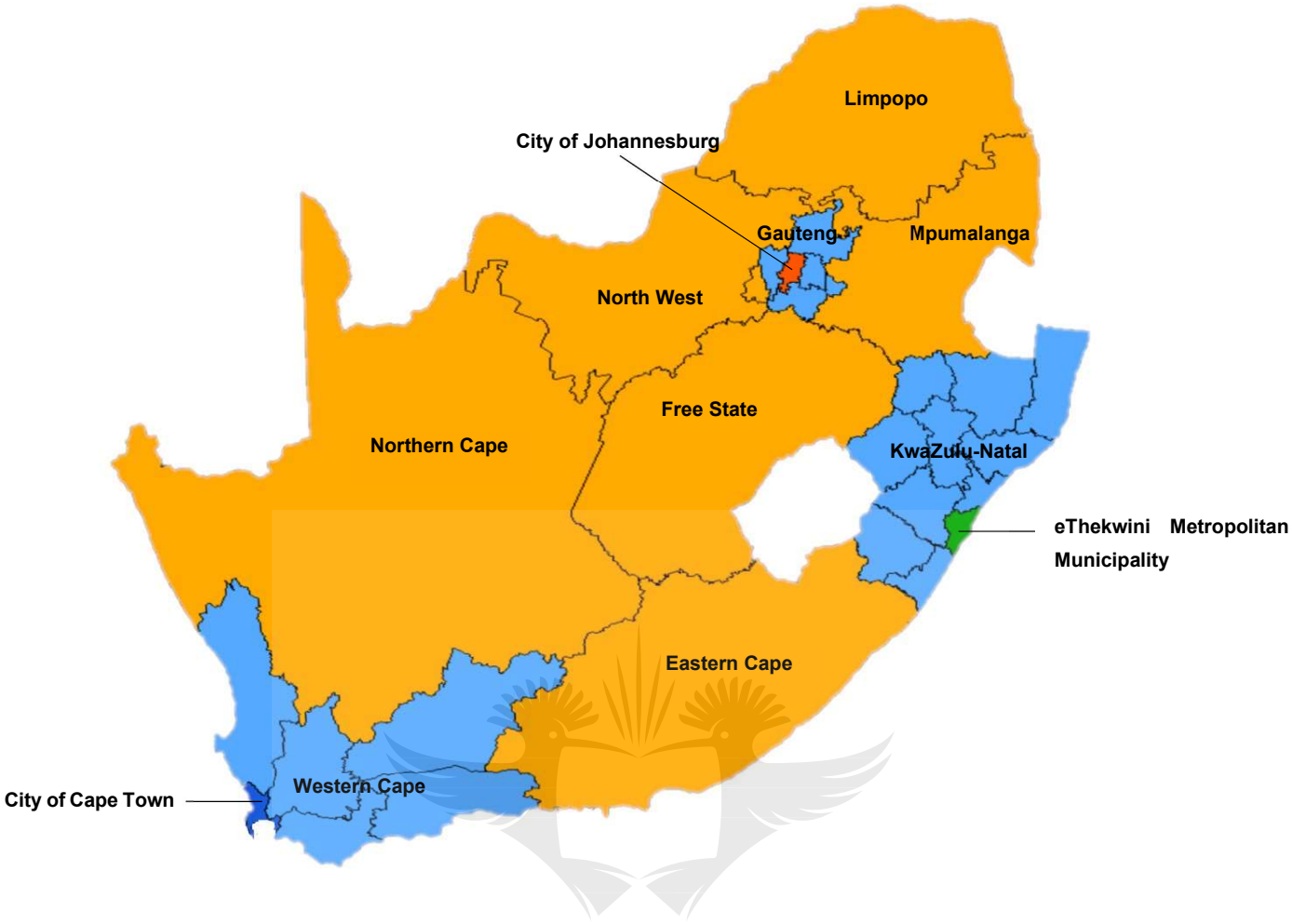

Figure 1-1: Provincial map of South Africa showing selected municipalities for research. Source: (Demarcation, 2019)

This was due to there being a greater likelihood of there being Rooftop Farms present within the denser urban environments found within these cities. Indeed, the cities of Johannesburg, Cape Town and Durban comprise the top 3 most populous cities in the country and are each the largest in their respective municipality and province (StatsSA, 2016).

1.4) Methodology

There have been three methodologies used to conduct the research for this dissertation. These methodologies are: a desktop study through online research, semi-structured sampling as well as participant observation. The study is largely qualitative in nature, and so purposive, non-random sampling methods were used to identify and evaluate the status quo of Rooftop Farms in South Africa's 3 largest municipalities.

In order to first begin finding and identifying Rooftop Farms and their key role players, purposive non-random sampling was used. The purposive non-random sampling technique is also referred to as judgement sampling, which is the deliberate selection of an informant or

participant to a survey, based on the qualities that they possess (Tongco, 2007). Here, key informants are observant or reflective members of a community of interest. These members are informants who would know much more about the 'culture' of study interest, and are willing and able to impart their knowledge to the researcher (Tongco, 2007). In this then role-players within the industry were identified according to a lose criteria relating to their involvement with Rooftop Farms. Role-players were deemed to be farmers, building-owners, project proponents and housing association stakeholders.

Once potential key role-players were identified, they were then surveyed through semi-structured interviews. A semi-structured interview is the verbal exchange where in the interviewer elicits information from a participant through asking predetermined questions. Semi-structured interviews are conducted in a conversational manner, in which issues related to the questions may be explored through the participants (Longhurst, 2016). Before participants were interviewed, they were informed of their rights with regard to information exchange, as given by ethical guidelines stipulated by the universities department. Such rights included that they may withdraw from the interview or survey process, should they not wish to share any information with the researcher or simply that they would not have their interview recorded.

The second methodology was a desktop study through online research. Secondary data is the re-use of data for a purpose other than which it was initially intended (Cole, et al., 2008). The use of this pre-existing data allows for research to be conducted that would otherwise have been impossible for a researcher to collect on his or her own (Cole, et al., 2008). The internet has emerged as a major information source for many researchers, and it presents itself as a powerful tool for providing both primary and secondary research for many social scientists (Eynon, et al., 2008). The use of internet search engines enables the researcher to find information within little time, and can provide reliable and traceable sources of data (Lee, et al., 2008). Secondary data has been collected by use of a popular internet search engine. Wherein initial desktop search was conducted by using key words such as "Rooftop Farm", "Rooftop Garden" in which the names of the provinces and cities were included for each search. These searches revealed articles of present and past operating rooftop farms in the selected cities/municipalities through social media, annual business reports, government press releases, news articles and also through word of mouth in order to find currently operating farms. Information within the articles was then used to head hunt relevant stakeholders mentioned within, these being farmers, facilitators, housing companies or change agents. Search criteria

was expressly restricted to urban agricultural practices that were taking place on top of rooftops, any activities that took place at ground level were ruled out.

After having determined potentially relevant stakeholders and role players, preliminary interviews were conducted. This was to establish who the key role players were as well as to confirm that the identified practice was applicable towards the research concerned. These preliminary interviews were short in which the questions asked were primarily concerned with asking the informant what their role in rooftop farming was, and to establish the context of their role with regards to the identified RF project. These initial interviews were conducted so as to further assess whom to include in the research analysis. It was also needed to ascertain that the farming activity was on a rooftop, and to confirm that the project was indeed being used to generate edible produce and not instead being used to grow ornamentals for aesthetics. These interviews were informal in nature, and were conducted either on site or telephonically, it was also the intent to first establish relationships with the participants, since it can be considered that the practice of rooftop farming is a niche market – so for some proponents they might be wary of information gathering activities that expressly concern them.

The preliminary interviews were also used to guide the questioning process. It was through these initial contacts that it was realised that a standardised questionnaire would not be appropriate for interviewing respondents. This is because various respondents played different roles and functions relating to the Rooftop Farm. For example, a building owner and a rooftop farmer may have different experiences of the operation and maintenance of a Rooftop Farm. Four questionnaires were then made so as to be relevant to the respondent based on the role they played. These questionnaires can be seen in Appendix 1, in which the Questionnaires consisted of the following:

- Questionnaire A - Project initiators, Maintainers and contractors
- Questionnaire B - Building Owners
- Questionnaire C - Farmers, Agripreneurs
- Questionnaire D - Restaurants, Hotels, other beneficiaries

While the questionnaires were somewhat different to one another, common questions between them asked the respondents about the challenges that they had faced, and how they felt about the industries potential.

Once a role player was identified, and was willing to be interviewed a telephonic or face to face interview was set up, or an email with the questions were sent. It was preferable to conduct a telephonic or face to face interview, however some respondents preferred to reply via an email in their own time.

In total 36 respondents were interviewed, and gave comment on their roles regarding their respective RF project. These interviews had been conducted over a period of 2 years between 2017 and 2019. An interview list with primary sources used is available after the last chapter before the reference list (see pg 162). A few respondents were re-approached in order to ascertain if any changes had been undertaken since last they had been spoken to. This was not done for all respondents since some had changed their place of work, or they were no longer involved with the project. Before conducting each interview, respondents were first asked for permission for the interview to be recorded. Many interviewees didn't mind being recorded, with some preferring to rather stay off record, or preferred to have details such as names of companies and stakeholders withheld.

Table 1-1: Number of respondents interviewed, and response type per municipality

Municipality	Total Respondents	Telephonic	Email	Face to Face
City of Johannesburg	**25**	11	4	10
City of Cape Town	**6**	4	2	0
eThekwini Metropolitan Municipality	**5**	4	1	0

The last methodology took place as participant observation, which is the act of understanding people or communities through spending time, living, working with or being them. In so doing, data is collected through field notes, photographs and recorded video or audio media (Laurier, 2010). For this study, participant observation took place through attending a Rooftop Farm tour of Inner-City Johannesburg. Pictures were taken of the Rooftop Farms visited, and audio recordings and notes were made of the farmers encountered, as well as of the tour itself. In addition, many of the Rooftop Farms in the CoJ were visited personally by the researcher, in

which photographs were taken of the installations, and some Rooftop Farmers were interviewed if they were willing. The aim of visiting each RF in person was done so as to gain a better understanding of how they were operated and maintained, as well as to further understand the context of the RF in terms of its location within the city.

1.5) Research Design

Once determining key role players, interview questionnaires were produced so as to conduct survey analysis. Survey formats and questions asked were each made to be slightly different depending on what stakeholder was being interviewed – See Appendix 1. Each survey had a generally similar format in the sense that the role of the stakeholder in the RF was determined. Questionnaires were divided up into 3 thematic categories to establish context of the farm and also to gain insight into farmer perceptions. The first section sought to establish who the stakeholder in question was, and what their role was in terms of the RF. This section then further investigated the when, why and how the farm was started, and who initiated the project. This was to gain understanding into the farm context and develop some background. The next section sought to determine the type, size and focus of the operation. Some questions focused on how the produce was grown in terms of growing method, what produce was grown and who benefitted from the produce generated. The final section aimed to understand current challenges in the industry of rooftop farming, and to gain perceptions of the farmers on how they felt about it's potential in the city or country as a whole. Here farmers were asked what challenges they experienced throughout the running of the farm, from its inception to the time of interview. They were also asked about their opinion of the industry as a whole, and in terms of the South African or city context. Before and after the informants were approached, additional desktop studies were conducted to further enhance information given by the interviewees, as well as to enforce what had been said in the interviews or add to what had been omitted. Information was gathered through publications that were provided by the relevant company on their website, as well as through press releases and news articles that concerned the rooftop farm specifically.

1.6) Challenges Encountered

Challenges varied from technical to academic issues. The first challenge to the research enquiry occurred when the questionnaires were produced. It was initially expected that the companies involved in maintaining the farms were doing so as a commercial enterprise. Problems were immediately encountered as a result, since the questions were not appropriate, nor adequately aligned with understanding the context of the farm. This was because many of the farms were

initiated with different motives, and were operated under different structures to what was initially understood. As time progressed it was found that questions surrounding issues such as site selection, and property owner support became redundant once the nature of the farm project was understood. It was also found that due the varying roles that stakeholders played in rooftop farming in each municipality, questions had to be customised so as to be appropriate for each interview. It was in this way that the initial questionnaires were then entirely scrapped, in which all questions concerning quantitative data were removed. This was done to encourage participation of informants in the interviews conducted. The thematic line of questioning was retained however, in which an informant was first asked for contextual background information, the role they played in operating the farm, and then asked on challenges experienced. Overall questions were aimed at understanding the motives behind the establishment of the rooftop farm, as well as to learn the reason for it being developed. Questions were also directed toward gaining insight into the impact on the community, and also if any sustainable technologies were being implemented on site. Each interviewee however, was asked what challenges they experienced throughout the duration of their role in the rooftop farm, and to ask what their perceptions on the rooftop farming industry were. Gaining insight into their opinions of the rooftop farming industry was to establish what the concerns were of the stakeholders, and if they felt the industry had any potential, or longevity. These adjusted interviews were conducted either through use of email, telephonically or face-to-face as per preference of the interviewee. On site visits were also conducted so as to receive better clarity on how farm operations are conducted and to gain a clearer picture of what the community context was in terms of site location.

Another challenge encountered was reluctance to participate. This reluctance was only encountered with two informants. One of the participants were hesitant to participate in the interview process for vague reasons. It was implied that his fear was that the information he might impart were business secrets, and so did not wish to give away details that might benefit other competing agencies. This was particularly problematic since his role in the rooftop farming industry in Inner-City Johannesburg was rather significant, and so gaining his perspectives would have been of great benefit to the study. The next participant worked for a corporate company, and so needed authorisation from management to become a participant. Due to internal processes within the corporate structure, that authorisation had not yet been given, the deadlines of this research has therefore excluded her participation out of the research.

The next issue that had been encountered was co-ordination with property owners. Some of the farms was on a rooftop that had exchanged ownership, or maintenance. The new property owners or farm facilities were unaware of the research being conducted with the former property owner/farm facilitator and so were hesitant to allow access on to the rooftop, or answer question relating to the RF. Communications broke down, and the relevant person that could assist were uncontactable.

Lastly, it was difficult to categorise some of the farms into certain groups, since it appeared that they either didn't apply to the definition set out in the criteria, or that their functions were blurred and tended to fall into different categories.

1.7) Research Report Outline

Chapter 1: Introduction – Background concepts to the research are introduced, where in the problem statement is outlined, study area context is given, the research methodology and outline is explained, as well as what the challenges to the research were.

Chapter 2: Literature Review – This chapter seeks to establish academic context regarding background issues concerning Urban Agriculture and by extension Rooftop Farming. First concepts regarding food security are established, in which Urban Agriculture is then introduced. This is then followed by an extensive study on Rooftop Farming as a practice, in terms of outlining types of Rooftop Farming practices, the different typologies, as well as the benefits and challenges that exist for the industry.

Chapter 3: South Africa's Agricultural Policy Context – Policies that may support Urban Agriculture and Rooftop Farming are explored from a National, Provincial and Municipal level for the selected Municipalities for research.

Chapter 4: Rooftop Farming in South Africa – A Tale of Three Cities – Herein are the results gathered from the desktop research, and semi-structured interviews. This chapter provides a discursive narrative for each identified Rooftop Farm according to their municipality, and provides the perspectives of those interviewed.

Chapter 5: Conclusion – This chapter serves to conclude the dissertation in which it sums up key topics within, and finalizes the results findings.

Chapter Two

2) Literature Review

It has been estimated that by the end of this century, the total global population will exceed 12 billion inhabitants (Lanz et al., 2017, Dawson, 2018). While the rate of population growth has begun to slow down particularly in developed countries, the population growth in cities within developing nations is still climbing (Dubbeling et al., 2010, Ackerman et al., 2014, Satterthwaite et al., 2010). Many developing countries seem ill equipped to properly manage the fast-paced urban growth taking place within their cities (Crush et al., 2011, Ackerman et al., 2014, Satterthwaite, 2016). Added to this is the fact that for the most part, the demographics found within these cities are primarily living under the breadline (Crush et al., 2011, Dubbeling et al., 2010, Ziervogel and Frayne, 2011).

As developing countries continue to experience rising urban poverty levels, the issue of adequate food security comes to the fore (Ackerman et al., 2014, Battersby and Crush, 2014, Dubbeling et al., 2010, Ziervogel and Frayne, 2011). While food availability is a factor that influences food security, a household's income is a more pertinent indicator. In this then, food security relates to access, and more importantly affordability (Battersby and Crush, 2014, Crush et al., 2011, Dubbeling et al., 2010, Lanz et al., 2017). As populations continue to grow, land transformation for agriculture will come under strain (Ackerman et al., 2014, Lanz et al., 2017). Urban Agriculture (UA) is then a natural solution that is springing about either due to necessity or as a form of resilience (Ackerman et al., 2014, Satterthwaite et al., 2010, Dubbeling et al., 2010, Mougeot, 2000, Despommier, 2013). As cities continue to densify and transform available and fertile land into artificial environments, Rooftop Farming (RF) presents itself as an opportunity. Whereby it is able to fill the niche environments that are found within the unutilized spaces above the city skyline (Thomaier et al., 2014, Despommier, 2013, Specht et al., 2014) .

There are various debates as to whether UA and RF serve as effective means to provide food security, regardless of such debates these activities are growing in popularity (Crush et al., 2011, Dubbeling et al., 2010, Rogerson, 2011, Ackerman et al., 2014). This research dissertation thus sets to explore the various needs for Rooftop Farming, what the benefits are that it can provide, and what the challenges are that the industry faces.

2.1) Growing urban populations

The current estimate for the global population has surpassed 7.5 billion people as of 2017 (Lanz et al., 2017, Dawson, 2018). With the world's population set to reach between 9.3 and 10 billion people by the year 2050, there are mounting questions on how institutions will be able to feed such escalating populations (Ziervogel & Frayne, 2011, Ackerman, et al., 2014, Eigenbrod & Gruda, 2015). Much of population growth is expected to occur within the developing regions of the world. In which Africa and Asia are expected to be the largest contributors (Dubbeling et al., 2010, Satterthwaite et al., 2010, Ziervogel and Frayne, 2011, Crush et al., 2011, Ackerman et al., 2014, Satterthwaite, 2016).

The growth that is taking place in these developing regions, are mostly taking place within cities that are already under strain due rapid urbanizing (Dubbeling, et al., 2010, Ziervogel & Frayne, 2011, Eigenbrod & Gruda, 2015). The cause of the increasing urbanization in developing countries is being promulgated through a city's own natural growth, and also due to rural-urban migration – which is perhaps the more significant factor (Satterthwaite et al., 2010, Dubbeling et al., 2010). Here, migrants are moving from rural area's to cities in growing crowds, in order to seek out a better living through job security, better access to facilities and amenities, and also - increasingly - due to climate change and environmental degradation (Ziervogel & Frayne, 2011, Lwasa et al., 2014).

A milestone for global urbanization had been reached in 2007/2008, in which this marked the first time in human history where more people were residing in an urban setting than in a rural one (Dubbeling, et al., 2010, Satterthwaite, et al., 2010, Ziervogel & Frayne, 2011,). At this time the amount of city dwellers was recorded to be approximately 3.3 billion people – wherein this estimate is expected to double to 6.4 billion urban residents by the year 2050 (Dubbeling, et al., 2010, Satterthwaite, et al., 2010, Eigenbrod & Gruda, 2015). Much of the increase in urban residents is expected to occur from within developing countries whose populations still currently reside in rural setting. It has been cited that developing countries may have cities that will soon house up to 80% of the country's total population (Thomaier et al., 2014). Developing countries represent an urban growth rate of about 3.6% per year between 1950 to 2005, which is fairly significant as compared to the 1.4% growth in developed countries during this same time (Eigenbrod & Gruda, 2015). Satterthwaite (2016), notes that much of this urbanization is taking place in cities that have growing economies. Wherein urbanization is taking place due to the various benefits living in a city would bring, such as potential food and job security.

Attaining such benefits grants individuals increased average life expectancy, higher levels of literacy as well as a stronger democracy. Indeed, increased proximity is advantages for businesses which now have access to greater opportunities for economies of scale, and reduced transport distances (Seto et al., 2011, Satterthwaite, 2016). Living in the city however does not necessarily equate to a better standard of living (Ziervogel & Frayne, 2011). Growth in developing city populations comes at a time where the availability of non-farm employment levels is limited. Dubbeling, et al., (2010) cite that productivity in the non-farm sector has declined in developing countries by 9% between 1980/3 to 2000/3. By the year 2030 urban populations in developing are set to house 60% of the world's population by the year 2030 (Dubbeling, et al., 2010, Ceron-Palmer, et al., 2012, Eigenbrod & Gruda, 2015,). Developing cities are thus growing in population size, but not in availability of jobs.

Africa is no exception to rapid urban growth, in which city populations in Sub-Saharan Africa are one of the fastest growing at 4% per annum (Dubbeling et al., 2010, Crush et al., 2011, Ziervogel & Frayne, 2011). Furthermore, 40% of the total population on the continent already reside in an urban area (Ackerman et al., 2014, Lwasa et al., 2014), and is expected to reach over 50% by the year 2030 (Crush et al., 2011, Satterthwaite et al., 2010, Satterthwaite, 2016). In addition, 80% of the population in Sub-Saharan Africa (SSA) is predicted to be urbanized by 2050, which is comparable to the 82% that exist within Developed countries (Dubbeling et al., 2010, Ziervogel & Frayne, 2011). In this then, it can be seen that within the next 30 years, the population size for many cities in the SSA will nearly double, wherein many of these city inhabitants may likely be unemployed and living in poverty (Dubbeling et al., 2010, Ziervogel &Frayne, 2011, Satterthwaite, 2016).

This may be important to note, since the effects of climate variability in the region are expected to be most acute in SSA. Prevalent issues such as poverty and food insecurity are expected to intensify in the face of this, and will cause people who are already affected by such issues, to become even more vulnerable (Ziervogel and Frayne, 2011, Satterthwaite, 2016). The UN Food and Agriculture Organization (FAO) has identified that urbanization will prove to be one of the strongest social forces in the years to come (Ziervogel & Frayne, 2011, Ackerman et al., 2014).

2.2) Food Security and Food Access

The number of people living in cities is currently around 3.2 billion, this is more than the global population in 1960 (Satterthwaite et al., 2010). Given that many of these rapidly growing cities

are in developing regions, further understanding is required of communities that exist in poverty, and their ability to be food secure, and whether or not they have adequate access to nutritious food resources. The question of food security for the poor is not a question of their ability to produce food, but is a question of their ability to have access to food, given their constrained income capacity (Satterthwaite et al., 2010, Crush et al., 2011)

2.2.1) Food Security and Malnutrition

Rapid urbanization due to rural-urban migration combined with limited job availability is engendering a shift in the locus of poverty from rural areas to within urban cities, a phenomenon Dubbeling, et al., (2010) refer to as 'urbanization of poverty'. Many developing countries already have half their populations struggling under the poverty line (Dubbeling, et al., 2010, Thomaier, et al., 2014 Satterthwaite, 2016), with a total number of urban poor estimated at about 1.2 billion people (Dubbeling et al., 2010, Satterthwaite et al., 2010). "Increasing urban poverty goes hand in hand with growing food insecurity and malnutrition in cities" (Dubbeling et al., 2010: 1). The growing percentage of the poor residing in cities is leading to concerns over a state's ability to ensure a stable framework for food security.

The FAO's most commonly used definition for food security states that it is "when all people, at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (Battersby and Crush, 2014). To further add to this is the definition by the International Policy Research Institute for its 2020 vision, whereby it sees food security be "a world where every person has access to sufficient food to sustain a healthy and productive life, where malnutrition is absent, and where food originates from efficient, effective and low-cost food systems that are compatible with sustainable use of resources." (Ziervogel & Frayne, 2011: 10). Given these Battersby and Crush (2014), find that the FAO's definition on food security lacks the inclusion of food production and instead focuses -perhaps too much- on food access. Having said that, Ziervogel and Frayne (2011), do however argue that both definitions are in alignment, in that the broader socio-economic issues that surround food availability are acknowledged, and where hunger is translated into an economic demand for food.

Food security issues, however, are often largely considered by states in developing regions to be a concern attributed to rural regions (Crush, et al., 2011, Battersby, et al., 2017). Dubbeling, et al., (2010) further add, that this perception by states toward biased priority outlook is mistaken. Urban food insecurity, tends to be largely overlooked by officials when considering

the needs of urban areas. This is mostly due to observations made from observing urban aggregate data - which shows that social conditions in cities are better than in rural areas. This masks the inequalities that exist within urban populations. Levels of malnutrition in low income areas and slums are dispropotionatly higher and possibly exceed that in rural areas (Dubbeling et al., 2010,Ziervogel and Frayne, 2011, Satterthwaite, 2016). Such inequalities can be attributed to the purchasing power of the urban poor, which serves to limit their access to adequate amounts of nutritious food (Dubbeling et al., 2010, Crush et al., 2011, Battersby and Crush, 2014).

Many financially constrained individuals in developing regions especially in sub-Saharan Africa are 'net food buyers' who rely on income for food security (Satterthwaite et al., 2010, Crush et al., 2011,). A large portion of a households' budget is spent on food, with their diets largely consisting of unhealthy staples that provide very little nutrition (Dubbeling, et al., 2010, Rudolph, et al., 2012, Battersby & Crush, 2014, Satterthwaite, 2016). This large proportion of food expenditure cause those that those living in poverty within developing cities to be especially sensitive to economic upheaveals such as that experienced post 2008, which caused increased prices of staples and placed significant pressure on low income households (Satterthwaite et al., 2010, Ziervogel & Frayne, 2011). Higher food prices thus further force low income households to purchase unhealthy but cheaper foods. To add to this, the urban poor often reside in delapidated neighbourhoods and have inadequate sanitary conditions, limited access to clean water as well as alarming pollution levels that expose them to a myriad of health hazards (Dubbeling et al., 2010).

Such toxic environments aggrevate food insecurity, in that chronic illness and/or infections hinder an individuals ability to effectively make use of nutrients consumed, thus intensifying the impacts of an already poor diet (Dubbeling et al., 2010). There is within this, a growing "silent emergency" of malnutrition, wherein this affliction serves as an indicator of chronic food insecurity and hunger (Ziervogel & Frayne, 2011, Ackerman et al., 2014, Thomaier et al., 2014) According to the World Bank, micronutrient deficiencies and stunting due to food insecurity have become a dangerous development issue which is largely prevalent in SSA and South Asia. In the case of urban areas however it is not the lack in the availability of food, but rather lack of access for the urban poor. The effects of this are mostly seen in children, in which 10 million children under the age of 5 are dying due to malnutrition (Ziervogel & Frayne, 2011, FAO 2015)

The African Food Security Urban Network (AFSUN) conducted a study in 11 Southern African cities, the results show that urban poverty and severe food insecurity are strongly interlinked. Four out of five households in the study areas are food insecure (Ziervogel & Frayne, 2011, Rudolph et al., 2012) and only 17% of respondents indicated that they were food secure. The study further found that 50% of household expenses were on food purchases, most of the food brought had a low dietary variety and illustrated that there was a heavy reliance on starch staples (Battersby and Crush, 2014) There was also an indication that health and food security are related, in which households that are food insecure exhibit higher levels of morbidity and mortality (Dubbeling et al., 2010, Ziervogel & Frayne, 2011)

2.2.2) Urban Food Desert and the Southern African Context

With city populations in Sub-Saharan Africa increasingly consisting of poor malnourished it becomes pertinent understand what this means to communities affected. The concept of 'Food Deserts', has over the past few years begun to gain traction and reflects the growing inequalities to health issues, compromised diets, undernutrition, social exclusion as well as differential access to retail food provision due to the retail industry (Battersby and Crush, 2014, Peyton et al., 2015). Urban Food Deserts are associated with economically disadvantaged areas in cities where there is inadequate access to healthy affordable food. This concept was originally borne out of case studies that were developed in the United Kingdom (UK), and then later in North America. It highlighted the retreat of supermarkets in low-income areas due to the construction of mega-centres on the urban periphery. In its initial application, Food Deserts had been measured by actual geographic distance of a low-income household from a food retailer (Battersby and Crush, 2014, Dubowitz et al., 2015, Wagner et al., 2019). In this then, Food Deserts were thought to be related to the presence or absence of a food retailer within an area. In which the size of the food desert could be measured by the physical distance to a supermarket (Brace et al., 2017, Dubowitz et al., 2015, Wagner et al., 2019). However, later understandings began to see the intricacies of Food Deserts and associated food security, in which various factors were realised needed to be considered such as financial income, mobility, availability of free time, education, dietary diversity and structural inequalities (Battersby and Crush, 2014, Wagner et al., 2019).

In the case of Southern Africa however, there is a slightly different dimension to the effects of Urban Food Deserts. Inadequate access to food is not in the form of the physical distance to a food supplier. This is because 79% of those located in poor areas are able to source their food from the informal market (Battersby and Crush, 2014). The informal market plays a significant

role in this providing food access, wherein informal traders are patronised perhaps several times a week. In contrast to this, Supermarkets are not frequented as often by rural locals, and are visited once a month for bulk purchases instead. It would seem then that retailers are not relied on to provide the daily needs of such household in the rural areas (Battersby and Crush, 2014, Peyton et al., 2015). Furthermore, a case study in Cape Town highlighted that supermarket trends go against that observed in the UK or North America. Wherein, in the Northern contexts, food retailers tend to move out of low-income areas due to perceived loss in profit making (Brace et al., 2017, Wagner et al., 2019). Indeed, it has been noted that there are increased numbers of supermarkets within lower income areas in Cape (Ligthelm, 2008). Food-market retailers have instead begun to further penetrate low-income areas, and are beginning to displace informal vendors as they establish new stores (Battersby and Crush, 2014, Peyton et al., 2015).

The concept of Urban Food Deserts is moving on from its focus of the presence or absence of a food retailer or supermarket. In which studies have found that the presence of a food retailer does not automatically grant a community access to nutrition (Brace et al., 2017, Wagner et al., 2019). It has been found in many case studies, that while there is a noted increase of super markets in lower-income areas, they are not necessarily selling healthy food items, and are therefore limiting access to the nutritional needs of their communities (Battersby and Crush, 2014, Peyton et al., 2015, Dubowitz et al., 2015, Brace et al., 2017, Wagner et al., 2019). In this then, it is important to bear in mind, that food security is not just dependent of quantity of food, but also on the quality. In which correct nutritional needs are to be met, in order for a community to be considered food secure (Ackerman et al., 2014, Battersby and Crush, 2014, Dubowitz et al., 2015, Wagner et al., 2019). Urban Food Deserts then do not exist due to a lack of access to food due to physical distance, but rather exist due to a lack of access to nutritious food. Whether due to a lack of nutritional diversity by a food retailer, or due to the inability to afford such food items, in which unhealthier cheaper food goods are opted for (Brace et al., 2017, Wagner et al., 2019).

2.3) Contextualizing Urban Agriculture

In light of urban populations who are unable to afford access to sufficient food and nutritional diversity, a possible solution may then to grow the food directly where it is needed. The practice of Urban Agriculture (UA) has been cited by many to have the potential to provide an array of community and household benefits. In which it can contribute to the amelioration of the needs for many communities who are burdened with challenges related to poverty. In which such

challenges are further worsened due to malnutrition and food insecurity. For many in developing regions such as in Africa, it is often an activity employed as a means for survival and to try offset the costs of food expenses. Some authors question its capacity to bring into effect the benefits it promises. Its potential can also lie in more than just amelioration of the poor however, and can fulfil many sustainability outcomes in terms of environmental benefits, capacitating food sovereignty as well as relieving pressure on the surrounding lands by farming the built environment.

2.3.1) Urban Agriculture

The practice of Urban Agriculture is oft cited as being a solution to the growing concern of food insecurity issues in developing cities. Whereby it may serve to provide access to nutrition and provide a means of possible income (Rogerson, 1992, Webb, 2011, Crush, et al., 2011, Mun Bbun & Thornton, 2013, Ackerman, et al., 2014, Eigenbrod & Gruda, 2015,). Without complicating the definition, urban agriculture can broadly be understood as being any agricultural activity that takes place within an urban environment (Altieri, et al., 1999, Mougeot, 2000, Haysom, 2009, Rogerson, 2010, Ackerman, et al., 2014, Retief, 2014, Eigenbrod & Gruda, 2015). Further elaborations on this definition include: the horticultural activity of producing either food produce (fruit, vegetables) or non-food produce (herbs, trees, flowers), wherein which such activities may include raising animal livestock. Urban Agricultural practices may further encompass post-production functions and activities such as processing, packaging and distributing of products and services created by the industry for use within an urban area (Haysom, 2009, Rogerson, 2010, Ackerman, et al., 2014, Retief, 2014, Eigenbrod & Gruda, 2015,).

Since what is defined as being “urban” is somewhat vague (Badami & Ramankutty, 2015, Malan, 2015), there is much literature that tends to include the role of the peri-urban zone in urban agriculture (Rogerson, 1992, Crush, et al., 2011, Ceron-Palma, et al., 2012, Mun Bbun & Thornton, 2013, Frayne, et al., 2014), whereby this is the area located on the periphery of urban centres, and serves as an interface between rural and urban interactions (Thornton, 2008). Although this peri-urban zone plays a significant role in urban agriculture in various city settings, it will not be the focus of this dissertation.

In 1996, it is estimated that roughly 800 million people were engaged in urban agricultural practices, with it providing livelihoods to some 200 million producers (Eigenbrod & Gruda, 2015, Badami & Ramankutty, 2015, Satterthwaite, 2016). It is however noted that this statistic

may be exaggerated since it was based on extrapolations of data, and so are not entirely accurate, with more conservative estimates stating rather that some 100 million people earned incomes directly from urban faming during this time (Eigenbrod & Gruda, 2015, Badami & Ramankutty, 2015).

Traditionally, growth in Urban Agricultural activities has often been most prevalent during times of crisis such as extreme food shortages, war, or economic decline (Altieri, et al., 1999, Crush, et al., 2011, Sanye-Mengueal, et al., 2016). Where war or relief gardens were grown in private residences that provided fruit and vegetables to citizens during the First and Second World War. Food gardens in this manner were also used as a means of food production during the Great Depression (Sanye-Mengueal et al., 2016). During the collapse of the socialist bloc in 1989, Cuba had lost Soviet support, and entered into an economic crisis as it's GDP dropped 35%, in response to this, urban gardens cropped up all over the country especially in Havana (Altieri et al., 1999). In Africa, it is largely seen as a response to poverty and pervasive food shortfalls due to political and environmental difficulties (Crush et al., 2011). In today's world - and perhaps tomorrow's world - the crisis now presents itself through rapid urbanization, rising poverty, burgeoning populations as well as climate change (Crush, et al., 2011, Ceron-Palma, et al., 2012, Ackerman, et al., 2014, Eigenbrod & Gruda, 2015). It is through this that Urban Agriculture presents itself as a solution to such growing exigencies, in which it is widely advocated as having the potential to engender food security, aid in poverty alleviation, ensure healthier nutrition especially to poor households, as well as generate cash incomes for the urban poor (Rogerson, 1998, Haysom, 2009, Rogerson, 2010, Crush, et al., 2011, Ackerman, et al., 2014, Sanye-Mengueal, et al., 2016).

With this however, many are either cautious in terms of overstating the potential of UA to solve such issues, or they are outright pessimistic about the practice entirely (Webb, 2011). There are indeed a variety of discrepancies regarding the academic findings concerning UA. These discrepancies are highlighted by many scholars that cite pro-UA reports, as having a lack of adequate or supportive evidence of claims made concerning the actual benefit that poor households generate. Whereby figures and data concerning the yield of produce and overall monetary income made by urban farmers, are questionable in terms of its actual impact on a community or individual (Webb, 2011, Frayne, et al., 2014, Badami & Ramankutty, 2015, Battersby, et al., 2017).

Aside from a lack of assertive data to support UA practices, Badami and Ramankutty, (2015) further give critical perspective of the necessity of UA by using the following thought experiment. At a global scale there is between 0.3 to 3.5 million km^2 that is occupied by urban land - depending how one defines urban land, and whether one includes the peri-urban zone. Added to this is the estimated 15 million km^2 dedicated cropland worldwide, as well as a further 34 million km^2 grazing land for livestock. This thought experiment demonstrates the point, in which even if 100% of all urban land were dedicated to food production it would still fall short of the capacity that is produced in rural areas.

As stated earlier however, Urban Agriculture evolves out of some sort of crisis, and is borne out of necessity. UA should not be viewed from the perspective of its substitutability of its rural counterpart as Badami and Ramankutty (2015) posit in their thought experiment. It should rather be from the perspective of its ability to bring about benefits, such as access to nutrition, employment opportunities, reduction in transport costs, as well as productive use of non-utilised urban space. Urban Agriculture arises out of a natural need for households to provide some sort of sustenance, it is created as a survival strategy, where it is then perhaps perpetuated out of a possible means to enhance food security at the household level, or generate some sort of alleviation from poverty either by offsetting costs or by being able to sell excess produce (Rogerson, 2010, Ackerman, et al., 2014,). Rogerson (1992) conceded that urban gardens cannot serve as a short-term solution to the nutritional needs of the urban poor, but emphasises that they should be enacted as complementary and not in-place of current food systems. He further continues by emphasising that any contribution to the poor makes a crucial difference, whether in the small amounts of food generated from UA, or the through the meagre income an unemployed individual may make from its sale (Rogerson, 1992).

2.3.2) Seeing past food production and ameliorating the poor

Urban Agriculture, however, goes beyond poverty alleviation and increased food productivity. With growing climate change awareness, there are numerous mitigation and adaptation opportunities that UA may create. In the wake of growing city populations, the consequential urban expansion is considered to be one of the primary drivers of habitat loss and species extinction. As developing cities continue to urbanize to accommodate their increasing inhabitants, the resultant land transformation will be permanent (Fischer, et al., 2009, Seto, et al., 2011, Eigenbrod & Gruda, 2015). Within developing cities, much of the land that is converted to built-up areas are taking place on what is considered prime agricultural land (Seto, et al., 2011).

Currently 40% of the Earths land surface is utilised by cropland and pastoral activities (Foley, et al., 2011). While so much land is used for food production, it has been noted that the expansion thereof as decreased dramatically over the last years – mostly due to intensification and mechanisation of agricultural activities. While city populations continue to grow, surprisingly, agricultural land will not be growing at the same pace (Seto, et al., 2011, Foley, et al., 2011, Drimie, 2015, Eigenbrod & Gruda, 2015, Lanz, et al., 2017). The intensification of agricultural land will lead to increased instances of land degradation and greenhouse emissions in order to maximise production outputs of available arable land (Foley, et al., 2011, Seto, et al., 2011). In this then, Urban Agriculture may serve to relieve pressures placed on the land, through making arable that which is already transformed (Eigenbrod & Gruda, 2015).

Urban farming makes food as local as possible, where travel distance from producer to consumer are significantly reduced. This greatly reduces the CO_2 emissions embodied in fresh produce, and helps to mitigate against overall greenhouse gas output (Ceron-Palma, et al., 2012, Retief, 2014, Ackerman, et al., 2014, Sanye-Mengual, et al., 2015). In addition, there are further reductions in energy used for storage, packaging and processing of produce that would result due to the shorter distances travelled (Specht et al., 2016). Furthermore, other opportunities for the improvement of a city's carbon footprint exist in the integration of UA in buildings. Which can significantly generate energy savings in heating and cooling as well as in the actual carbon sequestration of growing produce (Ceron-Palma, et al., 2012, Specht, et al., 2016). Other sustainable benefits exist through waste water recycling, storm water capture (thus a reduction in possible floods), as well as significantly reducing the Urban Heat Island effect (Ackerman, et al., 2014, Specht, et al., 2016). There are perhaps more significant underlying issues towards using UA as a vehicle for adaptation towards climate change other than the obvious benefits just mentioned.

Globalisation has increasingly complicated how Food Systems work and operate (Astee and Kishnani, 2010, James and Friel, 2014). Wherein which there exists a dependence on what is a very intricate mechanism that may prove quite vulnerable to any perturbation caused by global environmental degradation. This being in terms of soil loss and changing landscapes which diminish the quality of arable land, or any social unrest whether as a result thereof or unrelated (Fischer et al., 2009, Sonnino, 2016,). This is one of the reasons why there is an identified need for a change in the way global and local Food Systems operate (Astee and Kishnani, 2010, Battersby et al., 2017), and it is in this way that Food Sovereignty exists as a social movement (Block et al., 2012). Food Sovereignty is the engendering of each nation to develop its own

capacity to produce its own basic foods, in its own territory, where the people have a right to define their agricultural and food policy (Block et al., 2012). To this, the local production of food through Urban Agriculture serves as an adequate medium through which Food Sovereignty may be sought, although it goes against Battersby, et al. (2017) who advocate that food security cannot be attained solely through production solutions alone.

Urban Agriculture in the context of South Africa is not as well supported when compared to its neighbouring countries in the region, and that of the global sphere (Crush, et al., 2011). Thornton (2008) attempts to understand why this is the case and highlights possible reasons such as the former apartheid impositions that have now created a negative stigma towards UA. Which has transferred onto the youth, who see it has an activity done by the poor or elderly. He further highlights that social grants tend to reduce productivity in UA. It was later found, however, in a later study conducted on UA farmers in Johannesburg that two thirds of respondents were receiving social grants, indicating perhaps that the receiving of grants was perhaps not then a hindering factor to the practice (Mun Bbun and Thornton, 2013). Many urban agricultural activities in South Africa exist in the form of some sort of subsistence farming that aids in community upliftment, feeding programmes or as a means to provide an additional income, even if it is not much (Crush, et al., 2011, Geyer, et al., 2011, Nkosi, et al., 2014, Frayne, et al., 2014,). Local case studies though have also shown little impact in terms of UA providing for food security in South Africa (Battersby et al., 2017), and as Webb (2011) concludes on the matter "urban agriculture in South Africa does not provide the benefits so often attributed to it.

2.4) Introducing Rooftop Farming

Urban Agriculture is a well-established practice and is prevalent globally. While the percentage of those take part in UA is not large, a simple internet search provides links to many web articles, that describe the budding development of ambitious urban farms in the country. Farming in the city is beginning to sprout within South Africa's major cities - Cape Town, Durban, and Johannesburg (Mail & Guardian, 2016, Engineering News, 2017, eThekweni Municipality, 2011, Nick, 2013). Although there is much literature describing urban farming in South African cities, there is very little academic text regarding the status of newly developing Rooftop Farms in South Africa. Internationally too, literature notes the dearth in research regarding the practice. The works of Thomaier, et al. (2014) and Buehler & Junge (2016), serve to outline the extent of Rooftop Farming as a global phenomenon. Ceron-Palma, et al. (2012) and Specht, et al. (2016) outline the barriers and opportunities of Rooftop

Gardening, Sanye-Mengual, et al. (2015b) generate useful comparisons for technologies used to grow produce in Urban Rooftop Farms, there is that of Ackerman et al, (2014) in their account of Brooklyn Granges in New York.

Rooftop Farming is somewhat considered a rather appealing practice, since it does not directly compete with land use, and makes use of space that is not generally used (Ceron-Palma, et al., 2012, Sanye-Mengual, et al., 2015, Specht, et al., 2016, Thomaier, et al., 2014). Since these practices do not utilize actual land, it is often referred to as Zero-Acreage Farming or ZFarming. Which is used as an umbrella term to describe any UA activity that takes place in the form of Rooftop Farming, Indoor Farming, Vertical Farming or the integration of Greenhouses into building spaces as Rooftop Greenhouses (RTG) (Thomaier, et al., 2014, Eigenbrod & Gruda, 2015, Sanye-Mengueal, et al., 2016). For the purpose of the dissertation, only practices that involve, and are relevant to, Rooftop Farming, will be dealt with.

In order to describe the research focus of what rooftop farms in the context of this dissertation are, there is first a need to delineate the various terminologies and spheres that encompass RF, as well as what RF as a practice encompasses in and of itself. RF falls into an interesting niche, in terms of research and application. With rising concerns over anthropogenic pressures on the environment, and environmental pressures through climate change, RF and associated practices present themselves as a "Sustainability Holy Grail". In which many authors frame the vast potential they have in realising all three pillars of sustainable development (Specht et al., 2014, Ackerman et al., 2014, Thomaier et al., 2014). It is here that Rooftop Farming is not just a form of Urban Agriculture, but also manifests itself as a type of green infrastructure.

Green infrastructure refers to that which provides ecosystem services to the urban environment, in which it has also been termed a 'green space' or 'green system' (EEA, 2011, Gomez-Baggethun & Barton, 2013, Grard, et al., 2018). Wherein, ecosystem services are the benefits that humans receive from ecosystem functions - whether in the form of direct or indirect contributions from the ecosystem toward the wellbeing of humans (Ceron-Palma et al., 2012, Gomez-Baggethun & Barton, 2013). These can be embodied as greenspaces such as recreational parks, or structures to mitigate storm water inundation, trees that provide cleaner air or break up strong winds. Cities are dependent on ecosystems and the services they provide in order to sustain long term conditions for life, health, security as well as good social interactions (Gomez-Baggethun & Barton, 2013, Berardi et al., 2014). Herein is how an RF enters the concept of green roofs as an application of green infrastructure, whose associated

urban ecosystem services are in the form of storm water management, creation of green spaces, energy efficiency, mitigation against the urban heat island effect, sequestration of CO_2 and contributions toward improved biodiversity assets within the urban environment (Greenstone, 2009, EEA, 2011, Cuthbertson, 2017, Harada et al., 2018). 2.4.1) Clarifying what Rooftop Farming is not

Green Roofs are given to be anything that forms part of the final layer of a rooftop, in which it is made up of living plant matter (Berardi et al., 2014). As shown in Figure 2-1, it normally consists of a growing media such as soil, and includes a drainage layer, a root barrier and a waterproof membrane (Wu et al., 2013). It is in this way that Rooftop Farms are considered Green Roofs since many RFs make use of soil beds as a growing medium for their produce.

Green roofs comprise of 3 main rooftop systems: extensive, semi-intensive and intensive systems (Greenstone, 2009, Wu et al., 2013, Berardi et al., 2014, Labuschagne and Zulch, 2016, Cuthbertson, 2017). Their categorisation is mostly based according to soil depth, the weight the roof can handle, and level of maintenance required (Wu et al., 2013, Berardi et al., 2014, Labuschagne and Zulch, 2016).

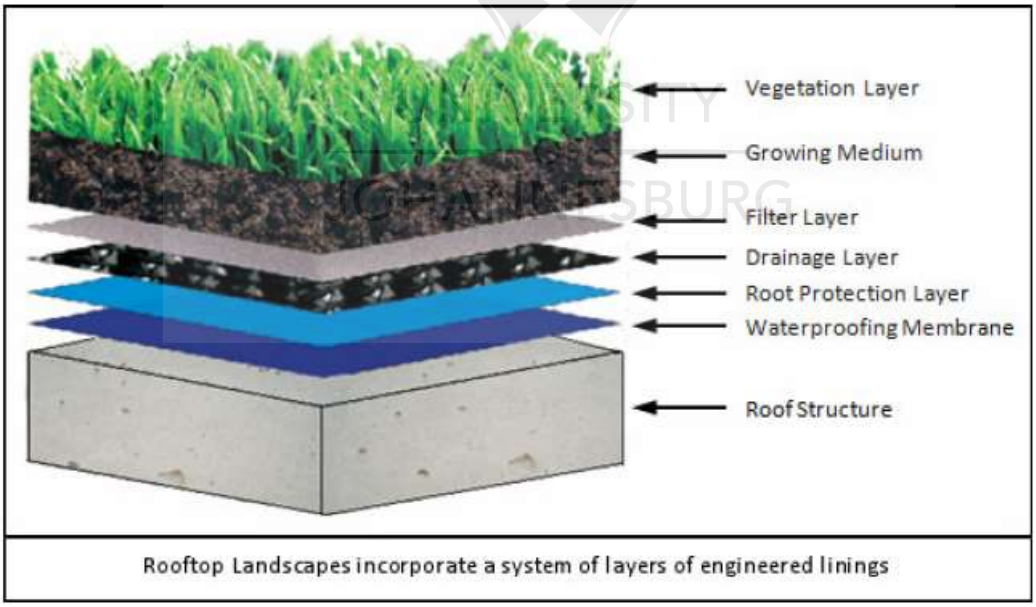

Figure 2-1: Cross section of the layers used in a typical Green Roof installation. Source: (Rooftop Landscapes, 2018

Extensive green roofs weigh the least, and have a soil depth ranging from 5-15cm (Berardi et al., 2014, Labuschagne and Zulch, 2016), where the roof carrying capacity ranges between 60 – 150kg/m2 (includes soil, vegetation mass and water retention) (Wu et al., 2013). An intensive roof can have a substrate (soil) height of between 15-60cm, where the roof is expected to bear

a load of 120-350 kg/m2 (Wu et al., 2013, Labuschagne & Zulch, 2016). This large load bearing capacity often calls for a need in reinforcing the integrity of the roof structure and enhanced drainage infrastructure (Berardi et al., 2014). The last type -semi-intensive- falls between the two former systems, where its substrate height varies between 10-25 with a weight ranging from 120 to 200kg/m2 (Wu et al., 2013). These points are important, since although these terms are referring to Green Roofs, the majority of RFs in the Global North are soil-based farms (Thomaier et al., 2014, Buehler & Junge, 2016). Where the load bearing capacity of the rooftop, and that of the needed soil depth which is applied directly onto the rooftop must be taken into account (Thomaier et al., 2014, Specht et al., 2014, Thomaier, 2017). Labuschagne & Zulch (2016) found that in the case of Johannesburg, the use of semi-intensive roof systems is perhaps most appropriate. In which they state that an intensive roof system would be too costly in terms of its requirements for reinforcement and retrofitting, and the use of extensive roof systems would not be able to support aesthetic vegetation that would be hardy enough to survive the climate environments experienced in the city.

The greening of roofs by use of vegetation add further terms to what a green roof is, in which they are also referred to as being ‘eco-roofs’, ‘living roofs’ or ‘roof gardens’ (Berardi et al., 2014). These multiple terms thus can cause confusion. Ceron-Palma, et al. (2012) makes a distinction between green roofs and roof gardens. They identify that a green roof is “…a complicated multi-layer structure to support it [the garden] and usually covers a large area”

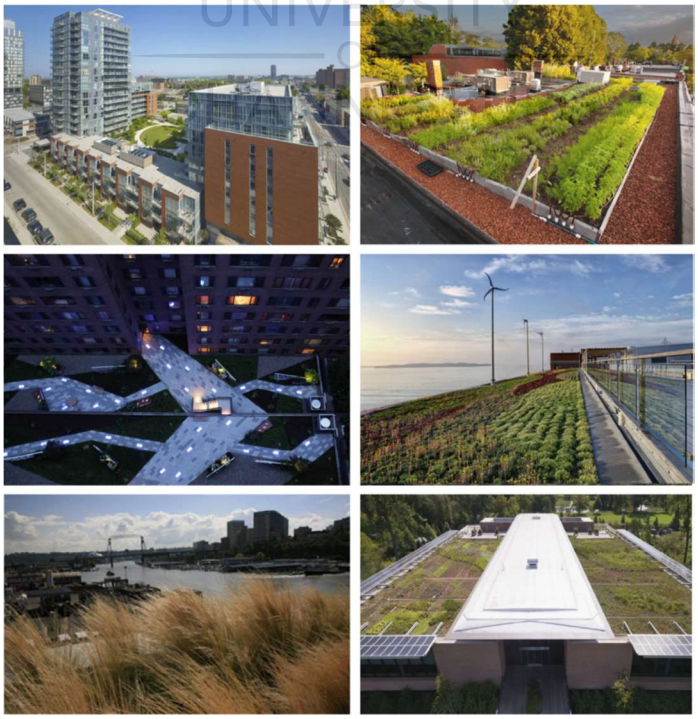

Figure 2-2: Various Green Roof and Rooftop Garden Context, in which aesthetics is the primary objective. Source: (Berardi et al., 2014: 413)

(Ceron-Palma et al., 2012: 89). They then outline that a rooftop garden is "… an area that is generally used for the recreation of a building's residents and is available for local food production" (Ceron-Palma et al., 2012: 89). Although the term 'roof garden' is given as being a space where food produce is grown, it still can be ambiguous, since the word garden implies the use of ornamental and aesthetic plants. Some further clarification is then needed. Green roofs as a concept is not restricted by what plants are used, in this then there is a need to properly separate the concept of Greening Roofing from Rooftop Farming.

Figure 2-3: Examples of ornamental sedums, grasses and succulents used in Green Roof installations. Source: (Berardi et al., 2014: 415)

The applications of green roofs are associated with storm water mitigation, aesthetic improvement and CO_2 sequestration. Figures 2-2 and 2-3 highlight the vegetation used for such roofs, in which they mostly synonymous with aesthetic plants such as sedums, grasses and ornamentals like perennials and semi-annuals (Greenstone, 2009, Berardi et al., 2014, Cuthbertson, 2017). For the purposes of this dissertation then Green Roofs are not adequate as a concept for describing Rooftop Farms.

With regard to RFs, it refers to any activity in which horticulture or livestock rearing is taking place, where the resultant product is intended for consumption (Ackerman et al., 2014, Ceron-Palma et al., 2012, Eigenbrod and Gruda, 2015, Thomaier et al., 2014, Sanye-Mengual et al., 2015 b). We thus move on into the realm of growing edible produce in and on the built environment. Where again there is a multiplicity of terms, however they all relate to the creation of produce, but their various contexts and use of technologies are what define them (Eigenbrod and Gruda, 2015, Despommier, 2013, Specht et al., 2014).

2.4.2) Rooftop Farming as ZFarming

In their paper entitled "Urban agriculture of the future: an overview of sustainability aspects of food production in and on buildings" Specht, et al. (2014), make a comprehensive analysis regarding literature surrounding various activities related to urban farming in and on buildings. They offer up the term Zero-acreage Farming, or ZFarming for short. Since many of these newly emerging urban farming activities take place in unused spaces such as abandoned buildings, or on rooftop spaces, they do not technically occupy any land or acreage, hence "Zero-acreage" (Specht et al., 2014, Thomaier et al., 2014, Thomaier, 2017). ZFarms include Rooftop Farms (RF), rooftop greenhouses (RTG) and indoor farms see Figure 2-4. Specht et al. (2014) continue further that ZFarming is a subtype and a specification of urban agriculture as a whole, and so therefore, it should be understood as being a complementary practice rather than one that is in competition.

The main difference between ZFarming and Urban Agriculture can be seen in the opportunities that ZFarms can create through the use of recycling resources in the form of synergies that can be made between building and farm (Specht et al., 2014). Since Rooftop Farming falls under what is defined as a ZFarm, the terms may at times be used interchangeably with regards to the literature contexts. The term ZFarm is used in this dissertation to refer to all agricultural

activities within a building context, where applications also include that of Rooftop Farming. Rooftop Farming however is specific to the act of farming on a rooftop surface.

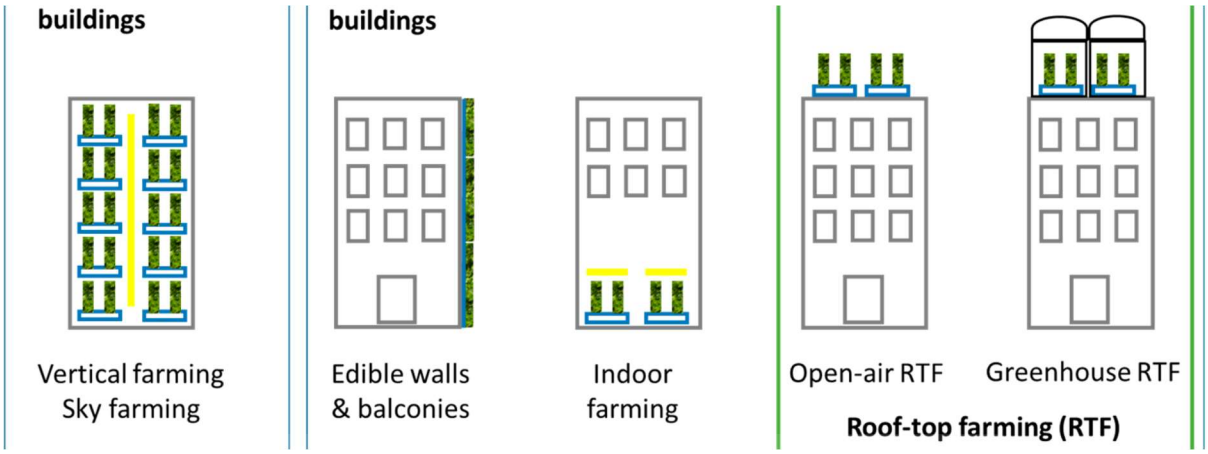

Figure 2-4: Different types of ZFarm installations. Source: (Buehler and Junge, 2016: 2)

Two studies have been conducted by Thomaier, et al., (2014) as well as Buehler and Junge, (2016) regarding the international extent of Rooftop Farms. The studies are very similar in outset, but differ in that Thomaier, et al., (2014) investigated ZFarming practices in general, whereas Buehler and Junge, (2016) investigated commercial practices specific to Rooftop Farming practices that were greater than 100m^2. Both studies found that the predominant farming methods used were that of soil culture and hydroponics – other methods can include aquaponics or aeroponics. Soil culture is the use of a soil medium that covers part or all of the rooftop or is within a raised bed or container (Thomaier et al., 2014). It is the use of 'soil culture' that makes RF fall under definition of Green Roofs as a concept outlined earlier. Since there are various soil layers involved that are applied directly to a rooftop above a waterproof membrane. Rooftop Farming however diverges from Green Rooftops due to the incorporation of hydroponics as well greenhouses into their design, which don't fall into the definitions that Green Rooftops give (EEA, 2011).

2.4.3) Soil vs Soilless

Hydroponics falls under an umbrella term of soilless culture, these make use of either a solid inorganic (clay pellets, chemically stable gravel) or organic substrate (nutrient rich water), for plants to grow (Eigenbrod & Gruda, 2015). Hydroponics has been the next step in urban farming and since its inception in the 1930's, has been able to provide a new frontier in terms of how we as humans generate produce (Despommier, 2013). Hydroponic agriculture has allowed for farming activities to be moved from the field and into the greenhouse. It allows plants to be grown in the absence of soil, in which plant roots are exposed to an aqueous

solution where they are able to obtain all essential nutrients needed for growth (Caplow, 2009, Astee & Kishnani, 2010, Despommier, 2013). These 'soilless cultures' have various methodologies and can have a wide range of applications depending on the site context and crop used.

Methodologies for hydroponic applications include that of Nutrient Film Technique (NFT), Floating Technique, Ebb and Flow / Flood and Drain systems, as well as Aquaponics – see figure 5 for examples (Sanye-Mengual et al., 2015 b, Eigenbrod & Gruda, 2015, Liu et al., 2016). NFT makes use of PVC pipes that run horizontally. In most cases leafy vegetables are grown through holes that are cut into the upward facing side of these pipes, where there is a constant flow of nutrient rich water flowing through them. Floating Technique is the use of a large container filled with nutrient rich water, this water should ideally circulate from one end to the other. Leafy vegetables like lettuce are placed into pots that are fixed into a polystyrene or wooden board, which is placed on the surface of the water so that their roots are suspended in solution. Ebb and Flow or Flood and Drain are different terms referring to the same mechanism. The system operates very similar to the Floating Technique, but the container is drained at regular intervals. The advantage of this is that the roots do not 'drown', and the water does not stagnate. This system also incorporates large aggregates as a growing medium such as clay pellets or gravel, which are then intermittently flooded with nutrient rich water. Aquaponics set ups can be in the form of NFT, Floating Technique or Ebb and Flow mechanisms, the only difference is that the system has been integrated with a fish tank. The idea is that the fish generate waste products such as Nitrates and Phosphates, the water is then recirculated through the hydroponics system, where the plants absorb the nutrients, and return cleaner water back into the fish tank.

Figure 2-5: Pictured demonstrating RF techniques 1a) NFT, 1b) Floating Technique, 1c) Soil-based container. Source: (Sanye-Mengual et al., 2015 b: 1479)

'Soil culture' is the use of a soil medium that covers part or all of the rooftop as can be seen in Figure 2-5, or is within a raised bed or container (Thomaier et al., 2014, Eigenbrod and Gruda,

2015). Soils used, can be in the form of produced potting soils, or can be made up of topsoil and various organic wastes such as leaf cuttings, and wood chips as mulch. Since these soils are created de novo on rooftops, they are termed as being constructed Technosols (Grard et al., 2018). RFs using soil as their growing medium can do so either in container form such as in pots or raised growing beds, or through direct application onto the roof surface that is prepared with a water proof membrane – See Figure 2-6.

There are various pros and cons between the use of soil and soilless cultures. Unlike hydroponically driven setups which are light weight, Technosols must meet the technical requirements that relate to the roofs load capacity (Grard et al., 2018). The use of a soil medium offers a rooftop farmer great flexibility in terms of what crops to grow, since he/she would not be limited to specific crops like in the case of hydroponics. Hydroponic operations are limited to crops such as leafy greens, vine crops and herbs. While soil RFs are able to grow these crops and in addition other crops such as tubers and rooted. This ability to grow a greater variety of produce therefore can help a farmer respond better to market demands as compared to hydroponically driven RFs (Eigenbrod & Gruda, 2015). The disadvantage however is that a RF with Technosols uses up to 10 times more water, and produces a lower yield than a hydroponics set up (Sanye-Mengual et al., 2015 b, Liu et al., 2016).

An Indoor ZFarm or RTG is able to grow produce all year round, irrespective of the weather. Open roof soil RFs can mitigate seasonal impacts, by growing season specific crops in order to maintain economic efficiency (Liu et al., 2016). The use of open-air soil rooftops allows for affordability, simplicity in operation and ease of growing different produce types. Whereas the use of indoor hydroponics can allow for fine tuning of plant requirements, which enhance efficiencies in production however require a greater amount of capital investment.

Figure 2-6: Brooklyn Granges rooftop farm in New York, currently the largest open soil-based rooftop farm in the world. Source: (Dailey, 2012)

In the case of hydroponics, since the nutritional needs can be controlled, the efficiency in productivity per m^2 greatly enhanced, and due to their water recirculation, they are very water efficient, however many practices are restricted mostly leafy vegetables (Buehler & Junge, 2016). To add to this their profitability and appeal may be somewhat decreased since they can energy inefficient, and require water and air pumps to operate on a constant basis (Sanye-Mengual et al., 2015 b). Having said this, these practices can be augmented to include solar power as some prototypes are already doing (Ceron-Palma et al., 2012).

The efficiency of soil vs soilless however is dependent of seasonality, in which soil methods perform much better in summer, with soilless based methods performing better and are more advantageous in the winter (Sanye-Mengual et al., 2015 b). This fact however while it applies to soil-based setups, is also dependent on an attached greenhouse. Statistically though open-air rooftops comprise the majority of case studies identified (between 40 to 47 depending on definition). In the case of greenhouse attachments farming can be conducted all year round and perhaps more intensively since the conditions can be precisely controlled (Sanye-Mengueal et al., 2016). With this though there is the added cost of infrastructure of greenhouse equipment,

as compared to open air farms. To achieve completeness, open air rooftop farms can vary their crops to accommodate ideal seasonal growth (Liu et al., 2016).

The studies further found – quite interestingly- that there were more Urban Rooftop farms that were set up who's motives were to enhance quality of life, and then followed by commercial enterprises, with a few farms existing to generate a better image for a business corporate (Thomaier, et al., 2014, Buehler & Junge, 2016). This can be attributed to the fact that many urban agricultural practices that occur in the Global North are more so enacted as a social response (Ceron-Palma et al., 2012), where in which urban farms serve to engender social and educational values, or are integrated as recreational spaces for residents or employees.

2.4.4) New evolution in farming techniques

Rooftop Farming - and by extension ZFarming - present new opportunities in building design, wherein synergies are able to be created between farm and building. This idea of exploiting building synergies is posited by Caplow (2009), in which he describes a growing need for innovation in architecture that is considerate towards the needs of sustainability outcomes, and greater efficiency in urban food production. He thus outlines Building Integrated Agriculture (BIA) as a new approach toward production, in which it makes use of hydroponic farming systems on and in buildings. In which a building optimizes renewable and local sources of energy and water through created synergies (Caplow, 2009).

Such synergies that can exist through BIA, are in the form of the exchange of heat, water and ventilation flows between greenhouse and building (Sanye-Mengual et al., 2015 a). Heat exchange flows between building and greenhouse can be beneficial since it would increase crop yield, this can be done by connecting a buildings ventilation exhaust into a greenhouse. Doing so would further enhance crop yield through the introduction of increased CO_2 from a buildings inhabitants into the grow area, which creates an environment that is most suitable to increased yields (Caplow, 2009, Ceron-Palma et al., 2012, Thomaier et al., 2014). The concept of a BIA operation is more considered in the framework of high-tech RFs, where hydroponically driven greenhouses are integrated into the building structure. Soil based open rooftops are however also able to be integrated into the buildings processes in terms of greywater recycling, but BIA conceptual designs refer to full integration of all building flows i.e. heat, energy, water and air – see Figure 2-7.

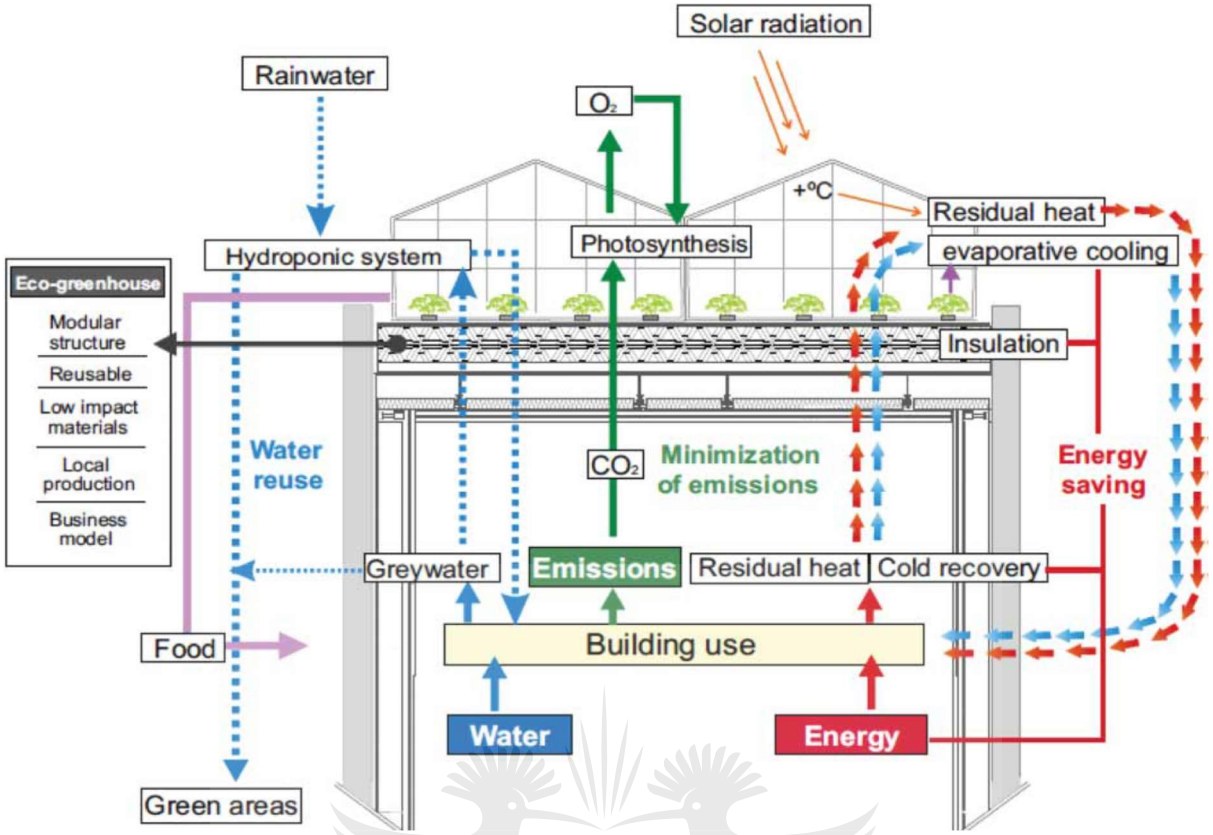

Figure 2-7: Diagram of building synergies that a High-tech RF would be able to exploit. Source: (Ceron-Palma, et al., 2012, p. 92)

The ability to grow produce indoors takes urban farming to the next level in which it allows for the opportunity to perfectly fine-tune growing conditions, so that exact criteria are met to produce high-quality edibles (Despommier, 2013, Specht et al., 2014). Due to this, Despommier (2013) terms all indoor farming activities as Controlled Environment Agriculture (CEA). Growing produce indoors requires the use of artificial light, wherein the advent of the Light Emitting Diode (LED) in the late 2000's, provided several unique advantages over conventional horticultural lighting (Eigenbrod & Gruda, 2015). Such advantages are in the form of increased longevity of lighting systems, low heat emissions, lower energy consumption, and (most importantly) spectrum specific lighting (Despommier, 2013, Eigenbrod & Gruda, 2015).

The ability to control spectral lighting conditions, has created the opportunity to select the most favourable light spectrum required for photosynthesis of plants, thereby enhancing the growth of a plant at all stages of development as is seen in figure 8 (Eigenbrod & Gruda, 2015). LED's are able to provide up to 3 times the light output than conventional lights, for the same wattage. Furthermore, less fertilizers are needed since vegetation periods can be shortened by alternating between red and blue light as the plant develops (Eigenbrod & Gruda, 2015). When one

considers the use of hydroponics, together with LED's, in context of computerised systems that are able to regulate nutrients needed, make pH adjustments, monitor temperature and oxygen content, the concept of CEA can be seen as being rather succinct (Despommier, 2013).

CEA can be applied to various indoor farming environments, and is especially prominent in RTGs. Despommier (2013), envisions that the next step for urban agriculture and CEA will be in the form of Vertical Farms (VF). A Vertical Farm represents the most far reaching of urban farming methodologies (Thomaier et al., 2014). VF's are the alleged final step in the evolution of urban agriculture, wherein high-tech green houses are stacked on top of one another, forming vast agricultural skyscrapers (Despommier, 2013). Such farms do already exist and are commercially viable, and range between 3 and 4 stories high, these can be found in Japan, Singapore, America and Canada (Despommier, 2013). The use of CEA however although advantageous in terms of production output and high-quality yield does pose a few down sides. Crops grown are mostly limited leafy greens and vine crops (although rice production is being investigated), they are incredibly capital intensive, and require technically skilled individuals to operate them, and are also mostly still very new for wide spread applicability (Ceron-Palma et al., 2012, Despommier, 2013, Eigenbrod and Gruda, 2015, Specht et al., 2016, Thomaier, 2017). Rooftop farms, however, are not restricted to using CEA, and so do not require such costs, or sophisticated technologies. The Studies conducted by Thomaier, et al., (2014) as well as Buehler and Junge, (2016) concerning the trends and status quo of ZFarms globally, both found that many of the rooftop farms identified (40-47 depending on definition) operated as open soil-based enterprises. These are very low-tech operations, and do not require the same level of sophistication or expertise as is seen in CEAs.

Figure 2-8: Example of a CEA installation, where magenta coloured LEDs provide Red and Blue light to enhance plant growth. Source: (Eigenbrod & Gruda, 2015: 491)

2.5) Sustainable Benefits through ZFarming and Rooftop Farming

ZFarming represents innovation in food production and brings to the fore new opportunities in urban design and potentials in meeting sustainability criteria. There is thus a challenge in designing urban landscapes that fulfil a wide range of functions (Specht et al., 2014). A major feature of ZFarms and RFs, is that they do not make use of additional land for food production, whereby unused urban spaces such as rooftops and vacant buildings may be exploited (Thomaier et al., 2014).They are therefore able to create a new paradigm with regards to integrating agriculture into urban forms. Through this architects, designers and planners are toying with eco-effective concepts, of how to shape their visions of so called 'arable cities' or 'sustainable eco cities' (Specht et al., 2014). This sustainable-urban-model of the future should reflect the need to facilitate the exchange in flows between cities, the natural environment and urban subsystems from the perspective of industrial ecology (Ceron-Palma et al., 2012). Currently, the typical city model is one that is linear. Where incoming and outgoing flows are characterised by imported resources, and reciprocated by exported emissions, in which there is not a closed cycle (Ceron-Palma et al., 2012). This 'linear metabolism' in traditional city models, has set the urban environment against nature, and nature against the urban environment (Greenstone, 2009). Creating a 'circular metabolism' or closed system based on an ecosystems/ecology approach would place these interrelationships within balance (Greenstone, 2009). Production in agriculture could provide enormous benefits if it is designed to meet multiple societal and ecological function in addition to its current modus of being primarily production oriented (Specht et al., 2014). Presently, its linear model is one of high resource

consumption and generation of wastes and CO_2 emissions per unit of food (kg) (Ceron-Palma et al., 2012). The idea therefore, is to transform increasingly dense cities around food infrastructure and energy resourcefulness (Ceron-Palma et al., 2012, Specht et al., 2014). ZFarms and RFs alike can engender this transformation through their ability to fulfil an array of sustainable benefits and provide for all 3 pillars of sustainability as will be presented.

2.5.1) Environmental benefits

In context of increasing climatic uncertainties, and the impacts that occur through the demands of growing city populations, RFs and ZFarms can be framed as tools to help mitigate and adapt towards such pressures. This is in the sense that they may relieve specific strains and disruptions that various spheres of nature are pitted against. These spheres are presented as elemental forms – air, water and earth – and should the phenomena of UA through rooftop farming practices take hold on mass, there are various benefits that they can endow. These benefits however are mostly estimates, and are assumptions made by authors. This since ZFarms and RFs are still very new, whereby the benefits to the spheres of nature mentioned herein, can only really have significant impact if it is carried out on a large scale. It should also be noted that these benefits can only truly be called benefits if they are thoroughly made use of and are implemented within a RF operation. In which the planning and design of an RF is done so with the specific mind set to impart the benefits that are posited.

2.5.1.1) The Air

In terms of how a RF may function in terms of fulfilling these visionary concepts of a futuristic sustainable city, is in the form of their location on the exterior of a building. Since RFs cover the outer part of a building that is most exposed to the sun - whether on the roof or on the sides in the case of VF's - they are able to a produce a noticeable cooling effect inside the building (Greenstone, 2009, Wu et al., 2013, Thomaier et al., 2014, Ackerman et al., 2014, Specht et al., 2014). This effect is due to RFs (greenhouse or open roof) acting as a shield against solar radiation. On a summer's day, a typical asphalt roof may reach up to 70°C, as compared to the near 26°C present on a rooftop farm (Greenstone, 2009). The implications of this are thus twofold: they are able to enact energy savings, and they can mitigate against the urban heat island (UHI).

To some researchers and practitioners, the phrase 'building-integrated' (as in BIA) is a synonym for 'energy-integrated' (Specht et al., 2014). This is due to the potential that a RF has, in producing energy efficiency within a building, in which they can act as cooling, heating

and energy recycling entities documented in various studies (Specht et al., 2014, Thomaier et al., 2014). A study conducted by Wu et al. (2013) presents such an example in his case study in Zhongshan, China. The study observed two adjoining rooms atop a 3-story building, one was covered with a vegetable garden, and the other was left bare. The rooms both had two separate air-conditioning units of the same kind that were set to 26°C. Temperature measurements were taken a meter above the roof, 1.5m from the middle of each room toward the ceiling, and also directly under the sunshield (30mm thick), that covered the hollow concrete roof (130mm thick) that went over each room. Measurements took place at 30 min intervals during the entire month of August of 2011. Results showed that the temperature under the vegetated roof was on average 6°C lower than the non-vegetated roof. Furthermore, the air-conditioning unit in the room with the bare roof, consumed 362.8kW.h of electricity, as compared to 295.1kW.h measured in vegetation covered room. This is a reduction of 18.7%, and its implications for cost savings can become appealing to any corporate looking to reduce costs. He et al. (2015) investigated this further in order to fill the gap in terms of data recordings for winter. They found that a vegetated roof provided a good insulation layer, especially during the night, and was able to reduce extreme fluctuations in temperature. However, they concluded that its effectiveness was most appreciated when air-conditioning was in use. Whereas under free floating conditions, there was no difference noted since it appeared the vegetated roof acted as a heat sink, where the indoor heat of the room it surrounded flow out, towards it. Regardless of this result, the conclusion remained in favour of the vegetated roofs ability to reduce energy costs through air conditioning. The issue of energy savings by use of vegetation has been quite thoroughly explored, with various other examples citing savings up to 40% through the integration of a RF to a building's exterior (Ceron-Palma et al., 2012, Specht et al., 2014, Thomaier et al., 2014).

Vegetation found in a RF are not only able to provide beneficial impacts to the interior of a building, but also impart them externally. Their insulation effect, and ability to reduce the solar radiation that reaches the buildings surface is important in decreasing the radiation given off by the building itself (Liu, 2004, Ackerman et al., 2014). In addition to this, plants reduce the ambient temperature through a process called evapotranspiration. This process involves the evaporation of water molecules from the surface of a plants leaves, the act of evaporation requires heat energy. It is in this manner that a vegetated roof will act as a heat sink and cool the surrounding area (Liu, 2004, Ackerman et al., 2014). The practical upshot of this, if conducted on a large scale, is the potential to mitigate against the UHI. The UHI refers to

increased temperatures that occur within city centres as compared to the rural surroundings (Liu, 2004, Ackerman et al., 2014). This effect can create a localised higher mean urban temperature, of between 0.6°C and 12°C warmer than the regions that surround a CBD (Ackerman et al., 2014). The increased rise in ambient temperature is as a result of the physical structure of urban environments. Wherein many building materials retain heat and amplify what are already increasing temperatures (Inostroza et al., 2016). There is growing evidence that climate change contributes to the increased frequency, intensity and duration of heat waves, and may serve as particularly significant to human health and mortality (Liu, 2004). Heat waves are a natural phenomenon, however, climate change is heightening its detrimental impacts by extending their duration, increasing their frequency as well as its intensity. To add to this, they are further aggravated by reduced levels of evapotranspiration that exist due to the lack of green belt areas in urban environments, which are instead replaced with heat retaining brick and concrete buildings (Inostroza et al., 2016). It is within this context that there is a greater need to create vegetated surfaces within urban cores (Ackerman et al., 2014).

2.5.1.2) The Water

Many RFs make use of Technosols (soils that are artificially mixed or prepared) and are open air RF, due to this the presence of foliage and soil atop a building surface are able to intercept rain water and is able to slow its progress into urban systems – storm water drains (Liu, 2004, Grard et al., 2018). This then has sparked some interest by governing authorities to encourage their development so as to aid in storm water management (Kumpf, 2014). The nature of the growing medium temporarily stores rain water, this can prevent possible inundation of city water systems and can prevent flooding in the area (Liu, 2004). With increased impermeable surface in the urbanscape there is need for surfaces that may retain and temporarily store water. Harada et al. (2018) observes literature concerning water retention abilities of soils on various rooftop farms. The studies found that there can be a storm water reduction potential of 87.7% (<2mm) with light precipitation, 85.6% with medium precipitation (2-10mm), and only a retention of 58.9% with heavy precipitation (>10mm). Ackerman cites that RF's are able to retain between 52.3 and 100% precipitation received. Grard et al. (2018) conducted their own study on the retention rates of 3 Technosols. These Technosols were that of potting soil, 2 that consisted of layered topsoil with mulch and wood chips, the one differed in that it was inoculated with a variety of earthworm species. They found retention rates of 84% and 81%, however it is not clear under what amounts of precipitation they were exposed to. There is however a cautionary note here, since it has been noted that due to fertilizers and nutrients

present in soils on RFs, there is a risk of leeching, which can adversely decrease urban water quality (Ackerman et al., 2014, Whittinghill et al., 2016, Harada et al., 2018). There are further doubts about a RFs ability to retain water, which it is often praised to enact. Since produce on a farm requires water to grow, farmers ensure that the soil is frequently irrigated. This means that the soil medium is already near saturation point in the event of a precipitation event, and so there is very little retention that actually occurs (Harada et al., 2018).

Since the implementation of a RF onto a roof requires some adjustments made in terms of infrastructure with regards to drainage. The use of correct planning and proper intent can open up opportunities for harvesting rain water, as well as recycling treated grey water (Astee and Kishnani, 2010, Ceron-Palma et al., 2012, Specht et al., 2014, Thomaier et al., 2014). Astee and Kishnani (2010) estimate that in Singapore there is approximately a total catchment area of 7435 hectares of exploitable residential land. This artificial catchment can produce the potential to harvest 175 million m^3 of rain water, given that the average rainfall in Singapore is a gushing 2360mm per annum. Such potentials can only be realised through costly integration and retrofitting of infrastructure into either new or present building stock (Specht et al., 2016, Thomaier, 2017). There are further opportunities in terms of using recycling treated greywater to water crops. Up to 80% of a household's waste water will consist greywater. Bearing this in mind, the average consumption of water in a greenhouse can about 0.7 – 1.5m^3/m^2 depending on what crop is used. Theoretically then, a rooftop greenhouse that is 1000m^2 in size could be satisfied of water needs by less than 200 individuals (Ceron-Palma et al., 2012). Greywater can be suitable for crop irrigation due to low organic pollutant and pathogen content (Ceron-Palma et al., 2012). Recycling water in this manner certainly creates appeal with regards to integrating efficiencies in urban structures, and reducing water demand in drought prone cities. Further recycling opportunities can also be exploited through organic waste generated by building occupants, such as food scraps. Organic waste can produce fertile compost with needed nutrients for healthy crops (Thomaier et al., 2014). This will also reduce solid wastes produced and encourage the production of a closed system metabolism within a building (Ceron-Palma et al., 2012).

2.5.1.3) The Earth

There is a growing need to reduce the growing demands that cities have on natural resources, especially in the form of land transformation and degradation (Seto et al., 2011, Eigenbrod and Gruda, 2015). Current efforts to feed the worlds cities has led to the global agricultural community farming a landmass greater than the continent of South America. This estimate is

only that of cultivation, and does not include land needed for grazing and pastures (Despommier, 2013). It is for this reason that many authors in ZFarm and RF literature often will often cite the potential that large-scale practice of urban farming and ZFarming may have in reducing pressure that agricultural production is placing on our environment. Added to this will be further pressures with expected population growth and the need to provide food security in increasingly variable conditions due to climate change (Caplow, 2009, Astee and Kishnani, 2010). For instance, Thomaier (2017) conducted a GIS study to identify rooftops greater than 500m^2, that would be suitable to support rooftop farming. This study found there are a total of 7302 available rooftops, with an area of 8 317 935 m^2 of potential exploitable Rooftop Farming space. Although this statistic may be impressive, she further cites that the City of Toronto has a total available roof area at approximately 50 million m^2, that could be used for rooftop farming.

The reason why such areas could be significant is that the use of CEA – hydroponic greenhouse farming – is able to enhance the efficiency of each farmable square meter. This is because crops grown is CEA setups could grow year-round and are protected from external factors such as pests and weeds. This also means that there is no need for harmful pesticides, which pose severe health risks to those that operate with them (Despommier, 2013). Caplow (2009) cites that 1 Ha of Hydroponic agriculture can offset 10 Ha soil agriculture. Given this then, Thomaier's (2017) survey of available rooftops equates to approximately 10 times its value in rural land. More importantly pose significant environmental hazards in terms of runoff or exposure to pollinating insects (Astee and Kishnani, 2010, Specht et al., 2014). If CEA's are used as a ZFarm or RF practice where closed systems are implemented, in which nutrients used, only leave the system through harvested plants. This means that there are no environmental consequences with regards to nutrient leeching through runoff of fertilizer during precipitation (Astee and Kishnani, 2010, Despommier, 2013). This also implies that ZFarmers do not have to apply fertilizers/nutrients to their crops as it won't be so easily lost.

Some authors have noted that the introduction of increased vegetation through green roofing, can increase biodiversity (Specht et al., 2014). Greenstone (2009) cites some case studies in which there have been an increase in predator birds such as hawks, found nesting near vegetated rooftops. In his own study of a RF using containers to grow produce he observes various species of insets such as Hymenoptera (bees, wasps and ants) and also Coleoptera (beetles). On mass, this re-introduction of insects and beneficial pollinators would introduce a wider range of ecosystem implications for species along the food chain. However, this improvement to

biodiversity may be greater appreciated if we look once more at the implications of what the efficiencies of hydroponic agriculture may bring. Caplow (2009) estimates that for hectare of used with CEA, 10 hectares of rural agricultural land could be freed up. In the case of Toronto this would imply that a possible 5000 ha of land could be relieved from agricultural use. With this in mind Volis (2017), in his paper "Complementarities of two existing intermediate conservation approaches" advocates for an 'inter situs' conservation method. In which species that are red listed as threatened be reintroduced into areas in which they are naturally found, with special focus on abandoned farm plots or degraded land. If largely densified cities were to co-ordinate urban agricultural production with the express purpose to alleviate land for conservation purposed, this would bear significant contributions towards rehabilitation. The process of rehabilitation, monitoring and conservation could also provide jobs to those who may find that urban farming is out competing their own rural agricultural practice (Volis, 2017).

2.5.2) Economic Benefits through changing food systems

ZFarms present an opportunity in terms of shifting agricultural contexts from the need for arable land, toward any space that has a willing farmer. This means that farming can in effect take place anywhere (Despommier, 2013). The significance is then on the fact that the supply of fresh produce can take place as locally as possible (Specht et al., 2014). There are thus huge implications on how current food systems may change. With regards to food security, its associated energy costs as well as the ecological footprint incurred through direct and indirect agricultural processes (Caplow, 2009, Astee and Kishnani, 2010, Ceron-Palma et al., 2012, Ackerman et al., 2014, Specht et al., 2014). These processes include fiscal and energy costs incurred through production, packaging, transportation, storage and refrigeration (Specht et al., 2014).

With regards to literature surrounding the energy embodied in fresh produce and its associated transport emissions, Specht et al. (2014) observe that most of it refers to the U.S, in which the emerging issue is encapsulated under "food miles". It has been cited that the average final delivery of food in the U.S is about 1640km with Ackerman et al. (2014) citing that this figure may be at 2080km, from farm to table, and the total supply chain has a movement of 6750 km. This number could potentially be reduced to just 49km for some foods that are produced at a more local scale (Ackerman et al., 2014). Reducing such long distances have significant implications on minimising spoilage and food waste. For Ackerman et, al. (2014), being able to mitigate food waste represents greater savings with regard to the energy embodied in food,

than savings through fuel costs. With a greater instance of locally produced food that may require less energy for transport, packaging and cold storage, there can be a strengthening of food systems. Which forms as a cornerstone toward climate change adaptation and mitigation for cities in the future (Specht et al., 2014).

2.5.3) Mitigating CO_2

The need to strengthen food systems through local food production, and the potential that it can have on reducing the ecological footprint, is highlighted by Astee and Kishnani (2010) in their case study of Singapore. It is cited, that in the city-state of Singapore, 95% of its vegetables are imported. This counts heavily against its ecological footprint, and leaves the population vulnerable to rising food prices and places them at risk to any crises that may occur within food production from imported countries (Astee & Kishnani, 2010). The city environment is densely built up, with little land available for agricultural production. To counter this, the government of Singapore has set aside funds for the allocation of food zones in other countries, in which food will be grown specially for Singapore's needs. It is in this context then, that Astee and Kishnani (2010) explore the applications and opportunities of Rooftop Farms in Singapore. 80% of the population reside in public housing under the Housing and Development Board (HDB). The authors have identified a possible 661 ha available for RF production, which they estimate as being able to produce an annual yield of 121 599 tonnes of vegetables. This figure is far greater than the current domestic yield of 18 967 tonnes produced by local farmers (Astee and Kishnani, 2010). Combining these yields, gives a potential of 140 566 tonnes of locally produced vegetables. With an estimated 82.6 kg consumed annually by an individual Singaporean, and a population of 4.8 million in 2008, the demand for fresh produce is roughly 396 480 tonnes annually. Rooftop farming therefore - when added to local production – could offset 35.5% of Singapore's vegetable needs. Which is significant compared to the 5% Astee and Kishnani (2010) cite as being produced by local farmers. In 2007, 46% of imported vegetables originated from China, 28% from Malaysia and 26% from other countries such as Indonesia, Thailand and Australia. Total imported produce during this time was about 381 532 tonnes and contributed to 28 401 tonnes of CO_2 emissions (Astee & Kishnani, 2010). If RF could produce the estimated 121 599 tonnes of fresh produce, then 9 052 tonnes CO_2 could be mitigated annually.

Caplow (2009) adds to this, by stating that for every hectare used for local hydroponics production, 250 tonnes CO_2 can be mitigated. He presents a selection of projects initiated by BrightFarm Systems. Two examples give statistical potentials on CO_2 emissions. The first is a

1000m^2 Rooftop Farm on a 6-storey public housing building in the Bronx, New York City. According to Caplow (2009) the farm can produce enough fresh produce to reliably satisfy the needs of 400 people, and mitigate 80 tonnes CO_2 annually. The second is a 5000m^2 RF on a shopping centre in Abu Dhabi in the United Arab Emirates, which could mitigate 3000 tonnes CO_2 of air-freighted imported fresh produce. Much of the fresh produce in the Gulf region is air-freighted from Europe and South Africa, and can account for 7 to 8 kg CO_2 emitted per kg fresh produce (Caplow, 2009). These case studies – as well as that of Astee and Kishnani (2010) – demonstrate the feasibility of a rooftop farm to provide adequate produce locally, and in so doing can give effect toward reducing CO_2 emissions related to intricate food chains. There are however cautions on such use of statics. Since methodologies and statistics for CO_2 footprints have not yet been quantified or thoroughly refined. There is a tendency then for many authors to logically infer findings from other studies onto their own (Specht et al., 2014). This however will not create accurate results, since there are many factors that must be taken into account, such as different geographic contexts, food system composition and mechanics, as well as cultural norms and policy regulations (Specht et al., 2014).

2.5.4) Generating alternate supply chains

It has been demonstrated here, that the ability to meet urban demand for fresh produce - through urban agricultural practices – can have great potential in mitigating CO_2 emissions by reducing reliance on imported goods. Strengthening food systems in this manner, can further create opportunity in garnering a diversity of other economic benefits, besides that of reduced transport costs of fresh produce. From an urban food production and planning perspective, there are various public benefits and commodity outputs that can be generated through bring production closer to consumption (Specht et al., 2014). This is in the sense that ZFarms and RFs allow fresh produce to be grown and integrated into a variety of buildings, allowing for mixed building use (Caplow, 2009, Ceron-Palma et al., 2012, Specht et al., 2014).

In which shopping centres, restaurants, warehouses, apartment blocks, school buildings, hospitals all can provide ideal setting for Rooftop and ZFarming (Caplow, 2009, Thomaier, et al., 2014, Sanye-Mengual, et al., 2015a). Food sector urban planning can be considered a critical issue regarding a city's economy when taking into account the various food sector establishments such as restaurants, fast food outlets, supermarkets, specialty food stores, bars and food wholesalers (Specht et al., 2014). If thoroughly implemented, ZFarming activities could effectively change the existing structural arrangements of current food chains and systems (Thomaier et al., 2014, Specht et al., 2014). Integrating local food systems into urban

planning may require a great amount of effort, but could prove worthwhile in context of urban areas (Specht et al., 2014). Such novel enterprises could generate impetus toward greater efficiency and sustainability in current food networks by targeting local markets, integrating agribusiness into communities, adding value to locally produced goods, as well establishing alternate and direct links to the consumer through alternate supply chains (Thomaier et al., 2014).

In Northern America, a categorization of urban agricultural practices found that most commercial enterprises are Rooftop Farms (Ackerman et al., 2014, Thomaier et al., 2014, Buehler and Junge, 2016). Many of these ZFarms and RFs address niche markets, and tap into new and specific distribution chains (Thomaier et al., 2014). Their limited size forces farmers to focus on quality over quantity, and grow novel produce such as white aubergines, or black tomatoes, that are not widely available at commercial markets (Thomaier et al., 2014, Specht et al., 2014).The ability to be located almost anywhere in the city, above a building with various commercial and food related activities allows ZFarmers to exploit specific distribution chains without intermediaries, and form new alliances with a strong reliance on personal contacts (Thomaier et al., 2014). These alliances can be in the form of vertical or horizontal collaborations (Thomaier et al., 2014). Vertical collaborations can exist all along the supply chain, in which specific retailers, restaurants or commercial kitchens are supplied via a subscription or contractual basis. Such vertical collaborations can land a ZFarmer with a mid or long-term contract that can guarantee a reliable income over several years (Thomaier et al., 2014). In return, retailers may boast about the product origin, where by bragging rights are owed to fresh produce that is locally grown in 'extraordinary' places with novel methods (Thomaier et al., 2014). Gotham Greens in New York is currently cited as being the world's largest commercial Rooftop Greenhouse (Ferris, 2012, Thomaier et al., 2014). They have

Figure 2-9: Gotham Greens making use of Vertically Integrated market channels, in which its farm is directly above Whole Foods Market. Source: (Gotham Greens, 2018)

teamed up with Whole Foods Market (Figure 2-9), which is an organic retailer, in which all fresh produce is grown right above the premises through integration of a rooftop greenhouse with the building (Thomaier et al., 2014).

There are also various rooftop farms are supplying herbs and greens to hotels in Fairmount, Canada. Brooklyn Grange sells a third of their produce to subscribed-to-clients, a third to a retailer and a third to farmers markets (Ferris, 2012, Ackerman et al., 2014). Horizontal collaborations may also exist, amongst farmers, with scientists and researchers as well as with educational facilities. These collaborations are able to produce revenues in the form of merchandising, educational tours offered of farms, as well as provide workshops to keen hobbyists, and renting farm spaces as unique events venues (Thomaier et al., 2014). Trent University in Canada, has an educational rooftop farm, managed by students, who then supply the university kitchen with produce grown (Sanye-Mengual et al., 2015 b). Further revenues can be generated at farmers markets, where ZFarms team up with their rural counterparts to supplement additional produce to provide a greater variety of produce (Ackerman et al., 2014).

2.5.5) Engendering upskilling

A slightly more nuanced perspective on economic benefits, can also present itself through the diverse' skills needed to operate a RF or ZFarm. Since many new commercial operations are becoming increasingly high-tech, there are various opportunities for specialised job qualifications (Despommier, 2013, Specht et al., 2014, Thomaier et al., 2014). Running a computer-controlled rooftop greenhouse, may require specialist skills such as management and transplanting of seedlings, monitoring plant growth and development, distribution to greengrocer, waste-to-energy management, quality control, IT personnel, human resource management (Despommier, 2013). It is also noted that ZFarmers need to have increasingly dynamic skill sets, since it is not just the growing of fresh produce that is required, but also need to have market savvy and also project management skills, and good co-ordination between building owners, tenants and retailers (Specht et al., 2016, Specht et al., 2014, Thomaier et al., 2014). Having said that however, most Rooftop Farms are on open roofs with soil growing mediums (Thomaier et al., 2014, Buehler and Junge, 2016). There are thus not that many specialist skills, needed, in fact many of these farms are reliant on voluntary labour, provided by building tenants or willing individuals that want to have a 'farm experience in the city' (Ackerman et al., 2014, Thomaier et al., 2014, Ferris, 2012). This is in the case of Brooklyn Grange, that has over 20 volunteers, where individuals come from varied backgrounds and have permanent jobs in non-related fields such as dentistry or law (Ferris, 2012, Ackerman et

al., 2014). So, in this sense then, the concept of job creation may be a variable factor with regards to the current status quo of Rooftop Farming.

2.5.6) Social Benefits

One can consider that a Rooftop Farm provides benefits other than the actual physical production of fresh produce. These can be in the form of social services such as hobby, community building and education, which in theory could be included in a cost-benefit analysis (Sanye-Mengual et al., 2015 b). Thomaier, et al. (2014) in their study, identified 73 ZFarms between 2011 and 2012 in North America, Europe and Asia. Of which, 35 of them were deemed by the authors as being geared towards providing social benefits. 20 of the 35, were classified as social and educational ZFarms (Thomaier et al., 2014). The purpose of such farms is to communicate social and educational values to the public, where many of them can be found at schools, universities and other private or non-profit educational and social institutions (Thomaier et al., 2014). ZFarms that are oriented in such a manner, create new exciting opportunities in providing nuanced educational platforms for children (Caplow, 2009, Thomaier et al., 2014, Specht et al., 2014, Specht et al., 2016). The can provide showcases for education and learning on food production and resource cycles. For example, the Science Barge, a 120 m^2 self-sufficient hydroponic greenhouse, complete with rainwater capture for irrigation, solar panels, wind turbines and a vegetable oil furnace for warmth and electricity, and zero net carbon emissions, zero chemical pesticides and zero runoff (Caplow, 2009). This forms as a powerful environmental education facility, to over 20 000 visitors a year, many of them students from various schools and countries that tour the venue to learn about sustainability (Caplow, 2009, Specht et al., 2016). Another example is that of the Manhattan School for Children that has a 150m^2 rooftop greenhouse installed on atop a 4-storey building (Caplow, 2009). The greenhouse can accommodate a class of 35, and is equipped with a aquaponic module, in which tomatoes, pepper, lettuce, and various other vines and greens are grown, and supplied to the school cafeteria. There is also a vermiculture operation (worm farm for fertilizer), solar panel array, rain capture, and a web-based interface for data logging and display (Caplow, 2009). This impressive classroom supports learning in neology, chemistry, physics ecology and nutrition (Caplow, 2009). Integrated learning facilities such as these, can help change the traditional images of the relationship between agriculture and the urban core (Specht et al., 2014). Where children reared in concrete environments, can receive hands on practical learning on food, nutrition and resource cycles (Ferris, 2012, Specht et al., 2014). It could empower the new generation, to make educated choices on their impact on the

environment. Which may help to re-establish a certain respect and understanding of earth's natural processes in the education system, in which the farm and classroom are co-located (Specht et al., 2014).

Education need not be limited to that of the younger generation, but can also extend itself to adults. Where tours, workshops, and even just the mere presence of a nearby ZFarm or RF can raise consumer awareness by reconnecting them with their food sources (Specht et al., 2016). Through this, transparency surrounding food production can be encouraged. Activists may find great appreciation for this, since now food sovereignty and ownership of food production can be nurtured in new spaces in experimentation and creativity are made available (Specht et al., 2016). Urban Agriculture is often cited as a driver for fostering community empowerment, or in providing opportunity for city residents - especially those in low-income and underserved areas - with a means for direct engagement in food production and procurement (Ackerman et al., 2014). Community engagement in food production and access are increasingly being seen as a social just issue (Ackerman et al., 2014, Specht et al., 2014). Community empowerment through ownership of food production, can become a powerful symbol between connecting production and consumption, and also in linking people with the land (Astee and Kishnani, 2010). Localised production can serve to reinforce community bonds, through providing a space by which residents may gather in mutual benefit (Astee & Kishnani, 2010, Ackerman et al., 2014). Astee and Kishnani (2010) note the small instance of elderly woman, who enjoy socialising with their friends while they maintain their buildings rooftop garden. To a community in a building, or in a city, a Rooftop Farm, or garden can provide a common social or cultural identity (Ackerman et al., 2014). In such instances, Thomaier et, al. (2014) refer to these ZFarms as being to enhance urban living quality. These farms provide building tenants with an aesthetic and recreational green space, and their development is spurred on by real-estate developers, who capitalizing on the novelty a rooftop farm provides. In this manner a building space is made more attractive and appeals to those desiring so called green and sustainable living spaces (Thomaier et al., 2014).

2.6) Impacts and considerations for RF installations

Rooftop Farming has the potential to yield a wide array of benefits, and has the ability fulfil a variety of sustainability criteria. However, RF practices are not in and of themselves sustainable if they are not managed properly or designed with the correct considerations in mind (Specht et al., 2014, Specht et al., 2016). It is important that various possible environmental, social and economic impacts are kept in mind when planning a RF installation.

2.6.1) Water misnomers

In North America, a Rooftop Farming enterprise may apply for green infrastructure grants or tax incentives, to provide additional financial assistance with regard to initial start-up or in order to sustain their operation (Ackerman et al., 2014). These financial aids are only allocated if the RF can demonstrate that it is able to impart any environmental benefits, where in storm water management is of particular concern (Ackerman et al., 2014). To this end, there are very few studies on the impacts and effectiveness that RFs have on storm water management, as well as on the resultant runoff water quality (Ackerman et al., 2014, Whittinghill et al., 2016, Harada et al., 2018). This leads to lack of clarity in terms of RFs being eligible for a grant or tax incentives (Ackerman et al., 2014). These issues are Ackerman et al. (2014) and Whittinghill et al. (2016) who investigate the runoff water quality, and Harada et al. (2018) who explores the efficiency in storm water mitigation. All three studies were conducted on the Brooklyn Grange Rooftop Farm in New York, The reason for this – although not expressly stated – is because this farm is the largest soil based open rooftop commercial operation to date (Kumpf, 2014).

Both Ackerman et al. (2014) and Whittinghill et al. (2016) concluded that although there us a higher than normal presence of nutrients in the runoff – namely Nitrates, Potassium and Phosphorus – it can be considered within safe levels. Nutrient levels detected, were lower than compared to extensive green roof systems, and many macro and micro nutrients were within stipulated limits (Whittinghill et al., 2016). It was noted that the operator for Brooklyn Grange had been using higher than recommended application rates for fertilizers, this issue then could further mitigate and improve the runoff water quality (Whittinghill et al., 2016). Harada et al. (2018) who investigate the water retention ability of the farm, found that it performed rather poorly in mitigating storm water. The reason being was due to the operator irrigating the soil more than what was perhaps necessary. The result was a continuous discharge of water from the RF in to the city's sewer system. Due to this constant irrigation, the saturated soil would then retain very little rain water in the event of precipitation, and so would discharge 96% of the rain water received (Harada et al., 2018). This compares rather poorly to the retention ability of 50-80% that green rooftops and other soil-based RFs are cited to have (Whittinghill et al., 2016, Harada et al., 2018). In addition, Brooklyn Granges makes use of municipal water, and so is a net contributor to the sewerage system, and so does nothing towards mitigating storm water (Harada et al., 2018).

Furthermore, the use of city water means that the RF is thus in competition with the cities demand for water, which reflects poorly during times of drought (Ceron-Palma et al., 2012, Harada et al., 2018). Consequently, there is then need for any RF to be cognizant of these impacts, in which runoff is properly captured, and re-used for irrigation (Ceron-Palma et al., 2012, Sanye-Mengual et al., 2015 a, Harada et al., 2018). This is imperative, if the goal is to impart any sustainable benefits, this especially since doing so would enact benefits twofold. In which there would be actual and effective storm water management, as well as there being adequate water recycling taking place, where in any negative impacts with regard to nutrient leeching would be made null.

2.6.2) Material considerations

Further environmental impacts can also exist in the form of acquisition of materials. Rooftop greenhouses must be constructed of light weight and strong materials, so as to meet load bearing capacity requirements of the building and remain sturdy against winds (Ceron-Palma et al., 2012, Sanye-Mengual et al., 2015 a, Eigenbrod & Gruda, 2015). Other materials would also be that of PVC piping for hydroponic setups, and also LEDs for indoor lighting (Eigenbrod & Gruda, 2015). In context of this, and the possible need to import such goods, there is a recommendation that there be a need for Life-Cycle assessments to be included in the planning process of RFs. With RFs and Rooftop Greenhouses still being quite new, there is a need to quantify any environmental burdens attributed to their increased use from cradle to grave (Ceron-Palma et al., 2012, Sanye-Mengual et al., 2015 a). Such impacts can be reduced through upcycling discarded goods, such as wooden pallets or safe to use PVCs.

2.6.3) Contamination and Health

With regard to greenhouses and commercial CEA's, the idea is to maximize efficiency through maintaining high density yield of produce per square metre. The close proximity of edibles with one another, can make them susceptible to parthenogenic cross contamination, where disease could rapidly spread through an entire crop (Ferris, 2012, Despommier, 2013, Specht et al., 2014). With some farms benefitting from additional revenues through workshops and tours, CEAs in this instance are constrained in this manner, since they may require stringent hygiene protocols similar to that of a commercial kitchen. This means that workers might have to done on sterile uniforms whenever they enter a grow room, and access would have to be restricted to visitors (Ferris, 2012). Open rooftop farms are not immune contamination either, as pathogens can exist in soils. In any such event, the contamination of a farms soil would necessitate the removal and replacing of the entire soil medium used (Specht et al., 2014, Grard

et al., 2018). To avoid this, sterilised Technosols can be used, although this may not be altogether ideal, since these soils do tend to have poor nutrient retention abilities (Grard et al., 2018).

In keeping with food contamination, there is little research on the health impacts of growing and consuming edible produce in the city (Specht et al., 2014, Thomaier et al., 2014, Liu et al., 2016, Specht et al., 2016). Soils in the city have higher heavy metal concentrations such as Lead, Arsenic, Cadmium, Chromium and Mercury (Liu et al., 2016, Grard et al., 2018). Furthermore, there is also risk that pollutants present in the city are may also be absorbed by the leaves or fruit, which would then be consumed (Specht et al., 2014, Liu et al., 2016). A study conducted in Guangzhou, China by Liu et, al. (2016) found however that the height of the building was favourable in minimising pollution contamination, in which further mitigation could take place if a greenhouse had enclosed the vegetation. The study found that the produce grown in the city, heavy metal levels well below the criteria, and had better results than produce that was marketed as being pollutant free. Other studies conducted in Hangzhou, China, and Paris, France also confirmed that there was minimal uptake of heavy metals from atmospheric and soil contaminants by plants grown on city rooftops (Liu et al., 2016, Grard et al., 2018). It was further found that in cases wherein soils were used as a growing medium, the inoculation of the soil with certain species of earthworms into the soil would greatly reduce the presence of heavy metals in the soil and further reduce levels of pollutants within the plants (Grard et al., 2018). In addition, the use of anaerobic biodigesters, and filters used for hydroponics or recycling water can effectively prepare recycled greywater for safe irrigation use of edible produce (Specht et al., 2016).

2.6.4) Impacts to social structure

It is always important to be conscious of the dynamism of the social environment within the urbanscapes. This especially in the sense that any addition of a disturbance, may create ripples within the fabric or a city's community. In large cities, like in New York, there exists disparities in the urban agricultural system, where there are potential negative impacts that are experienced by individuals and communities (Specht et al., 2016). These issues are related to ease of access to funding from government grants, in-kind assistance and also access to information regarding these opportunities (Specht et al., 2016). The trend towards being organic, and the success of the industry is largely linked to issues surrounding gentrification (Specht et al., 2014, Thomaier et al., 2014, Specht et al., 2016). Many commercial and image-oriented RF and ZFarm practices may engender exclusion and inequality through their drive to provide high value products,

which are targeted toward premium restaurants (Specht et al., 2014). These products are grown to provide profit, and not necessarily sustenance, where herbs such as basil, chilli, microgreens or bell peppers, fetch higher prices per kg/m^2 than more practical food goods like spinach or lettuce (Specht et al., 2014, Sanye-Mengual et al., 2015 b, Liu et al., 2016). The implication then is that may RFs fail to fulfil social justice issues that food activists are advocating them to be able to do and could perhaps worsen such issues like food deserts through social exclusion (Specht et al., 2014). Furthermore, should the RF and ZFarm phenomena take hold on a massive scale, there could be a risk of job displacement from farmers living in rural areas (Ceron-Palma et al., 2012, Specht et al., 2014). Although this impact does require consideration, it is perhaps not that likely, in light of the point made earlier with regard to their focus being on profitable crops over practical ones. Since rural farms have the luxury of space, there is always opportunity for these farms to diversify into other market demands, or could also tap into other markets through exportation.

2.7) Challenges and risks in Rooftop and Zero-Acreage Farming

Through using building stock instead of rural farmland or vacant land parcels, there are distinct opportunities and challenges that come into play. This is with regard to building-related challenges, technical constraints, regulatory frame-work uncertainties and also hesitancy from involved stakeholders (Thomaier, 2017). There are many barriers that Rooftop Farming must over-come, and perhaps the greatest of which is the fact that this practice is in relative infancy. There still many uncertainties surrounding various spheres that involve Rooftop Farming, such as consumer perceptions, its economic feasibility as well any environmental and social impacts that it may have (Ceron-Palma et al., 2012, Ackerman et al., 2014, Thomaier et al., 2014, Specht et al., 2014, Eigenbrod and Gruda, 2015, Sanye-Mengual et al., 2015 b, Whittinghill et al., 2016, Liu et al., 2016). The viability of urban agriculture and RF practices, in terms of the degree to which it is afforded political and cultural support, is to an extent dependent on perceptions of its ability to engender a significant impact on local food availability and security (Ackerman et al., 2014, Specht et al., 2016). To add to this, the ability to garner a reasonable return as an investment will also be an important factor with regard to its diffusion into the urban system (Sanye-Mengual et al., 2015 b, Specht et al., 2016, Liu et al., 2016, Thomaier, 2017).

The introduction of innovation may often be received with varied levels of resistance as it makes its way through its initial development phase (Specht et al., 2016). It is an entirely new form of agricultural production that is being introduced into the urbanscape, in which the

production of food will not take place ‘somewhere in the countryside’ (Specht et al., 2016). New groups of actors will be confronted with the task of integrating agriculture into the city. Wherein many such actors are not familiar with the topic of agricultural production. Involved stakeholders and parties may comprise real-estate owners, urban planning departments, architects as well as city political leaders or public servants (Thomaier et al., 2014, Eigenbrod and Gruda, 2015, Specht et al., 2016, Buehler and Junge, 2016, Thomaier, 2017). It is in this way that perceptions and social acceptance of ZFarming and RF, are vital precursors to its ultimate success or failure for its eventual wide-spread uptake (Specht et al., 2016, Sanye-Mengueal et al., 2016). It is this context of acceptance then, that RF must navigate and find place between the interconnected relationship of supply and demand. Where in the consumer must be willing to support the RF industry and its associated products and services. To which the producer must also be willing to take on the financial risk, and commit to ensuring a sustainable and profitable product or service.

2.7.1) Consumer hesitancy

A potential economic risk is the acceptance of customers for hydroponically grown produce, especially given that studies conducted in Berlin and Barcelona have indicated that consumers are critical of soilless growing methods (Specht et al., 2016, Sanye-Mengueal et al., 2016, Thomaier, 2017). Many studies report that implementing UA in buildings is much easier when hydroponics or aquaponics is opted for (Specht et al., 2016). Such new concepts in agricultural production clash with the preferred images of what traditional agriculture entail, where soilless growing is considered to be ‘unnatural’ (Specht et al., 2016). In many countries, hydroponically grown produce does not qualify for organic certification (Buehler & Junge, 2016). This true for many countries in Europe such as the Netherlands, the United Kingdom, Germany, France, Italy, Spain and Switzerland, as well as for other countries like Canada, Mexico, Japan and New Zealand. The US is currently one of very a few that allows for organic certification for hydroponic farming (Buehler & Junge, 2016). In hydroponics, there is a need to supplement, and add nutrients to the system, to enhance plant growth and development. These added nutrients are mostly macro and micro nutrients that plants naturally obtain from the soil, however when added in nutrient form they are obtained through mining, and so are in essence non-renewable (Buehler & Junge, 2016). This is why there is difficulty in obtaining organic certification. It should be noted however, that most RF’s in operation are soil based open rooftops (Thomaier et al., 2014, Buehler and Junge, 2016). In these cases then, it can be

considered that produce grown from these operations are indeed naturally grown (Buehler & Junge, 2016).

In the case of hydroponics, nutrient recycling through bio-digesters, and also integrating organic waste obtained from fish used in aquaculture, can strengthen legitimacy in organic practices (Specht et al., 2016, Buehler & Junge, 2016). That being said, in the case of Berlin, would-be consumer and stakeholders are sceptic as to the actual need for RF ad ZF in the city, and Germany as a whole (Specht et al., 2016). The reason being, is because UA is not considered real farming, in the sense that it may be viewed more as a novelty than as tool that can contribute to food security. There is thus the perception that its adoption may be better suited to cities that are densely populated and are not surrounded by arable farmland, in which it might find better place in cities that are afflicted by food deserts and inadequate access (Specht et al., 2016).

To further to the negative and critical perceptions of RF, are concerns over food contamination (Ceron-Palma et al., 2012, Thomaier et al., 2014, Specht et al., 2014, Sanye-Mengual et al., 2015 a). This is in the sense that many studies have found that would-be consumers are hesitant to purchase fresh fruit and vegetables grown in a city, where there are high levels of pollution, and risk of soil and water contamination (Specht et al., 2016). Various studies have concluded that cities grown on rooftop spaces yield negligible levels of pollutants in the edibles, where these results could be further improved by growing the produce in an enclosed greenhouse (Liu et al., 2016).

2.7.2) Investor Scepticism

The economic feasibility of a large commercial Rooftop Farming operation has not yet been fully investigated, wherein long-term studies regarding their profitability are lacking (Specht et al., 2016). Perceived economic problems exist in the form of high initial investment and operation costs (Specht et al., 2016). Many RFs require some form of retrofitting or upgrading of the rooftop surface. In which it may have to be waterproofed, refitted for adequate drainage installed, or might require additional equipment costs depending on how ‘High-tech’ the RF is intended to be (Astee & Kishnani, 2010, Ceron-Palma et al., 2012, Specht et al., 2014, Thomaier et al., 2014). In addition to this there is often a need to hire external expertise, where consultancy costs can become unexpectedly high. Then there is the need to consider the limited space availability, that force many RFs to produce low yield outputs which then often require specific distribution channels (Thomaier, 2017). The lack of straightforwardness dissuades

investors from venturing into RF enterprises, this with high capital inputs do not bode very well for RF practices. Especially in light of studies indicating that many of them currently in operation are struggling to maintain economic viability (Thomaier et al., 2014). To further emphasis these difficulties is the fact that it is oft cited that stakeholders do not perceive RF installations as yielding high profits, wherein the return of investment has a long repayment (Ceron-Palma et al., 2012, Thomaier et al., 2014, Specht et al., 2016, Liu et al., 2016). While Sanye-Mengual, et al. (2015 b) find that certain RF production techniques such as Nutrient Film and Float Technique yielded worse than their rural in-ground counterparts, Specht et al. (2014) and Liu et al. (2016) disagree. Liu et al. (2016) finds in their own trial in Guangzhou China, that RFs could be quite competitive with commercial farming. Specht et al, (2014) cites that there are various low-tech and high-tech examples that can profitable in most cases. With regard to the study conducted by Sanye-Mengual, et al. (2015 b), the main reason that their findings reflected poorly against in-ground agriculture was because municipal water was used for irrigation. Water used in city area are often charged at higher tariffs than in rural areas. Installation of rain or grey water collection can offset such costs and boost competitiveness. Although adequacy of rain water amounts is geographically dependent, where there are concerns that arid regions such as in the Mediterranean may not yield enough water needed for irrigation (Sanye-Mengual et al., 2015 b). Having said that, profitability of RFs is somewhat reliant on a 'density boost', where a RF situated in a densely populated may stand a better chance of generating worthwhile economic return (Specht et al., 2016). It is further noted that economic success is often more likely when there is emphasis placed on secondary outputs provided by the RF such as tours, workshops and merchandise (Thomaier et al., 2014, Specht et al., 2016).

Real-estate stakeholders however, stress the importance of economic viability in their investments, which they cannot see being fulfilled by RFs (Specht et al., 2016). It is for this reason that rooftop space, is in competition with other rooftop uses such as that for renewable energy production as provided by photovoltaic (PV) panels (Ceron-Palma et al., 2012, Thomaier et al., 2014, Specht et al., 2016, Thomaier, 2017). Since the return on investment for PVs is easily realised through offsetting electricity costs, use of PV presents itself as a safer option. Especially since the installation and use thereof is fast becoming well established and is better supported in legislature (Specht et al., 2016, Thomaier, 2017). It is perhaps however, a misnomer that a landlord or real-estate stakeholder must choose between one or the other in terms of an RF and PV installation. There are options in which a greenhouse facility can

accommodate Solare panel integration (Sanye-Mengual et al., 2015 a, Specht et al., 2016). Although such integrated installations of PVs and RFs (in the form of a greenhouse) are not easily found, and so there is a ned to create compatibility which can increase the financial input (Specht et al., 2016).

2.7.3) Technical Difficulties

Due to the dearth of exisiting models and high degree of innovation, the planning and implementation process is often complex especially with regard to lack of technical expertise and experience (Ceron-Palma et al., 2012, Thomaier et al., 2014, Specht et al., 2014). Specht et al. (2016) found that real-estate developers consider there to be a lack of proffessionalism within the UA bussiness entrepreneurs. Real-estate stakeholder perceptions jad negative views og agripreneurs, in which terms like 'freaks' 'weirdos' and 'dreamers' are used to describe them. It was criticized that there was a lack of knoweledge that young innovators had regarding setting up and maintaining RF of ZFarm projects (Specht et al., 2016). Overcoming the technical challenges related to cultivating edible produce in the built environment requires interdisciplinery co-operation, where there is a need to intergrate all areas of competency (Specht et al., 2014, Thomaier et al., 2014, Sanye-Mengueal et al., 2016, Specht et al., 2016, Thomaier, 2017). For low-tech operations, initiators may be able to carry out planning and implementation on their own. More sophisticated installations however, need extensive planning and management where all stakeholders are involved and various stages of the pjoject timeline (Thomaier et al., 2014). Where stakeholders are made up of the initiators, building owners, devolopers, engineering consultants, building businesses, investors, operators and public servants (Thomaier et al., 2014). The better model for implementation is one in which there is a single contractor, who has a full sprectrum knowledge of RF and ZFarm planning and implementation. Due to the complexity of the planning and implementation process and the fact that there is still experience lacking in this field, there are still many hurdles that must be overcome before a streamlined process is developed (Thomaier, 2017). In some cases an RF has taken between 3-4 years to complete, from initial planning to completed design, as knowledge building took place among the stakeholders, a projects installation could be reduced to be completed withing a year and a half (Thomaier, 2017).

Aside from financer and proffessional considerations, there is also need to take into account the more practical and basic requirements for setting up a RF. These are contextual factors such as site location and building applicability (Ceron-Palma et al., 2012, Sanye-Mengual et al., 2015 b, Thomaier et al., 2014, Thomaier, 2017). There are also design requirements too, in the

sense that an RF in many cases must conform to the space that it is given. With this being the case, the design of the installation is thus dependent on the building it is being applied to. Designs therefore must be flexible and dynamicm since building contraints such as carrying capacity, slope, location, regulations and accessibility come into the fore (Specht et al., 2014, Thomaier et al., 2014, Sanye-Mengual et al., 2015 a, Thomaier, 2017). These factors may largely depend on what the intended outcomes of the operation are, whether the conceptual layout is of a high or low-tech design, and also if the farm will be run as a soil-based or soilless operation. With regard to this the most relevant criterion is if the RF will function as being a commercial or non-commercial enterprise, and how its operational activities would be organized (Thomaier, 2017). In the case of the RF or ZFarm being commercial there is then a minimum growing area required depending on the growing methodology is used, since this would determine the payback period on initial financial input (Sanye-Mengual et al., 2015 b). Where a non-commercial farm is able to fit into more contorted spaces, a commercial RF would need a homogeneous rooftop space, with minimal slope to enable efficient large scale prodoction (Sanye-Mengual et al., 2015 b, Thomaier, 2017). The site location of an RF is particulalarly important especially if a greenhouse is to be installed. This since the design of the greenhouse must take into consideration any nuisances that it may produce that could impact onto adjecent buildings. Where these would be in the form of light reflections produced during the day, or artificial light that may disturb nighbours at night (Thomaier, 2017). In this way RFs must not interfere with their immediate environment, nor with other uses taking place in the building (Astee & Kishnani, 2010, Specht et al., 2016, Thomaier, 2017). If a commercial grow-op were to be installed there must be consideration of the flow of material and people within the building space, so as to facilitate efficiency of the buildings activities and of the RF itself (Astee & Kishnani, 2010). There must then be dedicated causeways and vertical access made available, for the eeffortless movement of equipment and produce, and to ensure there is little disturbance made on the everyday activities of the buildings tenants (Astee & Kishnani, 2010). A commercial operation may require further alterations made to the building space to accomdate related activities such as packaging, storage and processing, as well as to allow for onsite logistics, parking and dedicated throughways for delivery vehicles (Astee &Kishnani, 2010, Thomaier, 2017).

There is then the issue of the roof itself, in which the material and structure of the rooftop must be able to accommodate the load requirements of the RF (Ceron-Palma et al., 2012, Sanye-Mengual et al., 2015 b, Thomaier et al., 2014, Thomaier, 2017). In light of this load capacity,

it is fortunate that many greenhouse designs are able to made within light-weight sepcifications in which the average load is within the range of 8-12 kg/m^2 and can still remain failry strong (Ceron-Palma et al., 2012, Sanye-Mengual et al., 2015 a). In the case where there is need for heavier materials, or the application of a soil growing bed, there is then a need for specialist studies, where GIS and field collection of the buildings structural data is needed to select an appropriate rooftop (Sanye-Mengual et al., 2015 a). Reinforced concrete provides a stabile structure for RF operations, and ensures the strength needed for such an installation. If a rooftop is not strong enough, there is then a need for retrofitting additional structural reinforcements. This can only really take place with the owners consent, and within financial feasibility (Thomaier, 2017). In addition to this, the ability for RF's to engender synergies within a buildings energy and water flows cannot be fully exploited in many city structures. In many cases the urban building stock of today is not yet compatable with the innoavtions that RFs embody. These expensive additional benefits are thus more likely to be realised if the buildings owners already are planning to renovate, or if the RF is incorporated into the construction of an entirely new building (Thomaier, 2017).

2.7.4) Regulatory and Legislative contexts

The last of the challenges that Rooftop Farming faces is in the form of building regulations and legislative frameworks. While much of this relates to specific cities within the Global North, they still provide context as to the barriers that that RF as a global phenomenon are faced with. Regulations can be applied at different levels with regards to different legislations, but the issues that these regulations relate to and the associated challenges remain the same (Thomaier, 2017, Delshammar et al., 2017). This in the sense that they are mainly relevant to zoning, building codes and various related ancillary regulations (Thomaier, 2017, Delshammar et al., 2017). The installation of a RF may add a new building, in which an agricultural activity is added into a residential, commercial or industrial zone. These instances however mostly concern an enterprise that is geared toward large scale commercial production of edibles (Thomaier, 2017). The reason being is because some municipalities do not have zoning codes which permit the practice of farming within all land use zones (Thomaier, 2017). This then adds to the hinderances for integration of commercial RFs within city areas. There are also regulatory constraints with regard to a buildings height, in terms of the number of floors that it may have, as well as its floor-area-ratio – where these apply to both open rooftop and greenhouse installations (Sanye-Mengual et al., 2015 b, Thomaier et al., 2014, Thomaier, 2017, Delshammar et al., 2017). Whereby many buildings have already reached the maximum criteria

for this, and in some cities the addition of a greenhouse is considered as an additional floor (Thomaier, 2017). There are also various by-laws that may also come into play, which can influence the applicability of a RF atop a building site (Thomaier, 2017). These are issues relating to the distance from neighbouring buildings, fire and safety regulations, energy issues, wind load resistance, load capacity and parapets (Sanye-Mengual et al., 2015 b, Thomaier, 2017). Furthermore, there are indirect regulations which a RF must adhere to with regard to noise, odours produced, light and glare effects (in the case of greenhouses) and also waste disposal (Kumpf, 2014, Thomaier, 2017). Lastly, there must be considerations made regarding the building's heritage, and how the RF installation may impact on it (Thomaier, 2017).

In the case of Berlin, stakeholders were uneasy about the difficulties involved in reconciling the compatibilities between building legislature and RF installations. RFs have not been subsumed into building law, and so there is much confusion as to which official or department should be approached regarding its implementation (Specht et al., 2016). Stakeholders also found it difficult to support RF practices, especially since real-estate policies did not support practices that produced the highest possible profit (Specht et al., 2016). It was further noted, that there was a lack of consistency regarding building laws in context of RF installations, and navigation of the legal frameworks proved difficult due to the stringent requirements (Specht et al., 2016). There are however some positive case studies, in which the implementation of various pilot RFs has encouraged the legitimacy of the practice, where there is an impetus being generated toward legislative changes (Kumpf, 2014, Sanye-Mengueal et al., 2016, Thomaier, 2017). Where cities such as New York and Boston, have made amendments to propagate RF and ZFarm practices for educational and commercial applications. New York has also allowed for changes in legislature so that if a greenhouse meets certain regulatory requirements, it can be exempt from building height and area-floor-ration restrictions (Thomaier, 2017). Chicago has also made amendments, where commercial RFs are to be included into its zoning codes (Thomaier, 2017)

2.8) Conclusion

The literature has framed the dissertation in context of growing urban populations – particularly those within the developing regions of Sub-Saharan Africa. As these cities continue to become burdened by a populous living in poverty, there are increasing exigencies related to food security and malnutrition. Urban Agriculture is thus Urban Agriculture is a practice which is expected to reduce such food related pressures. Herein Rooftop Farming is presented as form of Urban Agriculture. In which it as an agricultural practices does not make use of actual land, this characteristic then opens up an array of opportunities with regards to integrated architecture. The integration of Rooftop Farming into the built environment can have many potential benefits with regards towards sustainability, in which it can contribute mitigation and adaptation against climate variability, and can help strengthen food systems at large. It is however still in the process of development, and so it's new entry as an Urban Agricultural practice still presents the industry with many challenges.

Hereafter, the dissertation will analyse and explore the policy contexts which may be applicable to Urban Agriculture and Rooftop Farming, so as to determine if there are any policy measure which may serve to support the practice – whether directly or indirectly. Policy frameworks from the National, Provincial and Municipal levels are looked at for each of the identified municipalities relevant to the research – these being the eThekwini Metropolitan Municipality (EMM), the City of Cape Town (CoCT) and the City of Johannesburg (CoJ).

Chapter Three

3) South Africa's Agricultural Policy Context

State policies are important in regulating and promoting certain activities within a country. The lack or presence thereof can stagnate, or foster development of a given activity in which ever sphere it occupies whether economic, social or environmental. This is especially true for Rooftop Farming, and by extension Urban Agriculture. What follows then, is an attempt to articulate policy drivers that exist within the varying forms of governance, that may serve to support the development of Rooftop Farming, or Urban Agriculture. In South Africa, at a national and provincial level, there exists no policy or legislative framework that is specific to urban agricultural activities. This section, first outlines what laws pertains to food security, and then has taken what may be relevant or appropriate to urban agriculture, in which certain policy outcomes may serve to promote or support its development through indirect means (Drimie, 2015; Malan, 2015; Rogerson, 2010). Urban Agriculture and Rooftop Farming inhabit and touch on many spheres of relevance, in which they can be seen as a food production activity, or a job creation opportunity, they can be interpreted as building resilience, in which they can be included in mitigation or adaptation outcomes (Ackerman, et al., 2014; Eigenbrod & Gruda, 2015). In this then, with a lack of specific policy contexts, one should consider as many relevant options as possible.

3.1) United Nations context

The right to food holds a government responsible for the provision of food that is acceptable to a given culture, in which its supply is sustainable – both in the environmental and economic sense – and that the access to food is not in interference with other human rights (Hendriks & Olivier, 2015). This right to food has been set out in 1948 in the Universal Declaration of Human Rights. It is also in the International Covenant on Economic, Social and Cultural Rights of 1966, in which it states that parties recognise that the right to food is part of the right for everyone to an adequate standard of living, in which this includes sufficient food, clothing, housing and also to the continuous improvement of living conditions (Hendriks & Olivier, 2015).

This has then been emphasised through the signing of multiple international states of the Millennium Development Goals (MDGs), which served as a global framework for working toward eradicating poverty and achieving equitable development (Skinner & Mersham, 2008;

Malan, 2016). The MDG framework was set about in 2001, in which signatories committed themselves to achieving targets set out in the form of 8 goals, where progress was measured by 18 targets (Lomazzi, et al., 2014; Hendriks & Olivier, 2015) . The MDGs came to a close in 2015, and were later replaced by the Sustainable Development Goals (SDG), which were adopted at the United Nations (UN) in 2015 (UN, 2015). Similarly the SDGs consists of achieving time bound targets, in which the goal is for member states to achieve outcomes by 2030 (Malan, 2016; Rosati & Faria, 2018).

Some goals that may be relevant to supporting urban agriculture and rooftop farming – but not limited to – goals 2, 8 and 9. The outcome for Goal 2 is for the end to hunger, where food security and improved nutrition is achieved through promoting sustainable agriculture. Goal 8 is for the promotion of sustained, inclusive and sustainable economic growth, in which there is productive and decent work for all. While Goal 9 is for the building of resilient infrastructure, in which inclusive and sustainable industrialisation is prompted to foster innovation. Other goals that are applicable are Goal 1, which calls for an end to poverty, Goal 3 whose outcome is for the promotion of healthier living. Other goals are more specific to the environmental elements that urban agriculture and rooftop farming could contribute towards. These goals are 11, 12, 13 and 15, in which Goal 11 applies to building safe communities that are sustainable and resilient, Goal 12 is for sustainable consumption and production, 13 calls on urgent action against climate change and its impacts, and then lastly the 15th Goal focuses on the protection and rehabilitation of various ecosystem and biodiversity contexts (Malan, 2016; UN, 2015).

3.2) The right to food in South Africa

South Africa is fortunate to be a net exporter of food, and is able to provide food security at a production level or through covering costs for imported goods (Malan, 2015; Hendriks & Olivier, 2015; SACN, 2017). This is largely owed to the production of cereals by commercial farmers, which is responsible for sustaining the countries positive food balance (DAFF, 2013; Hendriks & Olivier, 2015; Drimie, 2015). While it may be that South Africa is food secure at a national level, the same is not true at the household level (Battersby & Marshak, 2013; Hendriks & Olivier, 2015; SACN, 2017; Malan, 2015). The South African National Health and Nutrition Examination Survey (SANHANES) conducted a large-scale national assessment of food security in 2013 and found that only 45,6% of South Africans are food secure. Where 28,3% of the country's inhabitants were at risk of hunger, and 26% were experiencing hunger (SACN, 2017). Food security has improved since the 1990's, but there still remain challenges to addressing the issue at large, in which food security has not shown much improvement since

2008. While this can be attributed to the global financial crisis, and a series of climate shocks (DAFF, 2012 c; DAFF, 2015; Hendriks & Olivier, 2015). Another issue can also be rooted uncertainties relating to secure land tenure and related political uncertainties, these have served to undermine the agricultural context in terms of food security (Hendriks & Olivier, 2015; Battersby, et al., 2017).

The right to food is expressed as two parts in the Constitution where 27 1 (b) states that "every citizen has a right to access to sufficient food and water", and that "the State must take reasonable legislative and other measures, within its available resources, to achieve the realisation of this right". Herein the Constitution obliges the State to protect the right to food and ensure that existing access to food is not compromised, or that opportunities for improvement are not purposefully hindered. While this constitutes a negative duty, the State is then obliged to actively promote the adoption of relevant legislature that would fulfil the right. It further enforces through Section 28 1(c) where "every child has the right to basic nutrition, shelter, basic health care services and social services", and then finally Section 7 (2) "State must respect, protect, promote and fulfil the rights in the bill of rights" (DAFF, 2012 a; Malan, 2015; Drimie, 2015; Hendriks & Olivier, 2015).

The duty of ensuring food security for the country is entrusted to the DAFF, however, whilst the Constitution holds the State accountable for ensuring that these rights are not compromised and are enforced through legislature, it should be noted that the only legislature dealing with food security is the Marketing of Agricultural Products Act 47 of 1996 (Hendriks & Olivier, 2015). This Act relates to the regulatory framework regarding the establishing and enforcement of regulations related to the marketing of agricultural products. The Act plays a direct role in food security in terms of safeguarding against statutory measures, which may impact on food security and employment. It should be noted that this is a negative duty, so does not necessitate government to act on food security but rather ensure that it is not compromised (Hendriks & Olivier, 2015).

The most influential policy making instrument regarding food security is perhaps that of the Reconstruction and Development Programme (RDP) (DAFF, 2012 b). The RDP was implemented as a tool to address issues relating to poverty and inequality due to entrenched disparities (RSA, 1994; DAFF, 2002; DAFF, 2012 a; DAFF, 2012 b; Hendriks & Olivier, 2015). As one of its many objectives, the only one that pertains to food security relates to the need for Agriculture to "develop rural communities, society at large and the national economy"

(RSA, 1994, p. 53). Development in a manner that would sustainably enhance income, food security, employment and quality of life. Programmes outlined to fulfil this all relate to improving production, and broadening access for entrepreneurial development. Through this the RDP also mandated for the implementation of related legislative programmes, one of them being the Agricultural Marketing Act, and the other -which would relate to food security- is the White Paper on Agriculture, which was released in 1995 (RSA, 1994, p. 53; DAFF, 2012 b; DAFF, 2012 c; Hendriks & Olivier, 2015).

To date this White Paper remains the principle guiding document in terms of food security and food production for the Department of Agriculture Fisheries and Forestry (DAFF) (DAFF, 2012 c; Hendriks & Olivier, 2015). It relates to availing economic access to entrepreneurial farmers, and the development of financial services to resource poor farmers. It also relates to the brooding of access to agriculture through land reform (DAFF, 2012 b; DAFF, 2012 c; Hendriks & Olivier, 2015). It further states that food security is an issue that is important at both national and household level, and that it is to be addressed in a multi-departmental approach. Furthermore, it encourages various measures such as urban food gardens, and small-scale production for household income and food security (RSA, 1995).

While this is said in political rhetoric, the overarching aims for the White Paper emphasis objectives mandated by RDP. In which issues surrounding poverty, job creation and land reform are emphasised. In this way, the DAFF is to ensure food security though the provision of access to secure land tenure, job creation and capacity building. In order to bring into action requirements stipulated by the constitution, the RDP and that of international obligations, Cabinet launched an updated national food security strategy (DAFF, 2002). The aim of this was to streamline and integrate various food security sub-programmes in a singular framework – the Integrated Food Security Strategy (IFSS) (DAFF, 2002; Malan, 2015). The vision of the IFSS was to engender 'universal physical, social and economic access to sufficient, safe and nutritious food…" (DAFF, 2002, p. 13). It set forth food security and food access goals, in particular increasing household food production and trading, improving income and job opportunities and also improving nutrition and food safety (DAFF, 2002). In this one of the primary objectives of the IFSS was to mitigate rural food insecurity through increasing participation of food insecure households in contributing to the agricultural sector, in a way that was intended to spread growth and development (DAFF, 2002). The IFSS was however a failure, due to very little integration within intersectoral mechanisms, and so had not implementation or functional coordination structure (Hendriks & Olivier, 2015).

3.3) Overarching National Economic Directives

Food insecurity is perceived by Government to be a phenomenon that is the result of poverty which is most prevalent within by rural households who have been most affected by entrenched historical disparities (Battersby, et al., 2017). In this Government has then sought to redress such historical inequities through targeted economic development that aims to improve the livelihoods of the historically disadvantaged populous. In 2010, the Zuma Administration appointed the National Planning Commission to draft a vision and national development plan (NPC, 2011; Drimie, 2015). This National Development Plan (NDP) aims to eliminate income poverty by 2030 through an interdepartmental and cross-sectoral approach (NPC, 2011; DAFF, 2012 b; Hendriks & Olivier, 2015; Drimie, 2015). Since the NDP has engendered the alignment of departmental policy making since its inception, it is was seen as important to include so as to better understand the policy context for Urban Agriculture. With food insecurity being viewed as a symptom of poverty, the NDP is thus applicable to Urban Agriculture due to income generating opportunities that can be made through this activity.

3.3.1) National Development Plan

The NDP is responsible for being part of shaping a response by the DAFF to create an enabling environment for food security – this amongst other responses. Since 2012, the NDP has become an overarching development agenda for most government departments. Agriculture has been identified through the NDP as being primarily an economic activity within rural areas. In which the sector has the potential to produce a million new job opportunities by 2030 (DAFF, 2013; DAFF, 2015; NPC, 2011). To achieve this, the NDP has identified key activities as needing attention. In particular, expanding irrigated agriculture from 1.5 million hectares by another 500 000. This would be done by consolidating underutilised land in communal areas for commercial production. In addition, the NDP advocates for selecting and supporting agricultural sectors, and regions in the country that show the greatest promise for commercial growth and employment (DAFF, 2014; DAFF, 2015). The NDP, through such targeted strategies, hopes to support small holder and subsistence producers by stipulating that a third of the national food surplus be produced by emerging farmers. To help realise this, the DAFF, in their 2015 – 2020 strategic plan, has put forth various strategies to improve the production efficiencies of small holder producers. These strategies include organising smallholder producers into community-based organisations, strengthening their collective bargaining power in the market and providing support and training for Small Micro and Medium Enterprises (SMMEs) (DAFF, 2015). The NDP further calls for greater investment in the

agricultural and agro-processing sectors, areas related to SMMEs and also in fruit and vegetable production to better align the sector with guidelines for better nutrition. This call diverges from the usual development plans that place emphasis on grain crops (DAFF, 2015; Drimie, 2015). While there is a rural bias to be seen here, the NDP still makes provision for those who wish to use agriculture for income generation, and this is not necessarily limited to locality.

3.3.2) New Growth Path

The New Growth Path (NGP) places decent work opportunities, front and centre of the country's economic policy. Drafted by the department of economic development, the NGP broadly aims to unlock, and tap into private investment and job creation, by setting out macroeconomic and microeconomic interventions, so as to shift the country into an inclusive and sustainable growth (DAFF, 2014; DED, 2011). The NGP plans to achieve such a shift by creating 5 million additional jobs by 2020, and by setting key employment drivers and priority sectors, which government will focus on during the medium term. Such drivers for growth in job sectors include infrastructure, agricultural value chains, mining value chains, manufacturing, tourism, and high-level services such as within the green economy, knowledge economy, social economy, public sector, rural development and African Development (DED, 2011). The NGP aims to increase the small holder farming sector by 300 000 households which would add 145 000 jobs within the agro-processing industry (DAFF, 2015). In addition, the NGP intends to upgrade conditions for approximately 600 000 farm workers. This plan set forth by the Presidency, compliments that of the Industrial Policy Action Plan (IPAP) (DAFF, 2015; DED, 2011).

3.3.3) The Industrial Policy Action Plan

Having its origins in 2007 as the National Industrial Policy Framework (NIPF), which outlined cabinets approach to industrialisation, the IPAP reflected on actions which were considered "easy-to-do" during its 2007/08 cycle. Later this translated from "easy-to-do" to what government "needs-to-do" in order to create a new structurally sound path toward industrialisation (DAFF, 2013). Deliverables made by the DAFF, are included in the IPAP since 2010/11. These are expected to contribute towards the country's growth and development. It is the aim of the IPAP to upscale key interventions over a rolling three-year period, with a ten-year outlook on intended economic outcomes (DAFF, 2014).

The IPAP, through the NIPF sets forth to facilitate diversification of the country's economy by transforming the country's economy to go beyond its current reliance on traditional commodities and non-tradable services (DPME, 2014). In order to achieve effective transformation in this manner, the main aims for economic sectors would require a focus on promoting value addition (DAFF, 2014; DPME, 2014). Furthermore, the IPAP ensures a long-term intensification of the industrialisation process where there is movement towards a knowledge economy. Labour absorbing pathways to industrialisation will be promoted, where there is emphasis placed on tradeable labour-absorbing goods and services, which would be characterised by better participation of those individuals who have been historically disadvantaged (DPME, 2014). Agro-processing is strongly linked to South Africa's economic growth rate, as well as that of the sub-continental region. South Africa processes a number of competitive advantages in the fruit and beverages sectors. If fully utilised, these can place the country among the top 10 exporters of high value agricultural products (DAFF, 2014).

3.3.4) Medium-Term Strategic Framework

A new electoral mandate was ushered in after the 4th democratic elections, this set forth the strategic objectives and targets for government over the 5-year period of 2009 – 2014. These objectives and targets were embodied as the Medium-Term Strategic Framework (MTSF), and were brought to the fore in 2009, where they were adopted as 'MTSF priorities' (DAFF, 2014; DAFF, 2015; DPME, 2014). These MTSF priorities were translated into quantifiable deliverables during early 2010. This was done out of a need to solidify the planning and policy making process with respect to measurable outcomes. To this end, the MTSF represents governments desire to support a completive economy, the creation of decent work opportunities and encouragement of investment. The 2014-2019 period is the first MTSF cycle aimed at fulfilling the NDP principles, as outlined in September 2012 (MTSF). This first 5-year cycle is focused on completing 14 outcomes, in which 3 deal specifically to agriculture (DAFF, 2015; DPME, 2014):

- Outcome 4 is that of decent employment through inclusive growth
- Outcome 7 is a comprehensive rural development and food security
- Outcome 10, protect and enhance our environmental assets and natural resources

3.3.5) Integrated Growth Development Plan

In recent years, due to the global realities of the modern era food prices have be subject to significant inflation, and economic instability. Owing to this, there has been international concern over the volatility of food prices. This has prompted many nations, including South Africa, to re-examine, the role that agriculture plays in the economic and social sectors (DAFF, 2012 c). The Integrated Growth and Development Plan (IGDP) puts forth that the importance of agriculture must be re-emphasised within the context of the broader economic framework. In doing so, special attention must be given to ensuring food security at a national and household level, the economic growth and development of agriculture and also on rural economic development (DAFF, 2012 c; DAFF, 2014).

It is in this context that the IGDP wishes to position agriculture as being able to improve national food safety and security, as well as improving economic output in a manner that is sustainable and profitable. For the agricultural, fishery and forestry sectors, there are a number of cross-sectoral and sector specific policies aimed at managing the growth and development of the 3 sectors. The IGDP seeks to optimise the effectiveness of policies governing these sectors, where implementation is fast tracked, and where any national directives outlined within the MTSF, NDP and NGP are encompassed (DAFF, 2012 c; DAFF, 2014).

As stated in the IGDP, the primary purpose of the plan is to achieve transformation and restructuring of the AFF sectors, which it considers to be dominated by minority of large companies. It also seeks to reduce perceived constraints in areas of input supply, production and marketing by addressing these issues timeously and cost effectively. Interventions are at providing an enabling environment for the broad-based growth of the “missing middle”. In which competitiveness, sustainable resource management and strengthened, well-co-ordinated government systems (DAFF, 2014).

3.3.6) DAFF Post NDP

Following the development of the NDP and its MTSF strategic objectives, many government departments realigned their policy making and strategic plans to achieve the goals set out by the NDP. In this way, all strategic and policy documents published by the DAFF refer to fulfilling the relevant National Outcomes (NO) stipulated by the NDP. These become outcomes 4, 7 and 10 (DAFF, 2012 c; DAFF, 2014; DAFF, 2015). In this manner, the issue on food security was revised and a new co-ordinated response was developed as embodied in the "Framework for Zero Hunger Program" (DAFF, 2012 a). This programme was developed to decrease those afflicted by food insecurity, in which it resolved to improve the capability of all South African to access nutritious food (DAFF, 2012 a).

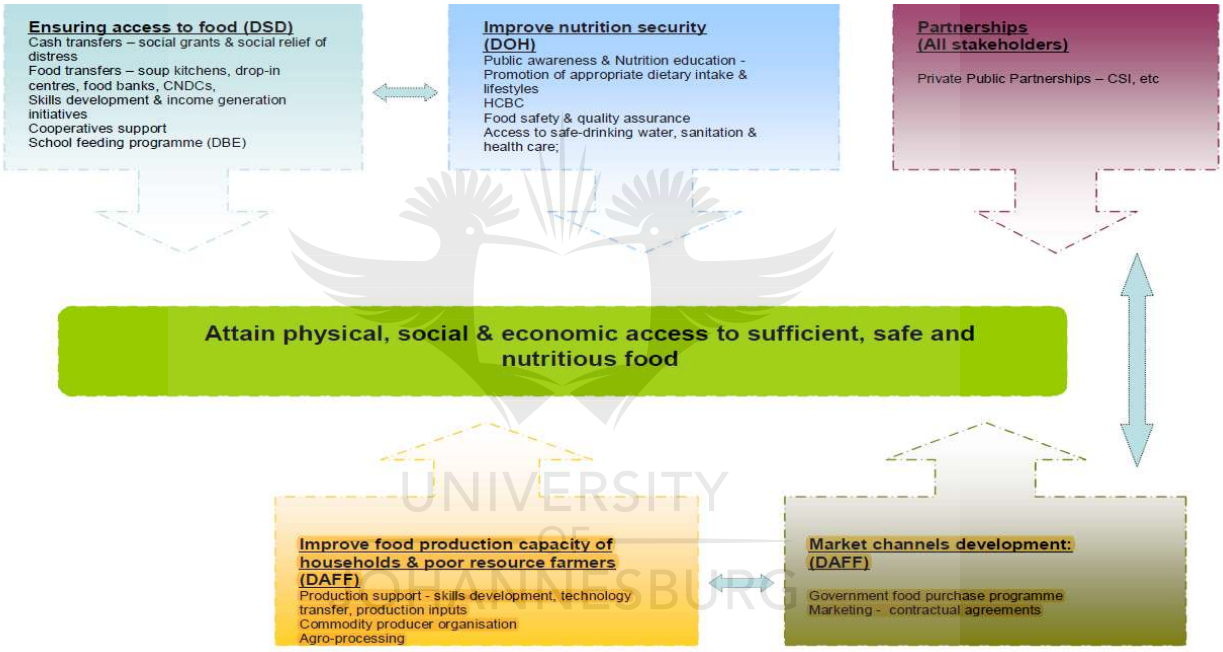

Figure 3-1: Logical Framework for the Hunger Programmer implementation and inter-departmental involvement. Source: (DAFF, 2012 a, p. 10).

The strategic objectives of the 'Zero Hunger Programme' are to ensure access to food and nutrition security by the poor and vulnerable, improve production capacity of households and resource poor farmers. In addition market channels would be developed to link the 'emerging agricultural sector', and also to foster partnerships along the food supply chain (DAFF, 2012 a; Drimie, 2015; Hendriks & Olivier, 2015). It should be noted that the Framework consists of three parts, wherein each is dealt with by a separate department through its own specified approaches, this can be seen in Figure 3-1. Ensuring access to food is undertaken by the Department of Social Development (DSD), access will be provided through food transfers (soup kitchens) and cash transfers (social grants) (DAFF, 2012 b). Nutrition aspects will be

undertaken by the Department of Health (DOH) through educational awareness campaigns, and through promoting healthy dietary lifestyles. The DAFF is then to carry out initiatives that are focused on capacity development for small holder and emerging farmers through skills training, technology transfer, access to extension services. This will then be complimented by the DAFF in co-ordinating the establishing of market channels through government procurement programmes aimed at supporting these farmers (DAFF, 2012 a; DAFF, 2012 b).

In this then, then Food Security Policy published by the DAFF in 2012 states that the role of agriculture in achieving food security is through the production of food, the generation of income through trade of products and job creation (DAFF, 2012 b, p. 25). While the Policy does place emphasises on the need to address the burden of malnutrition within the countries poor, the policy objectives as a whole reflect something else. The State recognises that the country produces enough food and that issues relating to food insecurity are due to ineffective access. Yet the perceived cause is due to poverty and lack of developmental capacity for smallholder development (DAFF, 2012 a; DAFF, 2012 b; DAFF, 2015).

The agricultural sector has largely been in decline in terms of employment as a result of mechanisation and changing land reform uncertainty. In this, Government has sought to utilize the sector to invigorate job growth and smallholder development and extension support (DAFF, 2012 a). This is reflected by the DAFF's Integrated Growth and Development Plan, who's interventions are geared toward providing an enabling environment which will facilitate in the growth of sector through the implementing equity interventions, enhancing economic profitability through sustainable resource use (DAFF, 2012 c). It outlines a vision for job creation through economic growth, where rural development and supporting the agro-processing sectors will invigorate the sectors performance. In this then food security is still an issue that is approached by the DAFF through a productions and poverty alleviation approach.

There are many challenges that face sectors within agriculture, forestry and fisheries (AFF). Such challenges are in the form of rising input costs, uneven international trade environments and also slow transformation of the AFF sectors, as well as increased climate variability (DAFF, 2012 b; DAFF, 2012 c; DAFF, 2014; DAFF, 2015). The Agricultural Policy Action Plan (APAP) has the directive to translate the high-level responses outlined in the AFF Strategic Framework, so as to make the necessary steps towards realisation of the responses. The APAP thus is aligned with the NGP and NDP, as well as the Medium-term Strategic Framework, with respect to its stipulated outcomes 4, 7 and 10 (DAFF, 2014).

In order for the APAP to adequately address Outcomes 4, 7 and 10, and also fulfil objectives outlined in the NGP, NDP and IPAP, it must unlock the productive potential of the AFF by understanding and exploring the constraints that are currently hindering them (DAFF, 2014; DAFF, 2015). Whether these constraints are in the form of primary production, beneficiation, marketing or a combination of these. Subsectors within the AFF, operate according to varied dynamics, and so encounter different challenges. The approach is then to be selective, as to which subsectors or value chains, should be prioritised, during the short to medium term, while recognising that agricultural commodities are often interrelated (DAFF, 2014).

The first iteration of the APAP however, focuses on a discrete number of value chains, identified as being strategic for meeting objectives as given by the NDP, NGP and IPAP, these being contribution to food security, job creation, value of production, growth potential, potential to contribute to trade balance (DAFF, 2014; Drimie, 2015). These echo that of the departments IGDP, and further demonstrates. This first APAP, is however not meant to be offered as a fully comprehensive plan, rather it is based on a model of the IPAP. In which it has identified ambitious, yet manageable number of focused actions. This is in anticipation for future APAP iterations, that will then take progress further, these are planned over every 5 years, and are to be updated annually (DAFF, 2015).

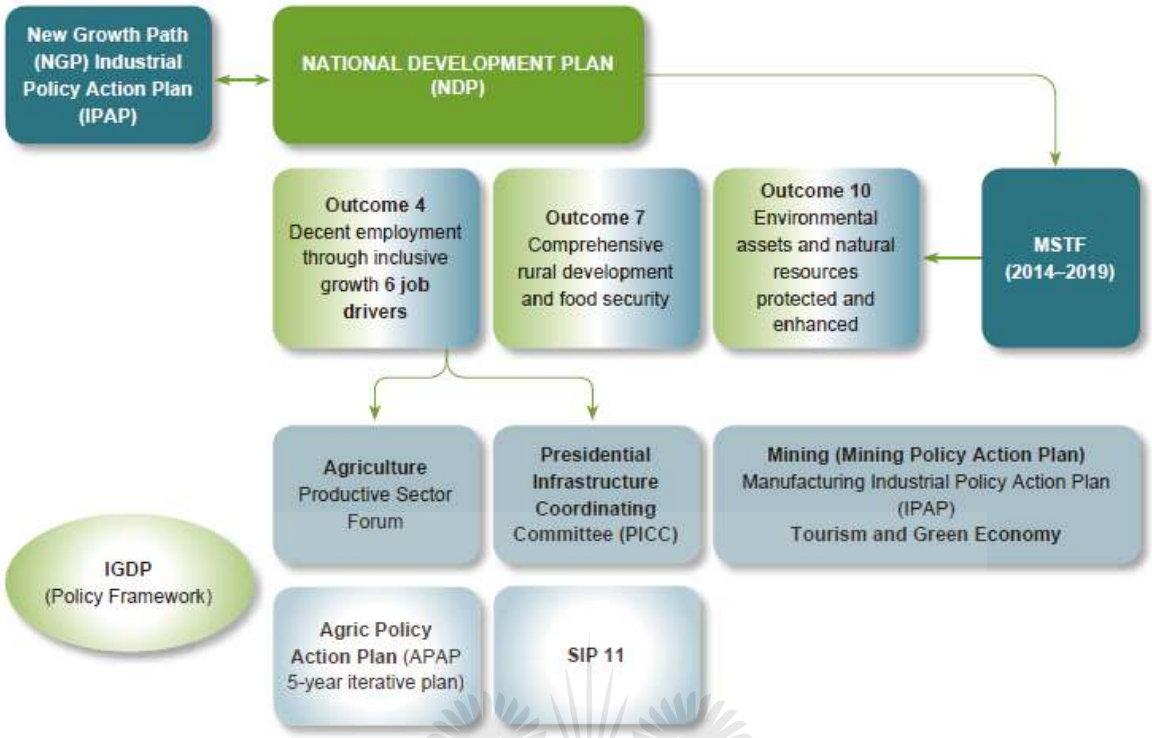

Figure 3-2: Diagram showing alignment of polices to national outcomes. Source: (DAFF, 2014, p. 2).

Figure 3-2 shows the intended alignment of the DAFF to the overarching strategic goals. It is in this context then, that Urban Agriculture must find its place in the South African Agricultural Policy environment. There are no policies at national or provincial level that relate to Urban Agriculture (Rogerson, 2011; Campbell, 2013). Instead, Urban Agriculture is conducted as an extension of other Policy initiatives that relate to economic or social development (Rogerson, 2011; Malan, 2015). This results in a frustrating organisational challenge, wherein it does not have a place in any one-single government department, wherein it is part Social Development, part Health, part Agriculture, Forestry and Fisheries, and also has an impact on Water Affairs, Human Settlements, Labour, Rural Development and Land Reform, Higher Education and Training and Economic Development (Rogerson, 2011; Campbell, 2013) .

Since UA has a role in so many varied departments, its function is then not fully defined or articulated (Rogerson, 2011). UA then is something that is either conducted out of a response to food insecurity or to income generation (Battersby & Marshak, 2013). Given that the States intended focus is thoroughly set on economic progression of the agricultural sector through rural development and provision of extension services to smallholder and emerging farmers, UA is then an activity that must justify its application based on how society determines its

implementation. Further investigation then of provincial and municipal policies for UA are thus focused on what directives are outlined in their medium and long-term strategic plans, as well as for any policy or programme that may relate to the development of agripreneurs.

3.4) Provincial Agricultural Contexts for study

The agricultural departments for the provinces of Gauteng, KwaZulu-Natal and the Western Cape each raise similar concerns, and also emphasise their own unique developmental foci. On review, each of their 5-year strategic documents demonstrate an alignment to the overarching national outcomes as set forth in the NDP and MTSF, and by extension the APAP – which echoes both these frameworks. These strategic documents outline a vision that highlights the potential that is within the agricultural sector to generate job opportunities. In this manner they state their alignment with the NDP and MTSF outcome 4, 7 and 10 in terms of creating an enabling environment conducive toward employment creation - particularly for previously disadvantaged individuals within rural communities.

It should be noted that agriculture is entwined with the rural context, and so the agricultural departments for KwaZulu-Natal and Gauteng have both been linked with the Department of Rural Development. While the Department of Agriculture for the Western Cape is a stand-alone unit, it still expresses directives toward enhancing selected rural communities within its borders. While in each instance there is an emphasis on economic development for the agricultural sector, each document has emphasised that the potential for job creation lies not within the primary production of produce, but rather in agro-processing – once more echoing objectives outlined in the NDP, NGP, MTSF and the IPAP. While agro-processing is the focus for employment opportunities, all three provincial departments do emphasis that growth in primary production should be maintained, however there must be a focus that this be done from a sustainability and resilience perspective. This is in the fact that the departments each recognize the growing challenges of climate change and associated climate shocks in the form of droughts. This is especially true for the Western Cape and KwaZulu-Natal.

Further similarities between strategic and planning policy documents centre around the provision of extension services. Extension services are provided by each Province in the following 3 forms. Capacity building is enhanced through skills development and training. Farmers are given advice and access to agricultural research and information resources. The establishing of academic partnerships to support student tertiary education in agricultural

practices. The means by which these extension services are rolled out are however undertaken in the different ways that each province sees most applicable.

3.4.1) KwaZulu Natal Department of Agriculture and Rural Development

KwaZulu-Natal (KZN) forms an important contributor to the development of South Africa. It is home to some 11.1 million people and is the second largest province in terms of population (at 19.9%), and economic contribution (at 16.5%) Gross Value Added (GVA) (KZN PGDS, 2016). For the KwaZulu-Natal Provincial Growth and Development Strategy (PGDS) a recognized challenge is "continued social and economic exclusion of millions of South Africans" (KZN PGDS, 2016; EDTEA, 2017). Addressing the issue of creating more and better jobs, can only be achieved through an enabling environment with safe, healthy and sustainable communities that are able to secure a livelihood within a shared and participatory economy. In so doing, the PGDS has recognised that agriculture and manufacturing represent key drivers to attaining job creation objectives. Both sectors have, in the last decade reduced in employment figures, even though their GVA had increased (GDARD, 2015; KZN PGDS, 2016; EDTEA, 2017). Agriculture has underperformed due to environmental impacts such as sustained droughts. It is expected that climate shocks will grow in intensity, which forebodes caution, given the intended renewed focus by KZN on agriculture (GDARD, 2015; KZN PGDS, 2016).

Between 2011 and 2016 there had been a substantial decline in the number of households involved in agriculture in KZN, where those participating dropped from 28,2% to 18,6%. This can largely be attributed to the intense drought that was experienced during this time, as well as to rising urbanization due to rural-urban migration (GDARD, 2015; KZN PGDS, 2016; EDTEA, 2017). Although the agricultural sector contributes only 4% to the provinces GDP, it still remains a key growth sector for employment creation as well as for 'radical socio-economic transformation opportunities. Job creation is to be seen as the main priority for the PGDS, in terms of attaining inclusive growth and transformation. Where benefits are distributed more widely – in which dependency on welfare can be reduced as a result of a broader economic participation. Despite the sectors low overall contribution to the provinces GDP, KZN produces almost 30% of the countries agricultural output. Hence, the sector can and does contribute significantly toward formal and informal employment, while also supporting food security in South Africa (KZN DARD, 2015 a; KZN PGDS, 2016).

Constraints to unlocking the sectors potential are in the form of inadequate access to funding for new capital development and maintenance of infrastructure, inappropriate land and water-

use practices, a concentrated agro-industrial base, limited access for agricultural graduates to commercial farms, poor co-ordination of agricultural agencies and erosion of the scientific base within the agricultural sector. In order to overcome such constraints, the sector needs to achieve greater production through more efficient and sustainable utilisation of the provinces available arable landscape (KZN PGDS, 2016). The whole sector needs to be expanded upon and diversified to extend available opportunities. Furthermore, unlocking the potentials within the industry will require an improved beneficiation process. In order to achieve this though, there is once more the matter of increasing the economies of scale within the sector where there is an expansion of current irrigation and water infrastructure, in which there is a rural transformation model implemented to support emerging commercial farmers. Increased agricultural production however, must be complemented with cognisance toward protecting the landscape, wherein degraded agricultural land is rehabilitated so that there remain sufficient resources to sustain the industry (KZN PGDS, 2016).

In KZN, there is an estimated 3.5 million people that experience various forms of food insecurity, and are in need of assistance, KZN has the highest disease burden in the country, as well as high instances of malnutrition, pervasive hunger and poverty (KZN DARD, 2015 a). As part of the Food Nutrition Policy, the Fetsa Tlala campaign has enacted various initiatives to address the key issues of food security. Such actions include promoting household, institutional and community food production initiatives (food gardens) to increase food availability and access. Increasing investment by government into infrastructure to promote the local production of food. Supporting local food market development, promoting indigenous food and conscientious organic agricultural production. Promoting activities which contribute to employment and income generation (KZN DARD, 2015 a).

Part of the departments strategic process recognizes the low success rate for entrepreneurial and SMME ventures within the province. There are few opportunities at present for which to absorb the incoming youth and female labour force. In this, the PGDS notes the importance of the informal sector, in being able to provide a sustainable livelihood, especially for those in poorer cities and in rural areas. The local economies are beginning to shift, as smaller players are being pushed out by larger retailers, who are growing in footprint, thus leading to greater market exclusion. KZN therefore acknowledges a need to stimulate entrepreneurship and put into place, activities and programmes, that are aimed at strengthening economic participation (KZN PGDS, 2016).

3.4.1.1) Planned Policy Initiatives

The department has reviewed its agricultural programmes and has resolved to implement a new path of transformation for its agrarian strategy. This is underpinned by several strategic programmes, whose combined intention is to unlock the provinces agricultural potential. In this manner the Agrarian Transformation Strategy is based on several interventions, ranging from providing for basic services and social amenities for rural communities, food security support, interventions in crop and livestock production, and also support for sustainable land reform. The transformation strategy is focused on the provision of agricultural support to various clients in the sectors, such as households on communal land, new entrant black commercial farmers. The next level of reform is based on a sound business model that will support the development and running of the 'farm businesses (KZN DARD, 2015 b).

In order to bring to fruition, the mandate to provide support and development of farmers, the Department has identified different approaches. Some of these are in the form Agri-Village development, River Valley model and Communal Estates. These form part as the department's pillars for the Agrarian Transformation Strategy. While none of these are specific to Urban Agriculture, it may be worth noting what strategies the department is implementing in order to achieve a strengthened rural agricultural community (KZN DARD, 2015 b).

3.4.1.2) Agri-Village Programme

The department has put forward the concept of an agricultural village as the basis for planning settlement areas geared for agricultural development. It has set out principles to be issued as guidelines, where it is emphasised, they be adapted to each situation as a case by case basis as needed. In this context then an Agri-village can be understood as a new settlement development, or an existing nucleus settlement which is converted for the purpose of streamlining a settlement pattern. This is so that the layout and density are in a manner for sustainable rural lifestyle, whereby land tenure is secure so that a household is able to produce its own food or for that of market consumption. Basic services are accessible, and essential social amenities are provided for. In addition there is improved access to public transport through economies of scale, where over time it is able to become a fledgling town (KZN DARD, 2015 a; KZN DARD, 2015 b; KZN PGDS, 2016).

3.4.1.3) River valley Catalytic Programme

The River Valley Catalytic programmes has been adopted by the Department of Agriculture and Rural Devolvement (DARD) as a methodology to develop rural area. The intention is to create a platform basis for integrated planning and development where the river catchments would serve as the foundation for rural development. Various projects such as irrigation schemes, economic infrastructure, improved market access, social infrastructure and skills development are incorporated into the overarching goals for this programme. Through this it is hoped the programme will also achieve re-greening of the environment where various environmental and planning dimension are integrated. To focus benefits from natural resource toward regional development and to attract sustainable rural development into a river valley (KZN DARD, 2015 a; KZN DARD, 2015 b; KZN PGDS, 2016).

3.4.1.4) Agricultural Communal Estate

The DARD through its 2015-2022 strategic plan has acknowledged that issues surrounding food security are those which transcends social health and economic boundaries. Through this they have recognised that solutions must be comprehensive and multi-disciplinary where an adequate response, is one which prioritises the eradication of hunger and malnutrition, poverty alleviation and inequality, where there is increased access and production of sufficient diverse food, as well as enhanced employment creation and economic growth.

Previously food security had been approached from a subsistence level, where it has been seen that this focus has not yielded the desired outcomes of an improved agricultural sector, this has therefore led to the DARD to seek to radically change their tack, where a new path has been decided on, which will borrow methods that have worked within the commercial agricultural sector, in which farming is to be seen as a business that would be both sustainable and profitable. Given this, the purpose of the agricultural communal estate approach is to engender a radical shift in farming yields to a business strategy to maximise development, in a sustainable manner. It hoped to unlock the economic and agricultural potential in communal areas so that there is stimulus within these sectors so that employment is created through primary and Agri-processing activities (KZN DARD, 2015 a; KZN DARD, 2015 b; KZN PGDS, 2016).

3.4.1.5) Approach to Skills Development

In order to ensure that the new programmes fulfil desired intentions, the agrarian transformation strategy needs to be supported by skills development initiatives to engender continuous skills development transfer to farmers. Partnerships with various training institutions and commodity organisations so that new entrant commercial farmers receive much needed skills development and capacity building. To demonstrate this, is the current partnership between the Agribusiness Development Agency and the Shukela Training Centre (STC) in Mount Edgecombe. Where the STC provide the practical training to farmers and farm workers.

In addition, the DARD will be formalising partnerships with academic institutions in KZN, so that young black students can be supported un the studies in key areas of the agricultural sector. Furthermore, post-graduate development programmes will be established so that current practitioners and undergraduates can further their skills set (KZN DARD, 2015 a; KZN DARD, 2015 b; KZN DARD, 2018).

3.4.2) Western Cape Department of Agriculture

The Western Cape Government (WCG) broadly endorses the NDP and has committed itself to implementing the National Outcomes (NO) as set out by the MTSF. The National Outcomes relevant to the Western Cape Department of Agriculture (WCDA), are 4, 7 and 10 (WCA, 2015). The Provincial Economic Review and Outlook (PERO) 2013, revealed that the agriculture and agro-processing sectors in the Province are leading the pack in terms of sectors that have a national and international comparative advantage (WCA, 2015; Western Cape Government, 2015). The sectors also show great promise in productivity within the rural economy. The significance of the Provinces agricultural and Agro-processing sectors is most evident in its exports, particularly horticultural exports. Industries in this sector have shown great potential in fulfilling the need to create jobs as per the NDP, and NO 4 – which is that of decent employment through economic growth (WCA, 2015; WCA, 2018).

3.4.2.1) Increasing employment opportunities through Agri-Processing

It is then, that the actual potential for job creation is not necessarily in primary production but is within agro-processing. In this way the sub sector is of priority for the Province in fulfilling its own provincial goals where its first Provincial Strategic Goal (PSG), is to create opportunities for growth and jobs (WCA, 2015; WCA, 2018). The Western Cape Government adopted an integrated plan called “Project Khulisa” to deliver on 3 priority sectors (WCA,

2015; WC EDT, 2018). These sectors being tourism, agro-processing and the oil and gas servicing sector. Since the DOA forms as being a key role player in agro-processing, where the primary focus of the Department is focussed on 3 key projects – Halal export promotion, the Halal Industrial Park, the Halal Certification Project and Wine and Brandy export promotion. The Halal Export Promotion extends to targeted countries such as Senegal, Singapore, Malaysia, Thailand, Nigeria and China. Efforts made by the targeted strategies set forth by Project Khulisa has placed the Western Cape as having the lowest unemployment in the country, with 11.6 point lower than the National value, and a higher economic growth rate than the rest of the country (Western Cape Government, 2015; WC EDT, 2018).

The Western Cape Province also acknowledges sub-outcome 2 under NO 4, which is to develop Trade Market access. This however, can be quite complex due to various regulatory compliances mandated by national government. In this, there still exist many challenges to improving market access, of which – a lack in BRICS Trade agreements is one of them (WCA, 2015).

3.4.2.2) Improving production through resource efficiency

The WC seeks to increase its agricultural production by 10% over the next decade. It is seen by the province that agriculture is shifting from a 'farming operation' to a 'business operation' (WCA, 2015). Through this, it is acknowledged that the agricultural sector is one of the most important and is one of largest knowledge-based sectors in the country. Needs to address pertinent issues such as food security and rural development within the context of climate change will therefore be addressed through science and technology with access to research being the key cornerstone. The availability of the technical advice and diagnostics would serve to drive lower input costs and improve production efficiency (WCA, 2015; Western Cape Government, 2017; WCA, 2018).

The Provinces PSG 4 is that of Sustainable Resource Management (SRM), this program is to enable a resilient, sustainable quality and inclusive living environment (WCA, 2015). Here the development of research and technologies and sustainable resource management portfolios will be linked to the interdepartmental actives of climate change adaptation and mitigation, energy, sustainable resource and land-use management. This will further be interlinked with the "smart Agri-production" of the Green Economy Strategy Framework (WCA, 2015; Western Cape Government, 2017; WCA, 2018). This will require collaboration with GreenCape which will extend its support, in providing an Agri-desk which would assist in giving green economy and

green technology advice to stakeholders (OneCape2040, 2012; WCA, 2015; Western Cape Government, 2017; WCA, 2018).

One of the fundamental elements to fulfilling resilience and climate smart agriculture, is the optimization of water and land resource use (WCA, 2015; Western Cape Government, 2017). Through biodiversity and water wise campaigns, and the Fruitlook Project, farmers are empowered with information on actual crop water use and various growing parameters provided on a weekly basis via the Fruitlook web portal. The overall aim is to assist farmers to increase production by using less water resources (WCA, 2018). The SRM programme will provide irrigation farmers with relevant information aimed at assisting them to effectively make use of natural resources, so that there is increased production while using the same amount of allocated water. In addition, farmers would be supported with information and technical advice on aspects such as mechanisation, conservation farming, on-farm value chain, waste management, and river bank erosion protection initiatives (WCA, 2015; WCA, 2018).

3.4.2.3) Supporting Capacity Building for emerging and small holder farmers

In order to address the national outcome of improving land reform, the province has committed to ensuring a 70% land reform success rate. As part of this, there is great emphasis placed on the creation of partnerships within the agricultural fraternity, in which a 'commodity approach' has been adopted toward farmer support. A key element to success is the development of partnerships between the public and private sectors. This would aid farmers through connecting them to experts in the field, and granting small holder farmers an opportunity to be part of mentorship programmes (WCA, 2015; WCA, 2018).

In 2005, the DAFF released the Agricultural Education and Training Strategy (AETS), for Agriculture and Rural Development in South Africa. This was the beginning of a multifaceted programme to transform agricultural education and training to meet the challenges of a changing agricultural landscape. The Green Paper on National Agricultural Training Institutes was published for comment in the Government Gazette (38081 on the 13 October 2014). This is then fulfilled by the Rural Development Programme, through the Farm Worker Development sub-programme, which is in collaboration with the Farmers Support and Development (FSD) and Structured Agricultural Education and Training (SAET) Programmes. These ensure access to training, development and support services to farms and farm workers (WCA, 2015; WCA, 2018).

The SAET programme partnered with various stakeholders in promoting and supporting skills development and capacity building in agriculture. Skills based training was provided to 1600 farmers and Agri-workers, whilst 481 students enrolled for full-time study in higher education training programmes. A total of 103 students graduated from these programmes and entered the sector primarily as farmers, farm managers, assistant farm managers, supervisors, agriculturalists and agricultural advisors (WCA, 2015; WCA, 2018).

3.4.3) The Gauteng Department of Agriculture and Rural Development

In Gauteng, agricultural production was estimated at R13.6 million of R2.6 billion provincial production during 2013. This number excludes agro-processing which amounts to R936 million, as part of the manufacturing sector. The agricultural industry grew from R5.4 million in 2004 to 13.6 million in 2013. With an annual growth rate of 18.8% in 2008, this figure then dropped to a growth rate of 2.2% in 2013 (GDARD, 2015). The Sector is under a lot of pressure from the provinces large urbanized component. Much of the agricultural output exists as the secondary and tertiary sectors. Which are the largest in the country, in which Gauteng is home to 4 of South Africa's major fresh produce markets, where in are many food processors are located within the province (GDARD, 2018).

In Gauteng, it is estimated that 37 560 Ha of land is utilised by emerging farmers, this accounts for only 4% of available and utilised field cropped land. Of this 65% of land used by emerging farmers is leased. This is seen as having possible negative impacts on emerging farmers in terms of farm investments and tenure security, which implies hindrances to productivity. Gauteng Department of Agriculture and Rural Development (GDARD) sees this as a need for an increase in transformation of ownership patterns (GDARD, 2015; GDARD, 2018).

GDARD has aligned its strategic plan with the MTSF to fulfil outcomes numbers 4 (decent employments, 5(a skilled and capable workforce), 6 (an efficient, competitive and responsive economic infrastructure network) and 7 (vibrant equitable, sustainable rural communities contributing towards food security for all) (GDARD, 2015).

While doing so, environmental management will play a key role in operational areas for GDARD, such as in Air Quality management, waste management, environmental impact management and also Conservation and Sustainable use of Biodiversity (GDARD, 2015). There is a renewed approach to the interpretation of the department's environmental management and protection management. The department has set itself to include a focus on supporting and facilitating energy security, sustainable development through green and

environmentally friendly and sustainable development through green and environmentally friendly and sustainable technologies and processes. Eco-Tourism increased participation of previously disadvantaged individuals and communities in environmental management and protection, and lastly to play a proactive role in radically transforming, modernising and re-industrialising the provinces economy through the sector (GDARD, 2015; GDARD, 2018).

GDARD has set out 3 main outcome-oriented goals, these are to place agriculture as a driver toward inclusive job creation, to focus on environmentally conscientious technologies for sustainable agricultural practices, and to utilize eco-tourism as a means to support economic growth (GDARD, 2015).

3.4.3.1) The Farmer Support and Development Programme

The Farmer Support and Development (FSD) Programme, is responsible for increasing agricultural development support to households and developing farmers and commercial producers for sustainable agricultural development. It is aimed at transforming the agricultural sector, providing necessary support for food security, skills development and strengthen of extension services in the province (GDARD, 2018).

The Agricultural Extension and Advisory Services is rendered to subsistence farmers, smallholder farmers, aspirant and commercial farmers throughout the province. The extension services purpose is to enable farmers to improve their practices as well as to help them to respond to the emerging challenges of climate change and an ever-changing market environment. The provision of this agricultural support is targeted to beneficiaries that may seek to increase and enhance food production, that increasing food security at a farm level. These services had been rendered to subsistence, smallholder and commercial farmers at a local, district and metropolitan level within the province (GDARD, 2015; GDARD, 2018).

In total, 6000 homestead food gardens were supported, and an additional 108 households benefitted from community food gardens. To further address and redress poverty, agricultural advisors provided support in communities, schools and individual backyard gardens by providing production inputs such as seeds, fertilizers, tools and irrigation materials, training as well as Extension Advisory Services (GDARD, 2018).

3.4.3.2) Agricultural Economic Services

The Agricultural Economic Services (AES) provides timely and relevant economics services to the sector in support of sustainable agriculture and mainstreaming of emerging agri-businesses towards equitable participation and business growth (GDARD, 2015).

The Department has ensured that 415 smallholder farmers benefit from agricultural economic advice ranging from food safety, quality assurance and access to finance, among other in order to make informed decision on their farms. The target has been achieved and exceeded due to market linkages with retailers and hotels. The department has ensured that 491 smallholder farmers benefit from agricultural economic information provided, ranging from food safety, quality assurance and access to finance, and also to make informed decisions on their operations (GDARD, 2018).

3.4.3.3) Research and Technology Development Services

The sub-programme Research and Technological Development Services (RTDS) is responsible for providing expert needs-based research and technology transfer services. The research sub-component facilitated and implemented agriculture production research and development in the province to provide solutions that will address specific production constraints experienced by farmers and relevant stakeholders (GDARD, 2015). One of the Gauteng provincial mandates of transformation, modernisation and re-industrialisation is linked to township economic revitalisation through the establishment of Agri-parks. There were no new Agri-parks established, instead planning and Geotech report for the site was developed. This was a requirement from Infrastructure Delivery Management System (IDMS) which was implement later in the year. The provincial commitment to establish Agri-parks is continuing as multiyear project, in which the existing Agri-parks were maintained with additional jobs. The IDMS process took longer than anticipated, however 146 agricultural infrastructures were established (GDARD, 2018).

The departments have also assisted in other specific goals, such as in supporting the development of 6 biotechnology SMMEs, and 75 students with bursaries. The department has also sought to increase land productivity and aid resource poor farmers through implementing the Agricultural Mechanisation Programme, as part of the National Zero Hunger Strategy. The DAFF has provided 72 tractors, 332 associated equipment, and trailers (GDARD, 2018).

3.5) UA relating policy context at Municipal Level

While having viewed national and provincial provisions for UA related policies, we turn to the Municipal level. In South Africa, as mandated by the constitution, a municipality has a right to govern local government affairs for its community as it sees fit, subject to national and provincial legislation (RSA, 1996). The three municipalities investigated are each categorised as being 'Category A' municipalities, which means that the municipality has exclusive municipal executive and legislative authority for their given area (RSA, 1996). Through this, municipalities are afforded their own unique approaches to given problems, and so it is at a municipal level that a clearer policy space can be seen for the case of UA and RF to eke out.

3.5.1) eThekwini Municipality

The eThekwini Metropolitan Municipality (EMM) has initiated a number of programmes to assist in alleviating the challenges of food security (EMM, 2018). To this end, dedicated structures have been created to drive the implementation of agriculture, aqua and poultry farming, soya bean project, community support farms, community gardens, mushrooms vs hydroponics project, One Home One Garden project etc. The Agricultural Department currently supports 85 established community gardens, where provision is made for the technical information, implements and seeds. Agriculture is responsible for providing support to communities with respect to organic fertilizer and compost, the provision of fencing, storage containers, toilets and water provisions, as well as the farming tools. It also provides up to ten fruit trees per community garden (EMM, 2011; EMM, 2018).

In terms of the urban and peri-urban agriculture, the Municipality has an Agroecology Programme in place, which compliments other municipal policies that have a focus on poverty and unemployment. The programme is geared toward promoting the appropriate sustainable approaches to the way in which agriculture is planned and undertaken. In this manner, the municipality has seven agricultural hubs, 16 fish ponds in place. The primary object for these programmes are to target those with the greatest need, where in the most impact can be made with limited resource input (EMM, 2011; EMM, 2018).

The Edamame (Soya bean) is one such project, aimed at agricultural development and support in the emerging sector, where I can also have the potential to improve health, job creation and strengthen the local economic development within the city. The Edamame Development Programme (EDP) was set up 5 years ago so as to establish the beginning of the soya industry in South Africa and being primarily based in eThekwini (EMM, 2018).

As part of the EDP, there is ongoing research taking place with key academic partners for small scale growers, and emerging farmers. The EDP is supporting 85 emerging farmers and has led to engaging and monitoring of 265 homestead and community gardens. Products have begun to make their way to the local retail market and has also begun to attract the interest of international consumers (EMM, 2018).

3.5.1.1) Becoming resilient

In order to respond to the challenges that Climate Change may present, EM initiated the Municipal Climate Protection Program (MCPP) in 2004. This is a phased programme, which focused on adaptation and enhancing the Municipalities ability to cope with impacts to climate change.

In 2013, the city of Durban, as managed by the eThekwini Municipality became one of 33 cities to joining an international consortium as embodied by the '100 Resilient Cities' (100RC) Programme. The 100RC is committed to guiding cities towards building resilience against physical, social and economic challenges that urban communities face in the 21st century (EPCPD, 2014; 100 RC, 2017). Through this, cities are encouraged to adopt and integrate resilience thinking so as to be prepared against climate shocks as well as daily or cyclical stresses that weaken the fabric of a city. In 2016, a plethora of international agreements had been made which would serve to influence the municipality. This was in response to this the municipalities Climate Protection Branch engaged in a process of strategic planning. This involved reviewing international, national, and local legislative and policy frameworks and their impact on the Branch (EPCPD, 2011; EPCPD, 2014). The Branches current projects were then tested against the new framework. Out of this the Branch proposed two Municipal Scorecard items – the Durban Adaptation Charter (DAC) and the Durban Climate Change Strategy (DCCS). These two Municipal Scorecards were provided with an international, national and local mandate, and should exist as the core elements of the Environment Planning and Climate Protection Departments Commitments (EPCPD, 2014).

3.5.1.2) Applying resilience thinking to urban food security

The Durban Climate Change Strategy project is funded and lead by the Environmental Planning and Climate Protection Department (ECPD), and the Energy Office of the eThekweni Municipality. Together the EPCD and the Environmental Office, have Commissioned Urban Earth, in association with Future Works! To assist in the implementation of a city-wide

development strategy for climate change adaptation and mitigation for Durban (EPCPD, 2011; EPCPD, 2014; EMM, 2018).

The initial consultation process identified and investigates seven key themes with regards to the strategy. Themes identified were relevant to Biodiversity, Health, Food Security, Water, Sustainable Energy, Transport, Waste and Pollution. Separate workshops were held for each theme, where sector stakeholders and technical experts gave their input on the aims and strategies that would make up the content for each theme (EPCPD, 2014).

The vision of the DCCS in terms of the Food Security and Climate Change component, is for City's resident to have a food security status that is robust and resilient in terms of availability, access and utilization of food in the face of climate change (EPCPD, 2011; EPCPD, 2014). The aims then are for the city to establish and maintain local food production systems robust and resilient against impacts due to climate change threats. Whereby the City will have food distribution and marketing networks that are able to adapt to climate change challenges, in which residents will have reliable economic access in the face of climate change. The City aims to be preparade against climate related disasters or events, and will be able to supply residents with adequate food during such disaster. Participants that had engaged in the workshops, identified a number of strategies, that would serve to contribute to achieving the food security vision and aims (EPCPD, 2011; EPCPD, 2014; EMM, 2018).

In order to achieve the aim of the city having a robust food production system that would withstand the threats of climate change, various strategies were proposed. For instance, farming practices should be encouraged to have ecological and sustainable approaches, where awareness is made and widespread training is done on how to do so through techniques like crop rotation, companion planting, organic and permaculture farming, rooftop gardening and regenerative agricultural planning (EPCPD, 2014; EMM, 2016). Farmers should be educated on efficient water use through various rain water harvesting methods and use of drip irrigation. Separation of green and organic waste for composting and mulching should be promoted, so as to divert methane producing waste entering into landfill sites. In this co-operation amongst small scale growers should be encouraged and supported. Further strategies given were for urban developments to include the reservation of space for food cultivation where departments are integrated so that sectors work with one another to develop local policies and laws on agricultural practices (EPCPD, 2011). Food production should become localised, where distribution is undergone at agricultural hubs that are supported by local small-scale

community farming efforts. Lastly, communities and farmers should be educated on what crops would be most suited to local climate change (EPCPD, 2011).

The City of eThekwini wishes to have a food distribution and marketing network that is resilient to climate change. In order to do so, the workshop stakeholders and technical experts put forward various strategies (EPCPD, 2011)s. Some of the strategies put forward include that the fresh produce marketing system should be decentralised, through a system of distribution hubs that would better supply small trader. In this manner, food markets should be established at transport hubs that are supplied by local small-scale communities. In this, informal traders will too, be supported through the provision of shaded trading facilities, access to micro-credit and also access made to storage and refrigeration facilities (EPCPD, 2014; EMM, 2018).

3.5.1.3) eThekwini's planned initiatives

Durban has recognized that reducing its carbon footprint can be made possible through the integration of green roof habitats throughout the urban environment. The eThekwini Municipalities Municipal Climate Protection Programme has implemented The Green Roof Pilot Programme (GRPP) (EPCPD, 2011). MCPP was initiated in 2004 by the Department of Environmental Planning and Climate Protection Department. The overall aim of the MCPP is to make Durban more resilient to future climate challenges. Such challenges are in the form of the Urban Heat Island effect, increased surface run-off and flooding. Here then, the objective for the Green Roof Pilot Programme (GRPP) is to explore the potential benefits of green roof habitats in resolving such challenges. The GRPP will be used as a testing ground for how best to apply rooftop habitats in Durban using local resources (EPCPD, 2011).

The project was initiated in 2008 by the eThekwini municipality's Environmental Planning and Climate protection Department and is still on going. The GRPP is located atop the City Engineers Complex roof in Durban. The total area of the green roof habitat measures at 550m2. It is divided into 3 areas that will test different green roof techniques. One area is used for direct roof systems, another for modular green roof systems and the last is as a control area (EPCPD, 2011). However, as a Green Roof, this concept thus may support green infrastructural implements more so than it would Rooftop Farming implements. In so saying, while this may support the development of greening for rooftops, it may not translate into using rooftops for food production.

The Municipality of eThekwini has an Agro-ecology Programme as part of the community and Emergency Services Cluster, which is aimed at promoting appropriate and sustainable

approaches to how agricultural practices are planned and implemented within eThekwini (EMM, 2018). The vision for this agricultural programme for the City is of Food Sovereignty for all residents in eThekwini, and for the development of a thriving Agro-Ecology Sector. An Agro-Ecology Sector that would contribute significantly to the health and wellbeing of the municipalities residents, for a small grower driven agriculture, for local economies, skills development and rural regeneration. To contribute to environmental sustainability and the sustainable use of natural resources (EMM, 2011).

The Municipality has identified eco-sustainable agriculture as being a vector for driving economic development, job creation, poverty alleviation and food security (EMM, 2018). As part of its strategic focus the eThekwini Municipality is in the process of implementing food gardens within its rural districts. This effort is paired with establishing aqua-culture initiatives to provide an additional food source.

3.5.2) City of Cape Town

The City of Cape Town (CoCT) has taken to adopting a dual approach to urban agriculture i.e. on the one hand it will focus on achieving household food security and on the other, it can provide as a source of income (CoCT, 2013). Primarily, the City will act as facilitator to create an enabling environment for urban agricultural development through reducing red tape, introducing and exercising appropriate regulations and management systems. The city can act as a catalyst which includes the provision of land, the construction of infrastructure and earth works, and in some cases provide production inputs, project management and extension services (CoCT, 2013; CoCT, 2017).

In context of alleviating poverty, the city will introduce a household level food production assistance programme. This has the following aims – to facilitate and support the establishment of food production initiatives in urban areas by groups of beneficiaries. Targeting groups of beneficiaries on the basis of vulnerability, with priority being given to initiatives involving woman and children, youth and different abled (CoCT, 2013).

3.5.2.1) Urban Agricultural Policy

In 2007, The City of Cape Town had implemented its own Urban Agricultural policy (CoCT, 2007; Battersby & Marshak, 2013; CoCT, 2013). The policies purpose is to develop an integrated and holistic approach for the effective and meaningful development of urban agriculture in the city of Cape Town. It will be utilised as a guiding tool by all role players to

align and synergise efforts to maximise positive impact of urban agriculture in the City (CoCT, 2007; CoCT, 2013).

The policy seeks to create an environment that would enable collaboration between public, private and civil society agents, to work collectively toward the creation of sustainable opportunities for local area economic development. In this the policy recognizes the status of urban agriculture in the City of Cape Town. Whereby it seeks to focus on agricultural activities by the poorest of the poor, within the urban (built) areas. The policy however is specific in that it does not include commercial farming and other agricultural activities outside the city's urban edge (CoCT, 2007).

3.5.2.2) Strategic Focus

In order for the City to obtain its vision of 'a prosperous and growing urban agricultural sector', it has set forth 3 strategic goals to achieve. It wishes to create an enabling environment for the poorest of the poor, so that they may be able to utilize urban agriculture as an element of their survival strategy with regards to food security. It is intended that this enabling environment will engender commercially sustainable economic opportunities through urban agriculture. In this, previously disadvantaged people will be able to participate in the land redistribution for agricultural development (CoCT, 2013).

The City believes that UA can play an important role in poverty alleviation and economic development. In which it was mandated to ensure that Urban Agriculture would maintain an integral part of future development planning (CoCT, 2007). This will include spatial planning, environmental planning, community development planning, economic development and infrastructural planning, environmental health. The CoCT will provide support and assistance to community groups, NGOs and private entrepreneurs (CoCT, 2007; CoCT, 2013).

3.5.2.3) Creating an enabling environment

In order to improve and make UA more sustainable, it is necessary to give it a formal status (CoCT, 2007; CoCT, 2013). To do this UA will be included as a multifunctional component in municipal land planning and standard development processes concerning land use and environmental protection i.e. land use plans, zoning schemes and site development plans should provide for urban agricultural activities (CoCT, 2013). The City will identify land in all urban areas suitable for UA. These pieces of land will be placed under the management of the UA unit, and subsidise water for those who are vulnerable (CoCT, 2017).

UA can be a primary vehicle for low cost job creation (CoCT, 2013). In this regard the City will accommodate UA in its Sector Support and Small Development programme, which will have the following aims – the facilitation of entrepreneurial and business development. An enabling environment that would cater to start-up new business, or to expand existing activities. Promotion of sustainable job opportunities and income generation. Start-up kits for survivalists will include basic tools (spades, pick axes, rakes, watering cans) production inputs (seeds, compost), skills developments and mentoring and advice) (CoCT, 2013).

The Urban Agricultural Development Programme cannot exist in isolation and will be linked to a number of supplementary and complementary programmes. Internally, linkages and integration will be made with programs related to poverty alleviation, urban renewal, new housing developments, sector and business support, skill development, local area economic development strategies, HIV/AIDs campaigns and others (CoCT, 2013; CoCT, 2017).

There is a need for all role players and affected parties in the City to come together to share experiences, identify and analyse problems and challenges and to re-assess the vision of urban agriculture in the City. To set about this, a plenary comprised of stakeholders were to hold an annual summit, as a consultative forum for UA. Those attending these summits were emerging and small food growers and farmers who were as a mouth piece for local UA practitioners. Furthermore, state role players such as officials from the City, and the Provincial Department of Agriculture (CoCT, 2013).

3.5.3) The City of Johannesburg

The City of Johannesburg (CoJ) is the country's largest metropolitan municipality in terms of population, size and diversity of its economy. The city also provides the highest number of jobs compared with other cities in the province (CoJ, 2011; CoJ, 2018).

3.5.3.1) City of Johannesburg 2013-16 IDP

Under the ANC, The City's priority on Agriculture and Food Security is one of the key strategic interventions identified to break the inter-generational cycle of poverty. It is intended to generate employment and sustainable livelihoods and is an important part of food security (CoJ, 2014). The focus is on a multi-pronged approach which will include actively supporting and providing incentives for small-scale growers to provide a steady support to fresh produce from the urban food system, improving access to markets and ensuring the City has various strategies and policies in place to realise the right to food (CoJ, 2011; CoJ, 2014).

In order to operationalise the efforts within the City, the CoJ Food Resilience Framework was established in 2012 and provides for the structure of three levels of intervention (CoJ, 2014). The first of which requires a range of instruments to be used in tackling the individual hunger on a da-by-day basis, including food voucher, food parcels, back-yard gardens and programmes connecting citizens to income generating activity which will enable them to buy food (CoJ, 2011; CoJ, 2014). Furthermore, the informal food supply sector is to be supported with local resource coordination to assist growers with access to basic supplies, finance and farming advice. Growers will be linked to properly constituted local trading spaces / linear markets, which largely do not exist in the most deprived portions of the City. Lastly, urban agriculture at the area level, is to be supported, where feasible, through the packaging of land, and establishment of hub-and-spoke infrastructure to connect networks of local producers to cold-chains, packaging houses and wider distribution networks (CoJ, 2014).

The key objectives of the City's interventions are to enable those confronted by hunger, to have access to basic food within areas that are identified as highly food insecure, the City will reduce food insecurity by 50% by end 2016 (CoJ, 2014). It wishes to provide support to individuals who have an interest in small scale agricultural actives, and link the end product to markets or communities. The agricultural value chain should be taken advantage of so as to stimulate local economic development in deprived areas through incentives and setting up sustainable local supply networks through small farmers in local areas. The CoJ also intends to facilitate the entry into formal markers through removing barriers to small farmers, infrastructure development and capacity building to meet quality and safety requirements. Partnerships should be consolidated and enhanced with retailers which would provide opportunities for small farmers and enforce affordable food pricing, and lastly to create an enabling environment that promotes healthy lifestyles and undertaking reasonable steps to ensure legal compliance (CoJ, 2014).

3.5.3.2) Urban Agriculture Support Programme

This focus area is aimed at providing a sustainable model for empowering communities to grow their own food, stimulation local economic development and facilitating access to the markets. A number of initiatives were undertaken to achieve this. The programme implemented Agri-Resource Centres, which were set up in all regions in the City, these were community based support systems for agricultural activity at an individual/household and communal level (CoJ, 2014; Malan, 2015). Small scale initiatives were rolled out, which targeted specific areas were at these Agri-resource centres. The City supported small-scale crop farming and small-scale

intensive animal farming through cooperatives and small enterprise. The Food Empowerment Zone was the City's Large-Scale Initiative, which made available large pieces of zoned for agriculture. These involved farms ranging from 1 Ha to over 100 Ha (CoJ, 2014; Malan, 2015; CoJ, 2018). These were set to supply retail giants. The CoJ sought to support emerging farmers, though dividing land into various pieces for a cluster of SMMEs and or cooperatives. This cluster of entrepreneurs which ranged up to 50 individuals, involved diverse farming activities, and made use of similar secondary or tertiary cooperatives such as a common slaughterhouse, or a common cold chain or distribution point system. The private- sector investment side consisted of a large portion of land within the farm where emerging farmers would be operating would be leased out to the private sector partner on condition that they commit to a mentorship programme for the emerging farmers to reach industry standards (CoJ, 2014). The CoJ also wished to engender a capacity to transform into manufactured food within the food empowerment zones for farming enterprises. In this regard the City will partner with various stakeholders primarily the Small Enterprise Development Agency (SEDA) through Gauteng Department of Economic Development (GDED) on incubator on food processing/agro-processing. Lastly to improve market access is as a key initiative to physically bring markets closer to communities either through setting them or providing mobile facilities, or by enabling the local producers to supply large retailers.

3.5.3.3) Promoting healthier eating and healthy lifestyles programme

The city, like many other urban areas in the world, is facing an increase in non-communicable disease predominantly brought on by how people lead their lives and treat their bodies through what they eat. This programme based around the intention of improving all residents in the CoJ so that they may have access to nutrition security. It has set out the following key outcomes to achieve this. The City is to create an enabling environment for high value commodities such as fruit, vegetables and animal products, are to be sold locally linking farmers in their own areas. Agribusiness Ventures and Farm Enterprises providing fresh, locally grown food for growing urban population and viable food procurement and distribution systems. Work with large food retailers, distributors and manufacturers to create localized system through which to ensure food security. Sustained visible multi-media and programmatic intervention in collaboration with multi stakeholders working towards a prosperous, healthy, productive citizenry.

3.5.3.4) Change in political structure and approach to urban food insecurity

The 2018/19 IDP review marks the second iteration of the IDP driven by the multi-party government, elected by the resident of Johannesburg in 2016. This new IDP has taken to address specific outcomes it sees as being pertinent. A growing, diverse and competitive economy that create jobs, and inclusive society with enhanced quality of life that provides meaningful redress through pro-poor development. Enhanced, quality services and sustainable environmental practices, with caring, safe and secure communities, and an honest transparent and responsive local government that prides itself on service excellence. In order to achieve these objectives nine priorities have been set forth to drive this strategic objective. Economic development will be promoted to attract investment towards achieving 5% economic growth that reduces unemployment by 2021. Pro-poor development will be utilized to address inequalities and poverty in manner that provides meaningful redress. A culture of a proud service delivery sector will be created, where there is an honest and transparent City that stands against corruption, in which communities feel safe and secure. The CoJ wishes to create a city that responds to the needs of citizens, customers, stakeholders and businesses. Enhance our financial sustainability, encourage innovation and efficiency through the smart city programme, where resources are preserved for future generations.

3.5.3.5) Policies that may affect urban agriculture through economic policy drivers

The Johannesburg Growth and Development Strategy provides a lens through which we can view the City of the future. This has formed as a fundamental, strategic, decision making instrument for the City, a long-term thinking model that has been incremental shaped over time. Of the priorities to attaining the 5 key objectives, 2 are perhaps most relevant to urban agriculture. The first priority is that of promoting economic development and attracting investment towards achieving 5% economic growth that reduces unemployment by 2021. The strategy to promote economic development is built on 5 targets, retaining and consolidating existing viable businesses and centres of excellence, attracting new businesses and investment, including those in the manufacturing sector, supporting the development and growth of SMMEs, achieving better spatial distribution of economic activity and job opportunities in the city, and delivering greater inclusiveness in the economy, particularly for previously disadvantaged citizens and youth.

In achieving this imperative, the city will play its part in countering ‘jobless growth’, through the creation of an enabling environment that support job creation. By 2021 the city aims to have achieved 5% economic growth (CoJ, 2011; CoJ, 2018). To do this the City mist encourage

entrepreneurship and innovation at all levels of enterprise (micro, small and medium-sized businesses as well as large corporations), encourage business re-investment in more productive plant and equipment and in upgrading workforce skills, and attract direct investment into the city from both foreign and local sources (CoJ, 2011; CoJ, 2014; CoJ, 2018).

To support this, the Economic Growth Strategy (EGS) is currently under review, as a key strategy to align the City's mission of creating an enabling economic environment. It will facilitate economic growth that creates jobs as its core objective, wherein which a thriving private-sector is understood to be a means of decisively and sustainable addressing unemployment, poverty and inequality (CoJ, 2018).

There are a number of strategies that are included in this, such as that of Investment Attraction, Expansion and Retention. This serves to re-establish Johannesburg as the leading African destination for regional corporate head offices, foreign direct investment and local investment (CoJ, 2018). Furthermore, existing businesses need to be retained and re-investment and expansion should be encouraging. The city should establish itself as an Entrepreneurial City which would foster a culture of entrepreneurship through City supported SMMEs and reform of the CoJ's approach to the informal sector. Environmental and Resource Sustainability: focus on economic growth that contributes to reducing Johannesburg's carbon footprint and water supply security (CoJ, 2018).

The second relevant priority is that of ensuring pro-poor development that addresses inequality and poverty and provides meaningful redress (CoJ, 2011; CoJ, 2014; CoJ, 2018). With many of the city's residents still being impacted by the countries past legacy and having to rely on social grants and welfare organisation or family or friends. The City has unapologetically focused on redress, development and the upliftment of poor communities. Pro-poor development means ensuring that the City's resources and funds are focused on addressing spatial and all forms of income inequality – ensuring inclusive and diverse communities suffering from inadequate service delivery in comparison to their more affluent counterparts (CoJ, 2018).

The city's people are seen as its greatest asset and sees that they need to be supported and encouraged to realise their full potential to become fully fledged urban residents. The City's pro-poor development agenda is articulated through the Human and Social Development Strategy and provides a framework within which the city policies can afresh conditions of poverty, inequality and social exclusion on a city-scale (CoJ, 2018). Two aims of this strategy

that are relevant here is for expanded social support and Investing in special development. For the first priority of expanded social support, the aim is to contribute to enhancing quality of life by providing basic services through the effective implementation of the Expanded Social Package (ESP), ensuring adequate access to basic services, the further development of health care services by expanding hours and services at clinics and advancing the City's efforts in combating communicable and lifestyle diseases, listeriosis, and substance abuse, and through contributing towards food security and promoting healthy lifestyle choices. The other priority for investing in spatial development, relates to implementing spatial planning that brings about meaningful redress (CoJ, 2018). The city has allocated 60% of its capital budget to the poor while continuing to develop an inclusive and integrated transport plan (CoJ, 2018).

Neither however verbalise the support of urban agriculture or food gardens or community gardens. It would appear that the new IDP is focused mostly on creating job growth in whatever form.

3.5) Other Policy Contexts

While this chapter has considered policies and legislation at the national, provincial and municipal levels, there is need to take into consideration the corporate level. Many of the policies mentioned, often emphasise the need for private and public partnerships. These partnerships often arise out of a need to fulfil directives as set out in a company's Corporate Social Responsibility (CSR). While definitions for CSR vary from society to society, and is subject to differing cultures and beliefs, it is widely understood that the phrase 'corporate social responsibility' is used to describe the practice of good corporate citizenship (Skinner & Mersham, 2008; Kloppers, 2014).

In South Africa, many local businesses are uncomfortable with the term 'responsibility' (Skinner & Mersham, 2008; Kloppers, 2014). This can possibly be attributed to the countries development history, in which big business argued prior to democracy that CSR is neither an admission of guilt for inequalities created, not is it implying responsibility for the socio-economic welfare of the country (Skinner & Mersham, 2008). This being the case, many South African companies responded more positively to the concept of 'investment'. With Corporate Social Investment (CSI) being the preferred term by local companies, it may serve to imply a focus on business oriented outcomes, instead of partaking in something because it is vaguely 'ethical' or 'their responsibility' (Skinner & Mersham, 2008). While it can be argued that CSR and CSI do not share the same meaning, in context of differing historical and cultural contexts

‘CSR’ is used here as an umbrella term. In which it serves to indicate that have a certain responsibility for the society wherein they operate from, and in this must manage that responsibility (Kloppers, 2014; Irene, 2017; Gubic, et al., 2017).

Kloppers (2014) notes that there are three types of drivers for CSR, in which these include economic, social and political drivers. Where economic drivers include a company’s reputation or image or is in the form of a pursuit for an advantage or increased competitiveness, it can also stem from consumer pressure or from investors. Social drivers can comprise pressures from NGOs, or a need to be licensed in order to operate or exist as pressure from local communities. Political drivers can manifest themselves as legal or regulatory drivers and political pressure (Kloppers, 2014). These drivers are each applicable to urban agriculture and rooftop farming to varying degrees.

3.6.1) CSR and BEE

For many businesses, engaging with CSR initiatives allow them to avoid government regulations. The implementation of regulations serves to restrict the manoeuvrability of a business and so force compliance. Through this, governments are thus in a position whereby CSR can be promoted through indirect regulation. In January 2004, the Broad-based Black Economic Empowerment (BEE) Act was signed into law (Skinner & Mersham, 2008; Rogerson, 2011; Kloppers, 2014; Irene, 2017; Gubic, et al., 2017). This placed CSR firmly onto the corporate agenda and is the beginnings of the establishment of an enabling environment towards equality (Skinner & Mersham, 2008; Kloppers, 2014). This was achieved through legislatives measures such as the BEE Act itself, the ensuing Generic Scorecard and the BEE Sector Charters which include CSR as an element of BEE scorecards (Skinner & Mersham, 2008; Kloppers, 2014). In which the Act mandated the Department of Trade and Industry, to issue out Codes of best practice for BEE, so that companies could receive guidance for implementation of BEE as is relevant to their own industries (Skinner & Mersham, 2008; Irene, 2017; Gubic, et al., 2017).

Codes that were issued out by the Department of Trade and Industry include indicators and weightings that measure compliance and are outlined in the Generic Scorecard. These indicators include amongst others – ownership, management control, employment equity, skills development, preferential procurement, enterprise development and socio-economic initiatives (Kloppers, 2014). These indicators have different weightings (Table 3-1), where compliance thereof will result in a given BEE status, and by extension BEE recognition level.

Table 3-1: compliance indicators and weighting in the Generic Scorecard. Source: (Kloppers, 2014; B-BBEE Commission, 2016)

Indicator	*Weighting*
Ownership	20 points
Management control	10 points
Employment equity	15 points
Skills development	15 points
Preferential procurement	20 points
Enterprise development	15 points
Socio-economic development	5 points

This recognition level then indicates how much recognition a business will receive through State or other business dealings. The higher the score accumulated through scorecard compliance, the more significant the level, and the more likely sought after a company would be for their business. In this, the State or a business entity would want to work with a level 4 contractor than one with a level 6 compliance (Kloppers, 2014).

When one considers Table 3-1 in context of rooftop farming or urban agriculture at large, there are some indicators that could be applicable to the industry. These being Skills Development, Preferential Procurement, Enterprise Development and Socio-Economic Development. Skills development consist of investment into any specified learning programme, in which 9 points are allocated, the other 6 points are awarded according to contributions to learnerships such as bursaries. A short fall for this though, is that this indicator is only applicable to company employees. In this then, if a company were to engender skills development for members of a local community, compliance points would only be rewarded in respect of Socio-Economic Development – which only awards 5 points (Kloppers, 2014).

The indicator for Enterprise Development is aimed at encouraging social investment and stimulating Black businesses, in which it directly encourages Black entrepreneurs in being able to participate in the economy (Kloppers, 2014). This entails monetary or non-monetary

contributions awarded to a beneficiary in order to assist or accelerate the development or financial sustainability of the beneficiary. This will award a business 15 points, and can add an additional 15 points, from the perspective of including Preferential Procurement, where a company can develop a business so as to be supplied by said business (Kloppers, 2014). An example that is somewhat relevant to rooftop farming is the SAB Kickstart campaign, which is funding farmers for training, and assisting the development of their farms, so that SAB may receive produce supplied by the farmers that were their beneficiaries (SAB InBev, 2019).

3.6.2) CSR and the SDGs

CSR however need not only relate to BEE compliance, but can also stem from corporate mandate to fulfil sustainability outcomes outlined within their own corporate sustainability strategies (Malan, 2016; Naidoo & Gasparatos, 2018; Rosati & Faria, 2018). The concept of Corporate sustainability has become a pertinent element in the long-term success of an organisation. Corporate sustainability refers to the "integration of the triple bottom line of financial profitability, environmental protection and social responsibility into organizations' core purpose and activities" (Rosati & Faria, 2018, p. 3). With the change over from the MDGs to the SDGs, the UN called for companies to contribute in the realisation of the goals through four approaches (Malan, 2016; Naidoo & Gasparatos, 2018). In which companies should demonstrate support through their core business activities, through advocacy and public engagement, through the more traditional social investment and philanthropy as well as through engaging in partnerships and other signatories (Malan, 2016).

In call for corporate action came about the development of the world's largest voluntary corporate citizenship initiative which is the United Nations Global Compact (Malan, 2016). The UN Global Compact is a strategic policy initiative aimed for business that wish to align their strategies and activities with ten universally accepted principles which touch on different spheres such as human rights, labour, environment and anti-corruption (Malan, 2016). In this, businesses are encouraged to adopt precautionary approaches to environmental challenges, as well as to undertake initiatives which promote environmental responsibility and encourage the development and the diffusion of technologies which are environmentally beneficial (Naidoo & Gasparatos, 2018).

In this then, there is mounting pressure from stakeholders, consumers and investors for businesses to integrate SDGs in the core of their activities. These are made possible through corporate sustainability reporting, and by extension corporate social responsibility. In this then

companies may use CSR/CSI in order to fulfil development strategies as outlined in their sustainability reports, which may have been integrated with elements of the SDGs (Rosati & Faria, 2018). With urban agriculture and rooftop farming fulfilling various requirements outlined by different SDG goals, it is possible for a company's CSR campaign to support such activities as part of required sustainability outcomes.

3.7) Placement of Urban Agriculture in the Policy Context

South Africa's agricultural policy is largely driven by directives that fuel the creation of job opportunities, in which the agricultural sector is used as a vehicle for the development of rural economies (Haysom, 2009; Drimie, 2015). This is further enforced by overarching national objects set forth in the form of the NDP, NGP and IPAP, to which the APAP has aligned itself to, and by extension the DAFF. Given this, the MTSF measure the performance of each department as to their progress in terms of achieving NDP outcomes. As a result, the DAFF, and other departments thus ensure that their strategic plans and annual reports are centred around fulfilling MTSF outcomes. Regarding agriculture relevant MTSF outcomes are 4, 7 and 10 (refer to Figure 3-2). Outcome 7 effectively relegates UA from its criteria since it is specific to addressing food security within rural areas. Thus, in order for UA to be applicable to departmental agendas, it must then present itself as an activity that creates employment opportunities as per outcome 4 - especially for the previously disadvantaged – or as one that emphasises environmental sustainability as per outcome 10.

This is evident since the agricultural departments for the provinces of Gauteng, Western Cape and Kwa-Zulu Natal each state their alignment to MTSF outcomes, the APAP and NDP. These frameworks each enforce the development of rural economies through using agriculture and agro-processing as vectors. Each province has also set aside mechanisms for capacity development and skills transfer for small holder farmers, as well as other funding for farming technologies at various levels. As climate change becomes more prevalent, issues around sustainable farming have become more important, in which an approach by each provincial department has been to extend access to research and information technologies. While the rural focus may work against Urban Agriculture, policy implements may serve to benefit those in peri-urban zones. However, there still remains to be no mechanism for support of UA at a national or provincial level (Rogerson, 2011; Haysom, 2015; Drimie, 2015) While government has sought to tackle the 'big policy questions' surrounding challenges to food security, little attention has been afforded to where urban agriculture would fit in (Rogerson, 2011). As a result, UA, inserts itself as an extension of other policy and urban development mandates.

These have a much wider agenda with regard to economic development and associated strategies, so they do not garner the necessary support that Urban Agriculture would receive from a policy specific directive (Rogerson, 2011; Haysom, 2015). It would seem then, that issues pertaining to UA is thus in the hands of municipal governance.

This can be seen in the city level responses to UA such as through the likes of CoCT's Urban Agriculture Policy, the CoJ's Urban Agriculture Support Programme, and eThekwinis Agro-Ecology Programme. These initiatives have each sought to support community gardens, and support smallholder farms, in similar provincial level approaches through capacity building, skills transfer and the supply of basic tools. In this there is also the underlying National directive of economic growth as per NDP. While UA seems to be being supported then at a municipal level response, there still remains little consideration for UA within the actual urban space. This is since many of these policy approaches are still based on some 'rural' sentiment, wherein farming is to take place on the city outskirts. Some of these policies however also include the establishing of market chains, such as those mentioned in the CoJ's framework, however these are more specific to the inclusion of informal traders in the overall formal system. This could perhaps serve to benefit Rooftop Farmers, since establishing a reliable market chain it is perhaps one of the greatest challenges (Specht, et al., 2014; Delshammar, et al., 2017; Thomaier, 2017).

In the absence of specific policy outcomes then, Rooftop Farming is perhaps most relevant to building owners. It is in this space, that Rooftop Farming must exist out of cohesive partnerships made between building owner and farmer. In which it is either the building owner, or the farmer who is seeking to establish the enterprise, either to fulfil CSR or BEE obligations, or out of entrepreneurial ambition.

Having explored the policy frameworks that may relate to UA and RFs, the next section seeks to understand the situational contexts in which South Africa's RFs have come about. In which role players for each RF have given their perspectives of their experience in initiating or maintaining a Rooftop Farm, and what the challenges they faced were. What follows then, is a narrative for of South African Rooftop Farming, and an early snapshot of the development of this new industry.

Chapter Four

4) Rooftop Farming in South Africa – A Tale of Three Cities

Rooftop farming in South Africa is relatively new, in which one of earliest farms were launched in 2009, with many new entrants only coming into existence in the last 5 years. This chapter is aimed at establishing a baseline status for the Rooftop Farming trend within the country by looking at its 3 biggest municipalities. This chapter presents a short narrative for each case study that has been identified within the 3 city municipalities. Following are the challenges that each role player encountered during their experience in initiating or maintaining their RF project. Perspectives are then provided by them as their views on the industry in the country at large. In which the chapter is concluded by a summary of the trends as given by the interviewed role players.

4.1) Research Outline

The research focus for the dissertation is on urban agriculture taking place on a rooftop space. Where Urban Agriculture is based on the definition in which it is "the growing of plants of plants and raising of animals for food and other used and around cities and towns, where related activities are included in terms of production, processing, delivery and marketing of farmed products" (Mougeot, 2000, p. 10). While Ceron-Palma, et al., (2012) give that a rooftop garden may grow aesthic plants and edible produce, the study focus is on the productive element of such 'rooftop gardens'. Therefore any identified rooftop space that had been used for the production of edible plants was then included into the results. In short, if there was any activity on a rooftop that grew edibles, it counted as a farm, what was done with the edibles, or grown alongside them did not influence the research criteria.

The results had been entered into Google Earth and were divided up into the following 3 categories: Operational Status, Growth Method and Rooftop Typology. Operational Status became something that had to be highlighted, since it appeared that while some farms were not presently operating, there were intentions to continue its activities. In addition, some RF's had to be dismantled due to building maintenance or were in fact being expanded. While other farms are at present defunct, they were still included in the results due the presence and cost of the infrastructure. In which they were still on the rooftop, and activities may likely commence once more due to the initial capital investment that such an installation embodies. Growth Method highlights the differences in growing mediums used, these being soil, hydroponics, or

even a combination of the two (mixed). The last category has divided the RF's according to their intended function.

Categories regarding RF function have been adapted from Thomaier's et al 2014, paper entitled 'Farming in and on urban buildings: Present practice and specific novelties of Zero-Acreage Farming (ZFarming)', which outlines 5 ZFarming typologies. These are 'Commercial', in which the main aim for the farm is for economic viability. 'Image-oriented', whereby the farm is not a source of revenue but rather imbues other benefits, such as growing herbs or produce for a restaurant kitchen, or corporate canteen (Thomaier, et al., 2014; Buehler & Junge, 2016). 'Social and Educational' wherein the overall objective is to instil sustainability values within a community or educational context, these are often non-profit. These can be found in schools, university, or other public, private institutions. 'Urban living quality' is used for enhancing a residential, commercial or mixed-use space, which can serve as a recreational area and is open to the public. Lastly there is then the 'Innovation Incubator' which serves as a prototype and promotes new and novel concepts in food production (Thomaier, et al., 2014; Buehler & Junge, 2016). These typologies have been applied accordingly to the South African concept, and for the most part have largely held true. For the purpose of this dissertation however, 'Social and Educational' has been altered, in which the two have been made distinct. The 'Commercial' typology has rather been changed to 'Entrepreneurial'.

4.2) South Africa at a glance

In South Africa there is a total of 25 rooftop farms, in which 5 are temporarily on hold. This compares rather impressively at a country level. Buehler and Junge had in 2016 undertaken a survey of rooftop farms internationally. The criteria of the survey were for any rooftop farm greater than 100m^2. With these criteria in mind, South Africa's total is then approximately 12 Rooftop Farms.

To put this number in perspective, internationally Europe as a continent only had 11 farms with countries such as Germany, Switzerland each having 2 and Netherlands having 3 (Buehler & Junge, 2016). Indeed, at the time the study was conducted, it found that Asia had 6 rooftop farms as per square area conditions. North America contributed the greatest to the results and had 40 rooftop farms with the USA contributing 30 farms to the list (Buehler & Junge, 2016). In South Africa alone, many of these farms had come into development within the last 4-5 years, it is likely that the results from Buehler and Junge's report may have added entries.

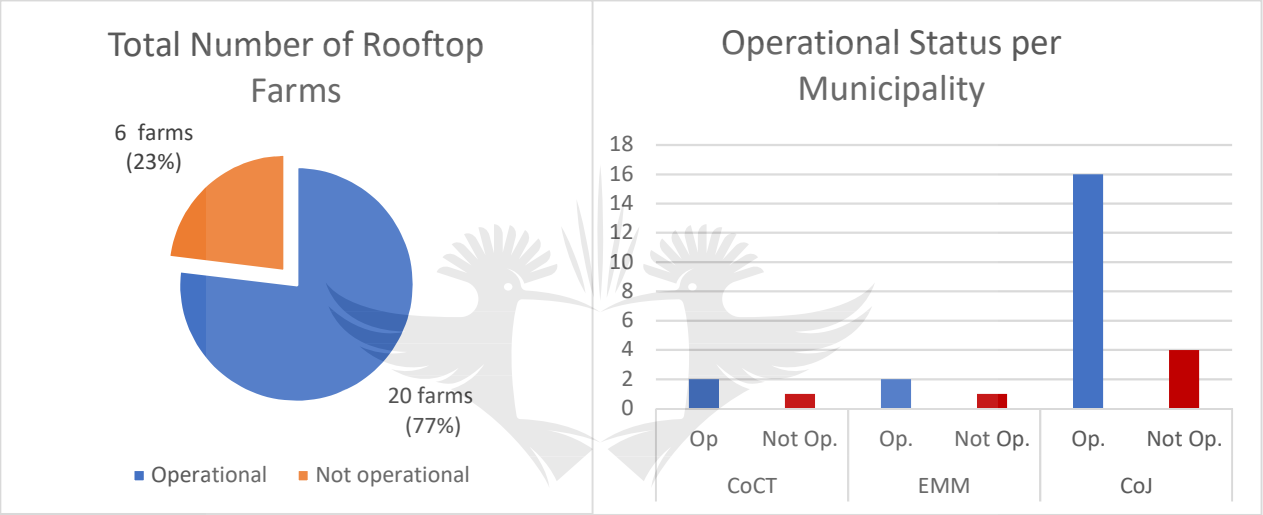

Figure 4-1: Pie Chart (left) showing number of operational and non-operational rooftop farms nationally, Bar graph (right) showing numbers of operating and non-operating RFs per municipality. Source: (Author)

Figure 4-1 shows how many operating and non-operating RFs there are in the country. The barograph alongside shows the operational status within each municipality investigated. Of note is that CoJ has the largest share of operating RFs in the country, while the CoCT and EMM appear to occupy a small percentage in comparison.

The Rooftop Farms at a country level are quite diverse, in which there is a varied typology in each city where there can't be said to be a singular focus. In which there are 3 different rooftop farming typologies in each city. As Figure 4-2 shows, the CoJ is the only municipality that is producing RF's that are profit driven, in which they are run by entrepreneurs. Figure 4-2 however, includes the total number of RFs, and has not excluded the currently non-operational farms. This was since many that were identified still had intentions of resuming farming activities in the near future.

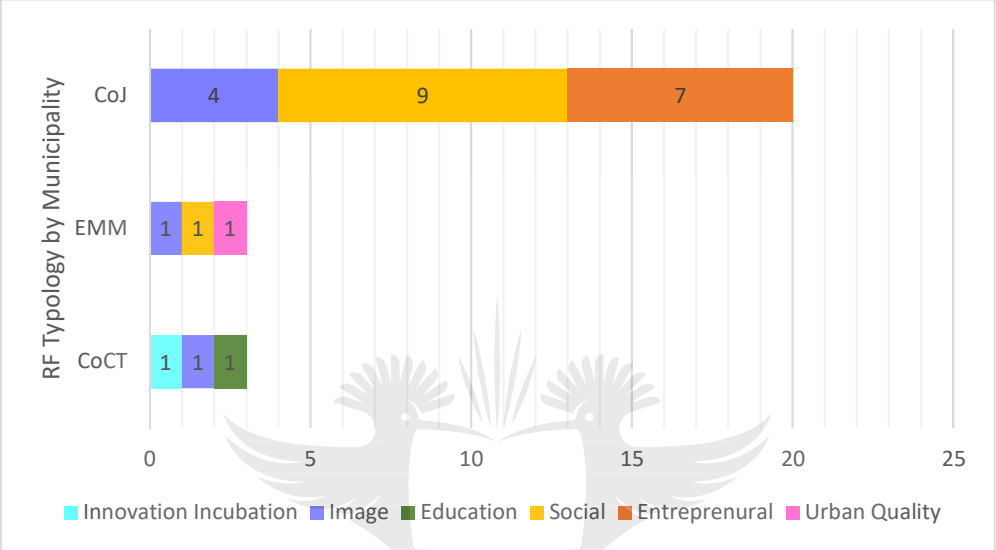

Figure 4-2: Different RF typologies within each municipality. Source: (Author)

There is varied use of growing methodologies among the RFs in each city, in which soil makes almost half the statistic. The CoJ however is the only city to host RF's that are primarily hydroponic (Figure 4-3).

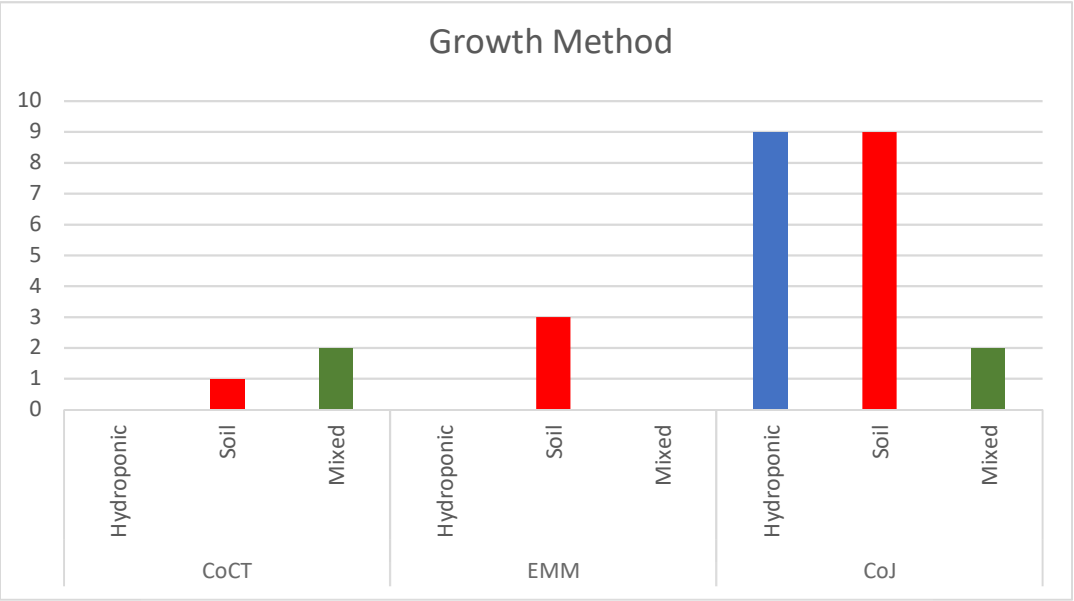

Figure 4-3: Growth method used within each municipality. Source: (Author)

This following section will now explore each municipality in further detail, and will relate further perspectives of stakeholders and role players for each farm.

4.3) City of Cape Town

The City of Cape Town (CoCT) is within the Western Cape Province and is located in the southern peninsula. As the provincial capital, and primary city of the Western Cape, it ranks as the second-largest economic centre in South Africa, and is also the second most populous after Johannesburg. National Parliament and many government offices are situated within the CoCT making it legislative capital of South Africa (Municipalities, 2019).

The metropolitan municipality has a coastline of 294 km, and is bounded by the Atlantic Ocean to the south and west. Cape Town's summers are usually warm, dry and mostly clear, in which its winters are cold, wet and partly cloudy. For most of the year, there city is quite windy, with speeds averaging approximately 20 km/hr throughout the year. The windiest months tend to be between November and February, where windspeeds have been recorded at reaching over 32 km/hr during this time. The regions rainy period is during the winter months, with good rains falling from April to end August, in which average annual rainfall is approximately 788mm. It should be noted however, that the Western Cape province, had experienced severe droughts between 2014/15 and 2018/19 (Weather Spark, 2016).

While the City of Cape Town is the only municipality in the country with its own policy for Urban Agriculture, this fact did not bode well in favour of rooftop farming. Currently the City

only has 2 operating rooftop farms, where a third had been implemented but has since ceased (Figure 4-4).

Figure 4-4: Distribution of RFs in the CoCT - blue shows currently operational, red shows non-operating RFs. Source: (Data applied to and taken from Google Earth)

4.2.1) The Westin and ON19

The Westin Hotel boasts a rather advanced, although small rooftop farm. While some definitions may categorise it as a herb garden, it still falls under the criteria as a rooftop farm. As per purposes of this dissertation, it is image focused. The RF consists of a hydroponic vertical wall with drip irrigated soil containers. It is also fitted with a wormery, which decomposes kitchen scraps and adds compost/fertilizer. The produce grown is that of varied herbs and microgreens which are grown for the hotel's restaurant – ON19 (see Figure 4-5).

Figure 4-5: Hydroponic wall, and soil filled containers, at the Westin Hotel RF. Source: (Head Chef at ON19)

The RF was established in 2012 wherein Vertical Veg, had been contracted to install and design the vertical fittings for the space. They then are responsible for the continued maintenance and upkeep of the farm, and ensure that the desired produce is grown as required by the needs of ON19. In this way the head chef of ON19 is in communication with Vertical Veg in requesting what produce the restaurant's kitchen would need. Upon enquiry, the head chef stated that the garden's size is too small to make an appreciable difference in terms of off-setting kitchen costs for the restaurant. In fact, the garden perhaps costs more than the value it provides. The initiation for the Westin Hotels' RF was to fulfil objectives by its corporate body, which had set forth its own environmental sustainability directives.

> *"It [the rooftop farm] was originally to find a way to actively participate in Starwood's trend setting initiatives of environmental sustainability and green policy by creating our own roof top garden. This also aligns with the recent Marriott merger and their environmental responsibilities". – Head Chef at ON19*

Furthermore, the restaurant's RF was also used as a platform to involve chefs in active participation of growing fresh produce for ON19 restaurant dishes. This then had additional promotional benefits which added to the overall experience provided to the restaurant's patrons.

> *"…it was to also get the chefs involved and participate in the project and for them to harvest the produce grown to incorporate in our ON19 restaurant dishes – a mini version of the 'farm-to-table' concept." – Head Chef at ON19*

The rooftop area is accessible to guests, where there are benches and artificial grass for them to sit and enjoy the view of the beach front. The space is also used for promotional events and parties.

4.2.2) Two Oceans Aquarium

The next rooftop farm to be discussed is located above the Two Oceans Aquarium (Figure 4-6). Unlike the Westin Hotel's RF, this rooftop space is inaccessible to the public and was not borne out of any corporate sustainability objectives. It started as a side project by one of the staff members at the aquarium, where it initially housed a variety of succulents. In 2017, one of the conservational biologists who was caretaker to the sea turtles residing at the aquarium, saw the space as a means to grow food them to eat.

Figure 4-6: The Two Oceans RF, growing various produce for the sea turtles and personal interest. Source: (Two Oceans Aquarium, 2017)

Produce grown consisted mostly of foods that were suitable for the turtles, in which spinach, lettuce, chard, beans and sweet peas were grown. The RF typology has been categorised as educational, since it is used as a segue to bring up issues concerning sustainability to those

visiting the sea turtles at the aquarium. The set up consists of assorted pots and raised beds and occupies a very small space due to the weight constraints of the rooftop.

> *"We kinda upcycled a little bit, because we don't have a budget for it, so we used from our tip, using different containers." – Conservational Biologist*

The garden is watered by collected rain water, and also from condensed water from the air-conditioning units on the roof. The RF however, is limited in size, and is not able to provide enough of food for the sea turtles since they consumed more per day than could be harvested.

> *"It provided a lot of the greens for our herbivorous sea turtles and also some greens were used for our cricket lab. Where we use crickets in turn to feed the amphibians… I don't think it had an actual impact on offsetting costs though. I think it was more of a nice thing to say – that we grow our veggies, because we did use the veggies to feed them. But for us to be able to be completely sustainable we would need to be producing about 2kg of food a day. It helped to supplement what we were buying especially for leafy greens, but for the rest of the veggies we still had to buy a lot in" – Conservational Biologist*

The Two Oceans rooftop farm is however impromptu, and in a sense exists as an experimental space. The area is used by employees during their tea breaks, in which there is a sitting area, and various potted succulents to decorate the area. In this regard then there were other crops planted in garden because it was 'fun to grow'. The garden also was used to grow herbs and fynbos plants that could stand the conditions on the rooftop.

The location of the building structure itself has also worked against the effective production of the RF, in which produce isn't able to thrive due to environmental factors. The area is subject to a wind tunnel effect, in which the seedlings are not able to cope against the resultant strong winds. This together with other factors such as extreme heat, cold, droughts and salty air, cause the RF to not perform as efficiently as desired.

4.2.3) Cape Town Municipal Council

The last Rooftop Farm to be discussed is classed as an Innovation Incubator and was located above the Cape Town Metropolitan Council – see Figure 4-7. This RF no longer is in operation, however, it will receive a special mention due to it having been the municipalities first RF installation. It was launched in 2011 as a pilot project to promote the implementation of more

RFs in the City Bowl. This was initiated as a partnership between the Cities Department of Environmental Resource Management (DERM) and an innovation company – Touching the Earth Lightly (TEL). The implementation of this RF was initially sparked by the DERM. The intended project outcome was to address the issue of rising unemployment in the CoCT, and to explore alternative job creation solutions within the city. As part of the project outcome, TEL conducted research in terms of gathering data on the available rooftop space in the CoCT. In addition, an explorative study was conducted into the available consumer market so as to determine the business sustainability for the RF. The founder of TEL also used the project as a learning opportunity as part of their curriculum.

> *"I pulled in students from the Worcester Polytechnical Institute in Massachusetts, and together we did an audit and a draft business plan, which we presented to the City of Cape Town. In that, I had mapped all available rooftops in the City of Cape Town that could potentially make use of the windswept barren rooftop space… where it can be practically and feasibly reimagined, reinterpreted, repurposed as potential arable urban inner-city farmland." – Founder of TEL*

Figure 4-7: Left soil filled crates growing produce, note the wooden shelter built from alien hardwoods. (Right) view of the RF from the street. Source: (Worcester Polytechnic Institute, 2015)

In this, TEL decided to use the pilot Rooftop farm as a proof of concept for other objectives, in which it sought to use locally sourced labour materials for its construction. The rooftop had been fitted with a wood decking, where the wood had been obtained from locally removed alien tree species.

"The notion was hunkered down, mimicking a birds nest made from locally sourced invading alien timber, in this case it was red river gum. It was cut from Table Mountain." – Founder of TEL

It was intended as a proof-of-concept, to show that the cities rooftops would be able to provide as a usable and productive space, for which locally sourced produce would supply nearby restaurants. The aim was then to grow high value crops such as microgreens, herbs as well as oyster mushrooms. The completion of the RF was used as a showcase for international delegates attending the COP17 convention at the time. In this, it was meant to demonstrate the cities commitment to sustainability, since the farm was also used as a testing ground for sustainable energy implements such as solar panels and a small wind turbine. These provided power to the water pump which provided water to the hydroponic vertical wall. The tank for the water was a large glass fish tank (approach 4m x 0.5) and was later envisioned to house tilapia, which would make the system aquaponic, a true closed system.

The project however has since ceased in 2015. Various factors are attributed to its failure, in which the main cause was due to a lack of tangible commitment to maintain the RF. The RF had never received an allocated long-term budget for maintenance and upkeep. Some employees from DERM each were designated a crate of produce to look after. The RF as a whole was tended to by visiting international students and interns, who would work in the building or who were fulfilling requirements for their course. This then resulted in infrequent and inconsistent care for the RF, and a lacklustre attitude towards it, as new interns or students would take over, and employees losing interest in looking after their assigned crate.

"The initial – and in retrospect flawed- suggestion was that visiting students from overseas would manage and maintain. But then what happened was the interns would be there for 3 to 6 months, then afterwards it would be 'ok we've done our special conscious period in Cape Town', then after that would go home, and the Capetonians would be 'ok well, that's nice'. It became an area where people would go for smoke breaks, or goof off. Every now and then you'd have one or two passionate people that would breathe life into it. Touching the Earth Lightly, or no other entity was ever given a maintenance contract. It never formed part of a broader or holistic environmental education plan, or fitted into a policy framework or programme beyond the cities having posters, where if you looked closely you

would see a building, and then on top you would see someone growing food."
– Founder of TEL

The final straw was the harsh drought, which was experienced in the region, in which all forms of water use was severely restricted. In a sense it is ironic that this RF pilot, which was meant to kick-off the trend for rooftop farming in the city, died. In this, is perhaps a reflection of the general attitude towards the concept by the municipality.

4.4) eThekwini Municipality

KwaZulu-Natal is situated to the south-east of South Africa, in which it is bordered by the Indian Ocean. The largest contributor to the provinces GDP is its manufacturing sector, followed by the agricultural sector which is also central to its economy. Much of its coastal belt is used for producing sugar cane, and subtropical fruit, while farmers inland tend to focus on vegetable, diary and stock farming (Municipalities, 2019).

eThekwini is the provinces largest metropolitan municipality and is the third largest in the country. The municipalities boundaries are larger as compared to other metropolitan municipalities in the country. The region is topographically hilly and has many gorges and ravines wherein there is no really a true coastal plain. eThekwini boasts to have the continents best-managed and busiest port (Municipalties, 2019).

The average weather conditions for eThekwini are generally described has having warm. Oppressive and wet summers, where its winters are relatively comfortable. Average temperatures range at between 14'C to 28'C during the year. Average Annual rainfall is approximately 975mm, where October to March are its rainiest months. The regions windiest times are between August and January where wind speeds during this time average about 18.5km/hr, with wind speeds having been recorded at a max of 32km/hr (Weather Spark, 2016).

The municipality of eThekwini, at present, has 2 known rooftop farms that are currently in operation, and 1 that is temporally on hold while it is being expanded (Figure 4-8). These are each located within the city centre and are in relative proximity to one another.

Figure 4-8: RF's operating in eThekwini - blue shows currently operational, red shows non-operating RFs. Source: (Data applied to and taken from Google Earth)

4.3.1) Area Based Management Building

The first RF to be discussed, is Durban's first RF installed in the city and falls under the Urban Quality typology although there are also attributes which make it fall under the Educational typology too. It was initiated and completed in 2011. The project intention was to convert the area into a usable public space, which would serve to transform the surrounds into something that encourages public engagement and interaction. In so doing, the newly transformed space would then discourage crime in the area through beautification and also provide an increased security presence. The RF is above what is currently the Area Based Management (ABM) Building (previously the Urban Management Building), in which the farm was formerly called the Facilities Management Priority Zone (FMPZ). The rooftop space was converted as part of the eThekwini's 'Municipality Renewal and Urban Management Programme'. The greened rooftop space was well timed, wherein it was completed before the COP17. With it being some 100m away from Durban's International Conference Centre, it served as a convenient showcase for visiting international delegates, to show the cities commitment to sustainable implements.

The space is approximately 1300 m^2 and consists of both an aesthetic and productive space. The RF itself, is part of a public access area, in which there is a succulent garden and green space, with benches for people to sit, a giant chess board as well as additional space to host events or pop-up markets. Produce is grown in soil raised beds and upcycled containers such

as metal drums and old tyres and is watered by collected rain water which is supplied by a neighbouring building at no cost.

> *"We don't have any JoJo tanks, so we've asked the people next to us if we could use their rainwater. They didn't mind, even the new guys that have moved in have allowed us to continue using their collected rain water." – Manager at ABM Building*

Figure 4-9: Public Access RF at the Area Management Building in eThekwini. Source: (eThekwini, 2015)

All fruit and vegetables are donated to nearby charity organisations, which aid the homeless, and another which supports the elderly. Those tending to the farm receive a basic salary as provided by the Expanded Public Works Programme. While the rooftop space does house solar panels, these are for the buildings lighting, and so is not integrated into the farm, in a manner where shade might be provided, or where pumps would be powered.

While it is stated that the RF came about as part of the Renewal Programme, its initiation came about in a far more nonchalant manner. In which the former manager for what was then the Urban Management Building saw the flat rooftop, and "decided" that it would be an ideal space to beautify. The result was a formed partnership between multiple private contractors and the municipality itself. A landscaping company by the name of TopTurf designed the farm and gave advice for its installation. Another company, Drake and Skull, then installed and maintained the space. Later, maintenance was overtaken by the municipality due to costs, and also due to eThekwini absorbing Drake and Skull as an entity. In this, the FMPZ changed its name as a new and similar programme came to the fore. This new programme is the Inner City Thekwini Regeneration and Urban Management Programme (iTrump). The rooftop space is still utilised as intended, in terms of discouraging crime, and providing a recreational space,

where it has an added focus of education. In this, the rooftop space receives many visits from various schools both locally and nationally, in which sustainability concepts and issues surrounding food security are taught to the learners. The RF is also used to generate income through providing tours to interested locals and international visitors and is oft frequented.

4.3.2) Old Durban Station Clothing Retailer

The next farm to be discussed is an Image type, located at the headquarters of a large local clothing brand retailer, near the Old Durban Railway Station. This RF was installed in 2017 and came about as a direct result of the installation of the FMPZ farm, and was also designed and installed by TopTurf.

> *"One of the group's divisions, lead the initiative. The garden was based on the Priority Zone in eThekwini" – Sustainability Unit at Clothing Retailer*

The rooftop space is situated in between two office buildings, and so the space was designed with foot traffic in mind. Thus, the RF was more intended as a productive green space, which then breaks the dull urban scene with some greenery, in which employees may sit during a break. Produce is grown in raised beds and upcycled containers, similar to that found at the FMPZ, and supplies the canteen with grown produce. It is likely that the produce grown is not sufficient enough to completely offset the kitchens costs. It would appear that the rooftop space is intended as the corporate's commitment to sustainability, while not explicitly stated, the RF is given as an example to the corporates actions towards such issues. Those maintaining the garden, and those responsible for installation at the corporate were not willing to give further comment. Presently, the rooftop space is being overhauled and expanded, the motivations behind this are unclear and remain speculative.

4.3.3) Central City Mission yaseThekwini

The last RF in eThekwini can perhaps be considered as something rather informal as compared to what one would expect a farm to be, in the urban sense as contextualised by a rooftop space (Figure 4-10). This farm is a Social type, and is located above the Central City Mission yaseThekwini, a Methodist church situated just a street behind the former FMPZ. It was initiated early 2019, as part of a community initiative to provide food security and skills development to those in need.

"We are a church, that works with the community, because our agenda is motivated by the centre in which we fund ourselves. In our church we have a centre for men, who come from the outskirts our province coming to seek employment in and around the city. So, we house them at the church because they cannot afford to rent property or a flat in and around the city. It is out of that mission project we then felt that we not only provided them with accommodation but also assist others in terms of food production, so capacitate them with skills. And part of that understanding, was that if you want to conquer someone you must conquer the brain and stomach" – Reverend at Central City Mission yaseThekwini

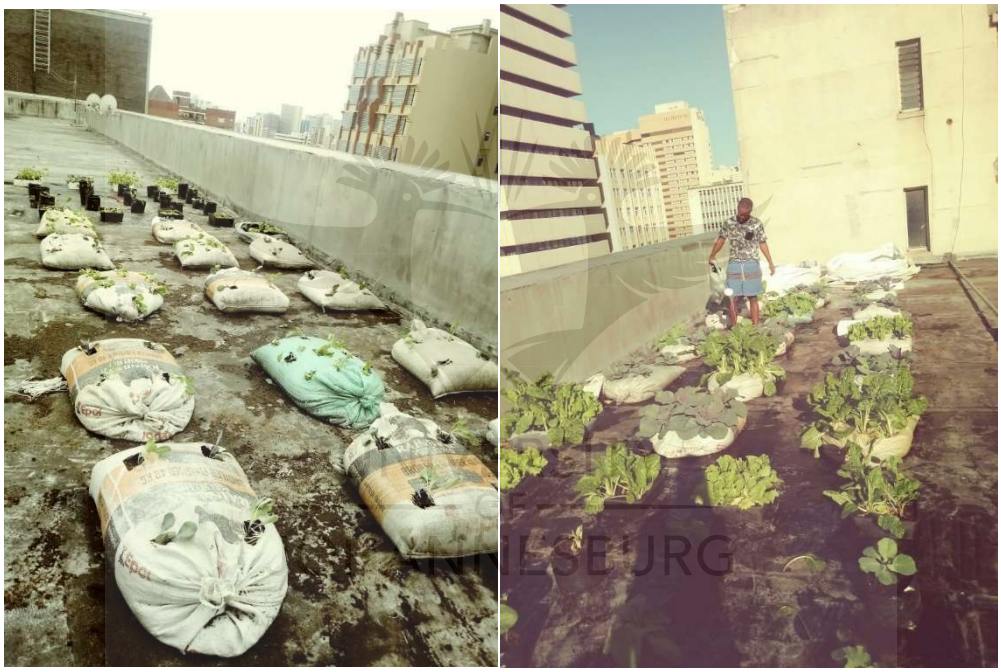

Figure 4-10: Unique soil containers used to grow produce for church soup kitchen. Source: (Church Rooftop Farmer)

The RF grows lettuce, spinach, tomatoes, cabbage and other similar subsistence crops, grown in soil in raised beds and containers. It is tended to by a volunteer farmer, who does not profit from any work put in. All produce is grown for the churches soup kitchen, which serves food to the cities poor every Tuesday. Quantities supplied by the RF are not sufficient for complete cost offsets in terms of ingredients needed for this cause.

4.5) The City of Johannesburg

The City of Johannesburg (CoJ), is in the province of Gauteng. Gauteng is the smallest province in South Africa, and accounts for approximately 1.4% of the total surface area. While this being the case, it is the most populous province, and is home to some 13.4 million people, which is approximately 24.1% of the national population. Gauteng is situated on the highest part of the interior plateau, which makes up the Highveld (Municipalities, 2019).

The province is termed the economic engine of the country and the subcontinent and produces about 35% of the country's GDP. In this the City of Johannesburg is thus considered the economic hub of the country and is often the first destination choice by those seeking jobs. The CoJ boasts to be the most advanced commercial city in Africa and is core to the country's economy. Due to its mining history, the cities demographics are ethnically diverse, and is defined by a long history of local and international migration (Municipalities, 2019).

Johannesburg has long warm summers, with winters that are cold, dry and clear. Average temperatures vary through put the year between 2'C and 27'C. The regions rainy months are from October to march, with an annual average of 604mm. Windy months tend to be between August to November with an average wind speed of 13 km/hr and having a recorded peak of 25km/hr (Weather Spark, 2016).

Figures 4-11 and 4-12 reveal that Johannesburg has great deal more RF's operating within its borders than the previously discussed cities. The city has 16 RFs that are currently being maintained, while 4 are at present not being utilised, either due to renovations or experienced technical or red-tape issues. Figure 4-12 shows the distribution of RF's by typology, where yellow represents farms that have a Social focus, orange is for those that are Entrepreneurially driven, and purple are RF's that function to produce Image benefits. Due to the larger number of farms for the CoJ, the farms won't be discussed wholly on a case by case basis as with the previous cities, but rather by typology, and investigated individually where appropriate.

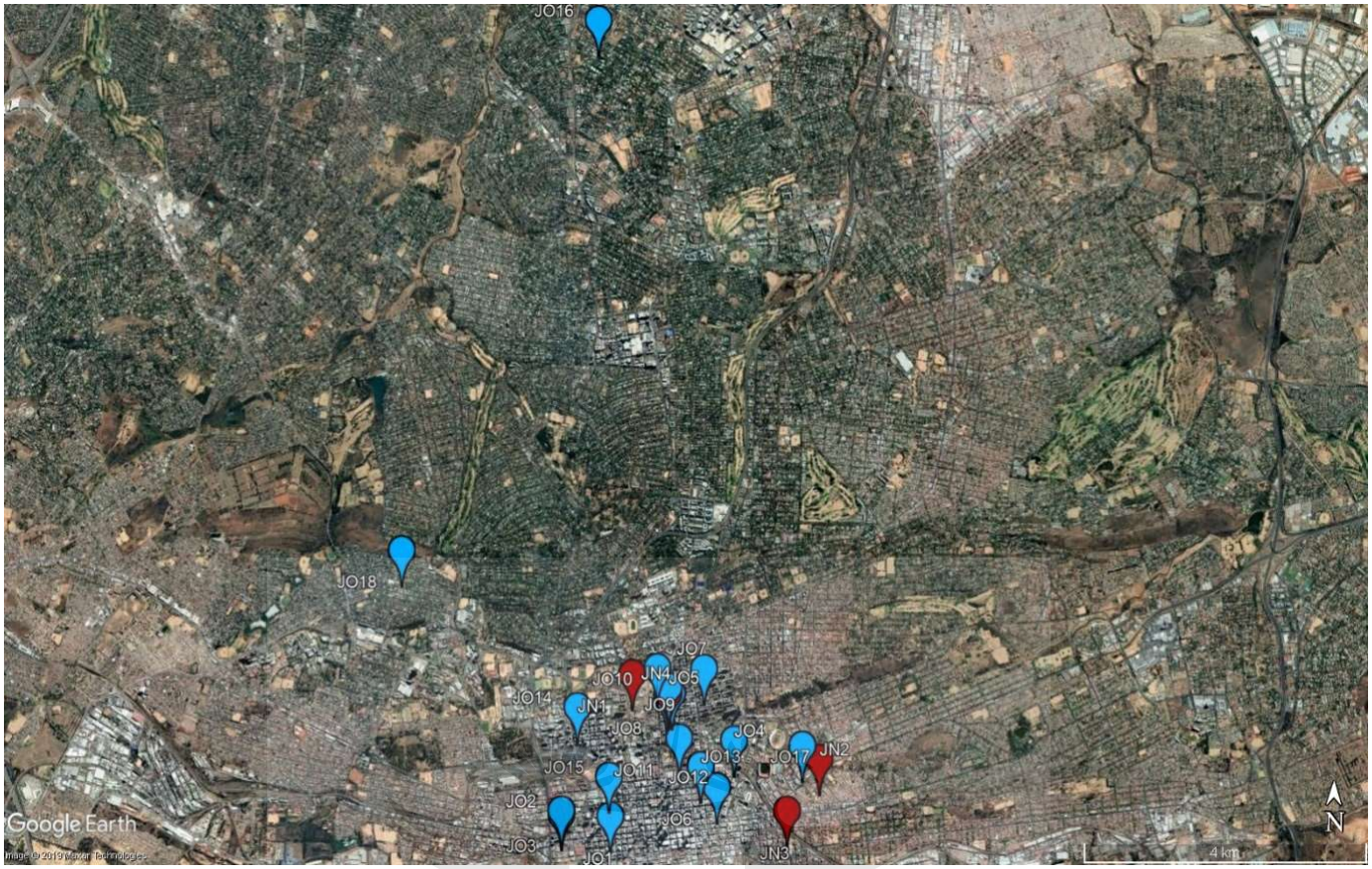

Figure 4-11: RFs operating in CoJ - blue shows currently operational, red shows non-operating RFs. Source: (Data applied to and taken from Google Earth)

Figure 4-12: RF's in CoJ by typology - Orange shows Entrepreneurial RFs, Yellow shows Social RFs, Purple shows Image RFs. Source: (Data applied to and taken from Google Earth)

4.4.1) Social RF's

Interestingly, many of the rooftop farms within the Social typology are mostly on top of buildings which are owned by a housing property group. Most of the property companies operating in inner-city Johannesburg own a great many buildings in the city and are either run by the state to provide social housing or are privately owned enterprises.

The first to be discussed is the Johannesburg Housing Company (JHC), as stated on their website (jhc.co.za), they were launched in 1995 as a non-profit social housing company by government. They own 29 buildings, but in total operate and manage 34 buildings in partnership with other building owners, in which they provide over 4300 rental housing units, and providing homes for approximately 19 400 individuals in low to middle income communities (JHC, 2017). They run several CSI initiatives each year and take part in various social outreach programs, in which their own staff members dedicate their personal time and money to a chosen programme. Through this came the development of rooftop farms on some of their buildings. These farms were initially launched as part of a wider recycling awareness campaign, with added drivers to promote food security within their communities. The principle driver for their CSI initiatives and community upliftment programmes is Makhulong A Matala. Makhulong which was launched in 2003 as a community development services to uplift communities living in JHC provided homes. This subsidiary works with tenants and other stakeholders to establish development for the youth, neighbourhood and tenant support services so as to empower them (JHC, 2017).

The next property owner is the Africa Housing Company (AFHCO) which was founded in 1996, and later came under ownership by SA Corporate in 2014, a JSE listed company. The property group manages 5500 rental units in Johannesburg and provides opportunities for residential and retail space (AFCHO, 2016).

Third, is the Johannesburg Social Housing Company (JOSHCO), which was established in 2003 by the CoJ. Its primary objective was to provide and manage affordable rental housing for those within the lower income bracket. Through this, were other objectives in terms of efforts to reduce the housing backlog within the city. The housing company predominantly serves the needs of those living between R3500 and R7500.

The final housing company to be considered here is Bjala who own Bjala Square, a 4-story building with 151 housing units. The building has spacious and upgraded rooms which are targeted for low-income earners (Bjala, 2016). The company seeks to prioritise tenants from

within the local area earning under the given threshold, thereafter tenants living outside the area and earn more than the threshold are considered (Bjala, 2016). Bjala through their partners Simanye, and through the help of the JDA launched their own rooftop garden and received later expansions as a result of donations from the CoJ, and then later partnering with a rooftop farmer who has since seen the sustainable growth of the farm on the building.

4.4.1.1) JHC owned RF's

Most Social RF's are located atop a building owned by the JHC, in which 6 out of the 9 farms operate on their properties. The driving force behind the development of rooftop farms on JHC buildings is Makhulong A Matala, a subsidiary of the housing company.

> *"Makhulong A Matala is just a direct translation of a Sesotho word - "greener pastures", but in our context, it's a community development link of Johannesburg Housing Company. So, it's registered as an NGO, our role is to provide community development schemes within JHC buildings. Community development services and social issues that emanate from the buildings are dealt through Makhulong A Matala" – Community Development Officer of the JHC*

The establishing of rooftop farms on JHC buildings had evolved out of a recycling initiative that was aimed to raise awareness for tenants around being environmentally friendly. Makhulong A Matala is a socially driven initiative to improve the quality of life for building tenants at the JHC. It is involved in many upliftment schemes for the property company by implementing socially driven projects in the buildings for their tenants. These projects include playgrounds and internet facilities for school learners.

> *One of them [Makhulong's roles] is community development within the JHC. The entire process [Rooftop Farms] actually rests on Makhulong, but the whole concept of food gardens came from the JHC in 2011 as a greening strategy, which was saying we want to create environmentally sustainable lifestyles. But what does that mean? It meant that, on the property management side, when we are buying buildings, we have to make sure that there is an energy saving initiative. We put energy saving lights, and heat pumps, all those energy saving issues that will make the Building environmentally friendly. But then on the community development side then the issue was "what then can we do"? Because the property was also doing*

recycling projects, we felt we could establish a project that can talk to food security in the building. So, if we are saying we are recycling waste for example, we save recycling material but then with organic stuff, we can take it to our food garden. But behind the concept of just greening it was more of addressing the food insecurity for our tenants because we realized there was need for that." - Community Development Officer of the JHC

The JHC farms are all facilitated by Jozi Food Farmers (JFF), who are one of the major role players in farm facilitation for their RFs. For some farms the JFF provide ongoing support and training to volunteer farmers, as well as expertise to the growing of vegetables, herbs and spices.

JFF tends to all of the JHC RFs and so they are all mostly run in a very similar manner. These farms grow their produce out of plastic crate containers – or in some cases out of old tyres - and use straw covered soil as a growth medium (Figures 4-13). The farmers that maintain the rooftop farms are all tenants that have been identified by the JHC. Most of the volunteers received skills training either from Jozi Food Farmers or from Food and Trees for Africa (FTFA) who had also facilitated capacity building for some of the other JHC buildings. These farms are community driven, in that tenants within the host buildings were given the opportunity to attend training workshops and are then made responsible in tending to the farm. In some cases, up to 20 individuals took part in the workshops, where this number was whittled down to 3 or 4 volunteers. JFF however maintains an ongoing service to Makhulong, and all JHC's volunteer farmers.

"The day to day maintenance rests with the members. So, when you get there, we would recruit members and train them to manage, establish and maintain the food gardens, but then once a week we get a support visit from a service provider which is Jozi Food Farmers. That help them with recruiting, typical skilling with what to plant now and then, which is a one-hour session every month. But then the day to day maintenance is done by members inside" – Community Development Officer of the JHC

These farms grow a variety of produce such as spinach, cabbage, sweet potatoes, peas, beans, onions, mint, rosemary and basil. Many of the JHC farms use shade netting to discourage birds and pests, and have made as much use of the rooftop space as possible. Disappointingly none

of these farms use any sustainability conscious techniques however, such as rainwater capture or grey water recycling. Consequentially, they all make use of municipal water for irrigation.

Figure 4-13: Images obtained from Rooftop Farms on top of buildings owned by the JHC. (Top left) at Hillcrest Mansions, (top right) Towerhills Manor Rooftop Farm (bottom left and right) Rooftop Farm at Lake Success

"The whole idea was to get the participants to have access to fresh food, and manage the garden. But also, we encouraged them to sell excess, any excess production for an income. That was sort of the outlook, to make those things sustainable. They don't have to eat everything and finish, and wait for someone else to supply it or the material. I remember one of them [rooftop farmer] started opening a bank account for the money that was generated from the produce." – Facilitator for FTFA

As part of objectives for Makhulong, the produce is grown by the tenants so as to engender income opportunities, as well as provide food and nutrition security to those living within their buildings. The produce that is harvested by the volunteers at the JHC farms, is mostly sold to building tenants, in which all profits made are retained by the involved farmers.

"we have a market day, maybe a once a month when we harvest, and we sell to the tenants… we sell a bunch [spinach] for R10" – Farmer at Douglas Village

"We can keep the profit … the money we make is not bad, it is worth the effort." -Farmer at Lake Success

4.4.1.2) Kotze Street Night Shelter

In the case of Kotze Street night shelter, it was initiated as a pilot programme to launch the Johannesburg Food Resilience initiative by the City of Johannesburg, which owns the building. The Kotze Street RF received skills development and facilitation management by two independent parties. These were the Wits Siyakhana Initiative (WSI) and Ubuntu Business Consulting. The Wits Siyakhana Initiative - which is part of the School of Geography, Archaeology and Environmental Studies at the University of Witswatersrand - aims to promote health within the urban landscape through improving food security, providing economic opportunities as well as healthier environments in context of urban food production and its distribution (Siyakhana, 2014). Siyakhana maintains a community food garden at Bezuidenhout Park. They facilitated the construction of the RF at Kotze street Night Shelter and also provided facilitation in skills development for a some of JHC farms such as Douglas Village and New Hampstead before JFF took over. Siyakhana worked closely with Ubuntu Business Consulting, who specialised in short term project management and large-scale strategic interventions (Ubuntu Business Consulting, 2017). In the case of Kotze street they

provided upskilling to selected candidates for the farms, and also educated them in marketing their produce to potential customers.

The farm consists of 26 grow tunnels that makes use of a hydroponics system. The hydroponics design is that of the Nutrient Film Technique (NFT), which allows it to be very water efficient. The CoJ approached the Wits Siyakhana Initiative to oversee its construction, and initiate the necessary relationships.

> *"Kotze Street was initiated when we were approached by the CoJ for solutions to social issues. We felt a rooftop farm would be appropriate for such a cause. We then identified Kotze Street as suitable for a rooftop space, the CoJ provided the funding for all the necessary materials and people involved. The farm is made up of 26 tunnels that operate on a hydroponics system" – Founder of WSI*

Farmers at Kotze Street were trained by Ubuntu Solutions as well as the WSI, in which volunteers had been trained, and skilled to operate the hydroponics system. Here too, volunteers were tenants of the building, and were selected by the property owner (CoJ). 22 beneficiaries were recruited by the CoJ and brought into the training programme. Of that the top 6 candidates were selected - according to their performance, attendance and participation. These top 6 farmers were then to form a co-operative to manage the farm, in which all produce grown is sold at the fresh produce market nearby. It was also then the role of Ubuntu Solutions to create a link between these farmers and potential customers.

Currently the RF has not been in operation since mid-2017, in which there had been a technical failure in the wiring, and power circuits. Since the farm makes use of hydroponics, electricity is needed to circulate the water, thus without a power source, all the plants have died out due to dehydration. The volunteers however are still growing produce – although in very small quantities – in make-shift soil beds on the roof itself (Figure 4-14). The beds cannot be expanded however due to the weight constraints on the roof structure.

Figure 4-14: Kotze Street night shelter, at the time the picture was taken, the NFT system had run dry (Top left and right). The farmers made a makeshift growing space with soil containers (Bottom centre). Source: (Author)

4.4.1.3) Bjala Square

The establishment of the farm at Kotze Street also sparked the growth of the rooftop farm at Bjala square, in which tunnels had been donated by the city for use (Figure 4-15).

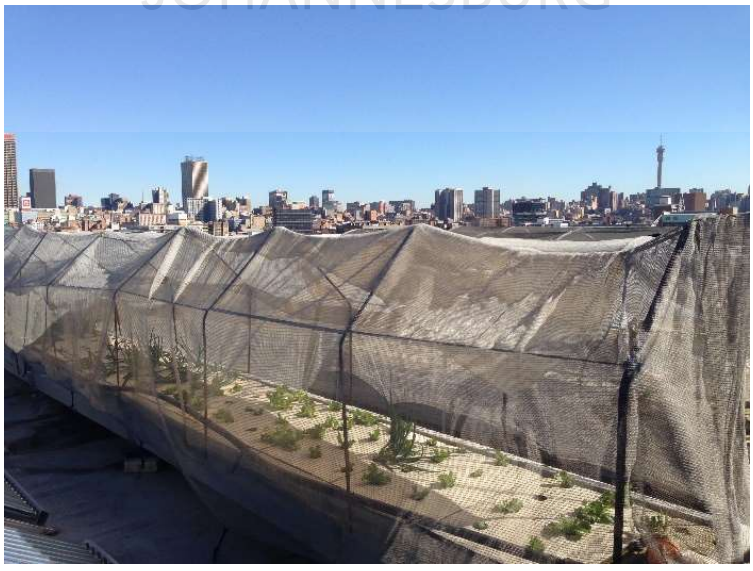

Figure 4-15: Donated grow tunnels to Bjala, by the CoJ. Source: (Author)

" Bjala Square was like a phase of the same project for the City of Jo'burg, they actually wanted another smaller demonstration site that wasn't the main site at Kotze Street. So Bjala was a very small set up that only had 3 tunnels and a seedling tunnel. But they were already involved with some rooftop gardening there - with aquaponics. So, they had some other infrastructure there already as well." – Co-Founder of Ubuntu Solutions

The farm located at Bjala Square is unique since it was the only farm to be operating an aquaponics system on a rooftop in the city. The dynamic between property owner and farmer is also unique, since it differs from other social houses in which volunteers do not maintain the farm. Instead it a private entrepreneur was added as a partner to Rooftop Roots which was an entity that managed the farming operation. The Bjala Square farm was also initiated as a form to engender benefits to the community through directing corporate funding for BEE initiatives. This was over-seen by BEE consulting company Simanye Trust.

"Effectively we started the project, we at Simanye Trust are a non-profit where we look at different social enterprises and we primarily fund them through BEE funding. So, we advise corporates in using their BEE funding in a sustainable way. As part of that we started Rooftop Roots in 2014 and then [partner] came in after that because we were looking for someone to take over like an entrepreneur" – Consultant at Simanye Trust

The project was initiated mid 2014 by Simanye as a prototype to test the viability of an aquaponics operation on the rooftop, in which it received a donation of 4 plant tunnels, as well as hydroponics equipment by the City of Johannesburg (CoJ), as part of the Food Resilience initiative that was launched in 2014.

"It is part of a vision of Simanye Trust, a partner of Bjala, to create social benefits and become more involved with sustainable development issues. I [partner] was then approached to be project manager to the farm. It was built as a prototype to show that it had potential to run. Later I became a partner to the project, and I invest my own money into it." – partner of Rooftop Roots

The Bjala farm grew mostly herbs and spinach, and other leafy produce such as spring onion and lettuce. The fish used in the aquaponics setup are Khoi and so are not intended for consumption as can be found in many conventional setups (Figure 4-16). Their function is purely to generate a nutrient cycle in the system as fertilizer for the plants. It is the hope of the co-manager of Rooftop Roots, that through use of aquaponics, there would not be a need for artificial additives, and could help him in marketing his produce as 'Organic'.

Figure 4-16: (Left) Aquaponics tanks with Khoi fish to drive nutrient cycle. (Right) Expansions made by Rooftop Roots, on top of Bjala. Source: (Author)

The goal was to give the residents of Bjala Square access to nutritious food, as well as to scale up, so as to provide a supply of fresh produce to informal traders. The farm had later expanded from accommodating 600 plants on a space of 300m^2 to 4000 over 750m^2. The use of A frames increases the surface area or productive space since vertical space can be utilised (Figure 4-16). The RF provides employment to one farmer that assists in the maintenance of the farm. This point is stressed, since farmers at the other social farms in the CoJ only receive compensation through the sale of produce, and are there voluntarily.

The farm is at present dormant, due to failure to establish an effective market chain, wherein which there were difficulties in maintaining a reliable buyer for the produce sold.

> *"We found a lot of issues in the supply chain itself. So purely addressing the farming aspect is complicated enough, but then the expectation in this country has always been 'Ok get an entrepreneur', and then they're supposed to market it, do the logistics, get it to the market, build a supply chain, do the entire value proposition, and source the base ingredients, source the best nutrients – and we find that's a very difficult proposition. We looked at it from an entrepreneurship model initially, but the actual issues*

that plagued us, weren't from what we did but rather came from a very difficult environment. We found that if you don't have the necessary skill, it's very difficult." - Consultant at Simanye Trust"

There are however still plans for the farm, in which it is expected to be expanded. Wherein the hope is that with a greater output of produce will engender a favourable outcome due to the larger scales of economy. In this however, the intention is to shift from a single entrepreneurial operation, but rather become a platform to begin upskilling people wanting to become urban farmers, and learn about using hydroponics, and maintaining such a set up.

"So as part of our larger proposal, we would like to make it into an academy. Maybe start off with 20 to 50 farmers, maybe younger farmers in the area, and teach the guys how to do that [maintain RF and sell produce]. If we have at least 20 guys, we can have a better value proposition to create one logistics chain and one supply chain…" Consultant at Simanye Trust

4.4.1.4) African Diamond Building

The last rooftop farm on top a property house building is that of the African Diamond Building. This was the first rooftop farm to be launched in Johannesburg in 2011. At the time the building was owned by AFHCO, and the farm was supported and funded by AFHCO and the JDA. The building has changed hands, in which JOSHCO now owns it, but since AFHCO and the JDA were responsible for its initiation, their perspectives were taken. The African Diamond building had operated in much the same way as the JHC buildings, in which plants were grown in a soil medium in tyres. In 2015, the farm received an extensive and costly facelift, in which containers were upgraded, as well as shade netting and water proofing of the roof surface. Shortly after the building was sold to JOSHCO. AFHCO currently does not own any other buildings with Social rooftop farms, but AFHCO was recently involved with the Urban Agriculture Initiative with the Chamber of Mines as will be discussed further. The launch of this farm reignited interest in the production of rooftop farms on their buildings, however it was explained that there are various other factors involved in the consideration of such an installation on their rooftops.

"For AFHCO, because our core business is residential … they [Investment Committee] come back to me and they say 'but you're already giving them free water, free electricity and free space, what more are they asking? So, to go get money for a capital outlet that were not going to receive back or is

not going to benefit the residential building in its self, in terms of tenanting, and retention of tenants in our building. So, we came up with a new thing, we need to see something that's going to be viable, more sustainable and more beneficial to the business, rather than just giving free hand-outs. But be that as it may, if you're a farmer and I'm giving you free water, and electricity and space. Already as a farmer you're saving on the three most significant costs. So, the farmer or the initiative they would have to come up with the capital to outlay whatever materials would be needed for that specific farming method." – Planning and Urban Development Administrator at AFHCO

AFHCO does not operate as a social house in the same way as the JHC and considerations for the implementation of a rooftop farm are largely formed around Corporate Social Investment. The emphasis here, is in 'investment', where the company must see a return in order for the initiative to take place. Since rooftop farm would involve costs such as water and electricity, the space that is available is often used for recreation such as a kid's playground, or additional rooms are built so that the space is "productive". It is implied here, and later answered that so long as a farmer is able to put up the initial capital costs, rooftop space and associated overheads will be provided by the property house. The involvement of the JDA in this farm and some others like Bjala, was also out of CSI, in which initial start-up costs such as soil and containers were funded by the corporates involved.

4.4.2) Entrepreneurial RF's

While AFHCO no longer owns buildings with any Social motivations, they have instead turned their attention to supporting rooftop farms that have an Entrepreneurial motive. Of the 7 Entrepreneurial RF's in the CoJ, 3 of them are on AFHCO properties. Interestingly, the majority of Entrepreneurial farms, are hydroponically grown, in which 6 of them have been borne out the efforts of a business innovation company Wouldn't It Be Cool (WIBC).

WIBC is an entrepreneur incubator, in which they seek to enhance the development and capacity building for young individuals from previously disadvantaged backgrounds. The overall objective is to begin to steer CSI towards BEE initiatives that are sustainable and make a genuine impact to beneficiaries.

"We work with young entrepreneurs, mostly coming from previously disadvantaged backgrounds. We make sure that we give them financial

support, like business start-ups so that they are able to get on the ground and start making money. We give them training, we give them mentorship on how to run their own business."- Marketing Co-ordinator WIBC

The founder of WIBC is also a director for the Johannesburg Inner City Partnership (JICP), which is a community of various city stakeholders that is seeking to revive the city through corporate and government partnerships. Through this connection, WIBC had managed to kick off the Urban Agriculture initiative.

"We noticed that when it comes to Johannesburg and in other cities, the role of Urban Agriculture is misrepresented. We then began to train people in Urban Agriculture and set them up to run their own farm. This then translated to rooftop farms." – Founder of WIBC

4.4.2.1) WIBC and pilot RF at the Chamber of Mines

The Urban Agriculture Initiative was launched in October 2017 and was launched with the implementation of a small rooftop farm on top of the Chamber of Mines (Figure 4-17). This farm is Gegezi Organics. The farm came into development by happen stance at an event, in which the owner of the farm - who initially had an interest in farming mushrooms in the city- had expressed his interest in urban agriculture to the founder of WIBC. The WIBC, being involved in establishing unique initiatives then set up the necessary relationships and an impetus for this new initiative was formed.

"he made this happen [WIBC founder], … I knew about this last year, I was told they were working on something and that maybe in March the next year or before spring something would pop up… he told me 'We have the space at the Chamber of Mines, we want to start it [Urban Agriculture Initiative], we want a proof of concept, so I need you to make this work for me… When I got there, I didn't have to pitch or present, I was given everything on a silver platter" – owner of Gegezi Organics

Gegezi Organics had only been in operation for 66 days when the interview was conducted, and already had produced 2 crop cycles of basil. The farm is constructed out of a greenhouse which is about 100m2 in size, covered in a durable plastic housing and makes use of Nutrient Film Technique hydroponics. Overheads such as water and electricity are – according to the

owner – very small. The Chamber of Mines has provided the space rent free for the next 3 years, and already Gegezi Organics is looking as expansions.

> *"you make cash here, you break even. In 21 days, I am already able to have a full head of crop. I don't even stress about that [costs of expansion], I'll be funding myself – I don't need an investor" – owner of Gegezi Organics*

Basil is a very valuable crop as compared to other crops such as spinach or swiss chard which can fetch up to R7 and R36 per kg respectively, in the case of Gegezi, he is able to fetch between R180 to R240 per kg for his crop of basil. Gegezi had received training on effective hydroponics techniques as provided by the WIBC and Urban Agriculture Initiative, and also to better know how the produce market works in which he gets sales agents that buy from him at the best price possible. It can be seen here that there is a potential for efficient production given the right skills and production, and market demand can be sustainable. While interviewing the owner of Gegezi he was helping a customer who ran factory for vegan products. His interest in the farm was for its sustainable solutions, its use of natural organic products in the production as well as its high-quality produce. Although a hydroponics cannot be said to be organic, and neither is Gegezi certified to be organic, his use of nutrient additives was all in packaged products said to be so. The buyer seemed satisfied with this (his main concern was animal by-products) and commented on how certification was so costly in any case, and so didn't mind supporting a local initiative.

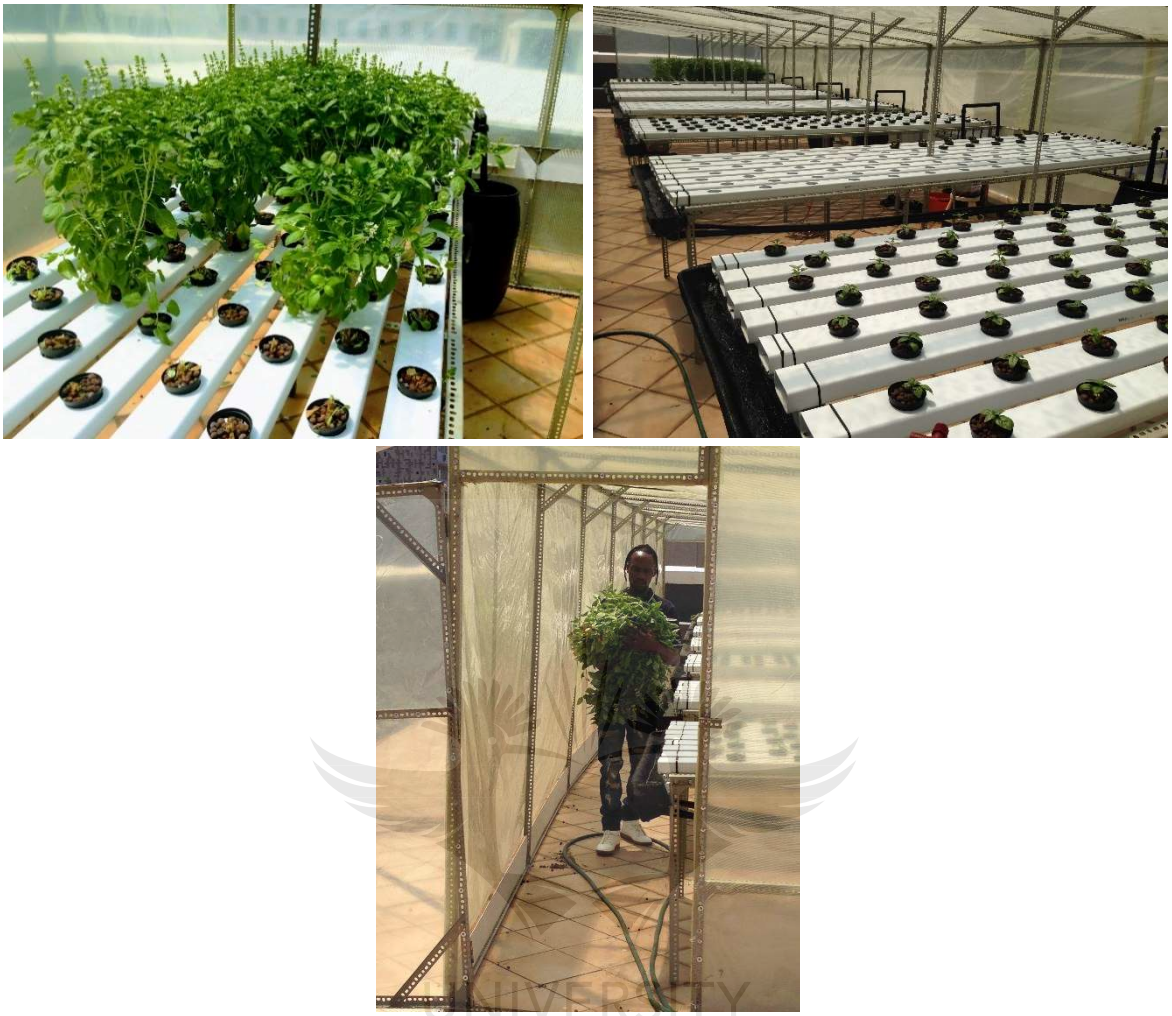

Figure 4-17: (Top left and right) Nutrient Film Hydroponics setup on Chamber of Mines, growing basil. Former owner of Gegezi Organics carrying fresh crop of basil for a customer. Source: (Author)

Such business relationships are imperative in newly emerging industries such as urban agriculture. The farm however has had a change in ownership, wherein there is now a new farmer tending to the RF at the Chamber of Mines. Reasons as to why this change occurred were withheld, but were said to be due to compliance issues. While it may be speculative the main reason may be that a hydroponic NFT system cannot be marketed as organic.

This farm, however, was to serve as a pilot project to show that it was possible to create a sustainable business model around the concept of rooftop farming. WIBC founder is quoted as saying:

> *"We expect no fewer than 500 permanent jobs to be created in this process"*
> *– WIBC founder*

4.4.2.2) WIBC to farm more rooftops

Indeed, the following year, 5 new rooftop farms sprouted up within the city, with an expectation for 20 more farms to go up on top of Johannesburg's buildings. This was made possible through international beverage giant SAB InBev, who have various entrepreneur support programmes. Of which WIBC manages the SAB Kickstart programme, this was then used as a platform to further the agenda of upskilling and equipping urban farmers in Johannesburg. SAB Kickstart consists of a graduation programme, where interested individuals sign up and receive a 5-month training course. This course teaches them how to maintain and operate and hydroponic farm. The course also includes maintaining the farm as a business, in terms of establishing a market, what products to sell and developing market chain linkages.

> *"I saw they were looking for farmers … so I applied, was interviewed and was trained for 5 months, and then after that I was able to get a farm… The farm is mine. What the WIBC and SAB did is, they got funds to get me started with the farm, so it's like a loan, so within 3 years I should pay for the whole tunnel [rooftop farm infrastructure], so after that it will be mine." – Rooftop Farmer at Fox street*

> *"It was a loan basically, and according to how they worked it out – which to me was questionable- they said after 3 years I would be able to pay it back. When I did my cash flow projection for if I were to plant lettuce, maximum I'd be getting R20 per kg… Then when I worked it out for my plants at a capacity 3300, the revenue without taking the costs out was about R12 000 per harvest." – Former Farmer at Stanhope Building*

It can be seen here that not all beneficiaries felt like the loan was achievable. The reason for this was because the prototype farm had grown solely basil, which is a high value crop. Projections for the loan and business model were all centred around this. In addition, the projections assumed that the farmers would be able to establish a market. However, as was found out, and is echoed by those at Simanye, one can establish a farm, and train a farmer, however without the correct market chain linkages, the farm will fail. While the farmer, at Stanhope had left the operation due to a perceived infeasibility of the project, the farmer at Fox street felt otherwise.

"Mostly I take my produce to Jo'burg Fresh Produce Market, so what I grow I take to one of the agents there. What I do is I communicate with her before I plant anything, I ask what would be in demand, maybe a month before, and they tell me and then I grow it… I'll also ask what the price would be, I've never had any problems with them... It's definitely profitable, because where I was growing previously, it needed a lot of labour, for the same space as I was using before, in this system I can produce more produce, or rather get more income, than I used to do on an open land." - Rooftop Farmer at Fox street

In this then, is also something to be noted in terms of what can be seen as differing opinions on what is sustainably viable. Since the Fox Street consists of two separate farms which are each roughly the same size as that at Stanhope, and had also grown lettuce as primary crop (Figure 4-18). Having said that, the Fox Street farmer was planning to grow basil during the upcoming summer season.

Figure 4-18: (Top left) 1 of the farms at Fox Street, (right) second farm visible from location of the first. (Bottom) NEFT A frame growing lettuce in first Fox Street RF. Source: (Author)

Another farm that was launched as part of the Kickstart programme is located at the Outreach Foundation in Hillbrow. The farm is located above a preschool, and the building premises is largely focused on community development. The RF when visited was still finding its feet, in terms of understanding the right conditions for operation. At the time the entire system was growing spinach, and due to a recent heat wave, many of the crops were under strain. The tunnel was made of 30% shade clothe, much like all the other WIBC funded farms. This then shows the extreme temperatures that occur on top of a rooftop. The farmer however was not discouraged. Yet, while she wishes to run the enterprise as a business, her motives are mostly socially centred.

> *"I've got a church group that I supply with spinach, so on a weekly basis I've sent the church produce, but I sell it cheaper because it's the church. I'm more of a social entrepreneur … The plan is to grow more vegetables [wider variety] especially with the creche downstairs. I've spoken to the principle to say they must actually have vegetables that's available when they need…So part of the food security is saying, 'let us as urban farmers be the ones that are - the convenience of people - supply fresh vegetable." – Rooftop Farmer at Outreach Foundation*

The WIBC is not only producing urban farmer graduates but is also training any individuals willing to be part of the agri-business value chain. This comes out of a frustration with regards to previously failed urban and rooftop farms, who cannot get off the ground due to a failure to establish market linkages. In this then, many graduates coming out of the WIBC and SAB entrepreneurship programmes are encouraged to establish business relationships with one another so as to develop a cohesive market ecosystem that would then begin to support urban agriculture in the city. As an example, one of the graduates has started a business that supplies condiments, as part of the WIBC agenda, he sources his ingredients from other graduate farmers to make his products. While this is a small example, the outline is clear, that the intention is to develop the correct market environment to support the industry.

Other examples of market linkages support for the farmers, is also in the form of a mobile app called Khula!. This mobile app was developed so as to link urban farmers with interested clientele. This acts as an aggregator, in which orders received are then fulfilled through the supply of different urban farmers who have available stock. It would seem, however that the

founder of WIBC is not in favour of the aggregation concept. Market linkages can be directly made through an RF's ability to be located on top of the customer. The solution is then not through aggregation but rather through an established symbiosis between rooftop farmer and building owner. Where a corporate receives produce for its canteen, or a restaurant harvests its produce from the roof. While this is his sentiment, the WIBC it seems is playing a crucial role in developing the necessary market infrastructure to sustain urban farmers throughout the city. This is through developing Hola Harvest, a brand for which WIBC farmers supply their produce to, and is then marketed to major retailers in the country. Hola Harvest is already supplying to two retailers, however will soon be rebranded to Mila Fresh. The reason being that Hola Harvest has too many stakeholders involved and so a simpler management structure is required. Having said that, the actions of the WIBC is starting to take rooftop farming to the next level. In which the consideration is not only from the front end or producer side, but is now also building a viable back end, through the consumer side. This is rather important, given that many of the farms find difficulties in finding a buyer.

4.4.2.3) Greatermans Building

The last farm to be looked at was not started through the WIBC, but rather through more traditional ideas of entrepreneurial business start-ups. This RF is based on top of the Greatermans Building, which is owned by AFHCO (Figure 4-19). The farmer was once the farmer who was sourced to maintain and make profitable the rooftop farm at Bjala Square. Using his own capital, he has started up the Greatermans farm, and while it is not fully operational yet, he has an arrangement with the property company to supply produce to the tenants. It is this market chain concept for a RF that is the most favourable outcome, in which the farm will be supplying those within the building it operates above. The farm produces

Figure 4-19: Massive hydroponics setup above the Greatermans building. Source: (Author)

excess than what the tenants demand, and so the farmer sells to the Johannesburg Fresh Produce Market (JFPM).

A question that each farmer was asked was as to whether or not the agents they deal with are helpful. It would seem that no one has really had an issue. This is in light of research findings made by Mun Bban and Thornton (2013) on urban farmers in Johannesburg, wherein agents from the JFPM didn't seem to want to deal with them due to the small batches. Since none of the rooftop farmers had any issues, it may be over quality that is produced. Each farmer was also asked if they had health certification, however none of them had any, and while this wouldn't increase the value of their crop, it may serve to increase their access to the market.

> *"I haven't had any problems with them, I guess because of the freshness, it's pulled on the day – I haven't any problems with my stuff moving… I haven't got certification and while it won't necessarily increase my value, it would increase my probability of selling directly to some retailers" – Greatermans Rooftop Farmer*

So in this then, it can be seen that rooftop farmers are able to access the market, and that there is further room for them to do so. In addition, it would appear that the JFPM is an important access node for farmers in order to sell their produce and is seemingly not hindering their abilities to be profitable as may have been previously stated.

While these are only a handful of urban farmers, they stand out from other urban farmers in that they operate hydroponically grown produce. This gives them an advantage over other urban farmers since they are able to shorten the growth cycle of their produce, maximise on the horizontal space by going vertical, and are able to increase their yield through careful nutrient monitoring.

4.4.3) Image RF's

In the CoJ, there are 4 rooftop farms whose function is image based, As mentioned, these farms are not producing greens for profit, but for cost offsetting in providing fresh ingredients for their kitchens.

Figure 4-20: mixed hydroponic and soil growing methods growing above banking corporate building. Source: (JICP, 2015)

The first farm to be looked at is that located on the building on top of a large banking corporate (Figure 4-20). The farm was part of the JICP Urban Agriculture Initiative. Initially skills had been provided by Ubuntu Solutions, wherein which 4 farmers had been trained to maintain the farming set-up. The farm consists of two set-ups, in which one section a hydroponic tunnel, and the other consists of a series of raised soil beds. However, over the years, the arrangement has changed, and now there is only one farmer, and only the soil section is being maintained. All grown produce is used to supply the corporates canteen and provides fresh grown food for the staff. It is likely, however, that this farm came about as part of the JICP Urban Agriculture Initiative, since the banking corporate in question, is a member.

The next mixed rooftop farm is located at the Troyeville Hotel. The farm is on a rooftop terrace and can be made accessible to the public. The farm consists of two vertical growing walls, which is the hydroponic component, and then several pots and upcycled polystyrene prawn

packaging containers, that are now being used to grow parsley in soil. At present the farm is in transition, but the produce was used to offset costs for the hotel's restaurant. While the owner of the hotel feels that it is at present a novelty, he has plans for later expansion on another section of the roof where there are intentions for a full hydroponic and green house setup.

There is then The Saxon Villas Hotel, which has a soil rooftop farm on top of one of their undercover parking complexes on the property (Figure 4-21). Interestingly the entire rooftop surface has been covered with soil and is used to supply the kitchens restaurants with ingredients that are hard to come by.

Figure 4-21: Soil RF located above parkade at the Saxon Villas Hotel. Source: (Author)

> *"It's pretty big, it is built on top of the parking lot. We grow a large variety of herbs, 20 different types of tomatoes, broad beans, Jerusalem artichokes, globe artichokes, peas, beans, an assortment of heirloom marrows and squash, cucamelons, beetroots, turnips, lettuces… depends on what we have asked to be planted for the season really. It's a big space." – head chef at Saxon Villas Hotel restaurant*

Much like the Westin Hotel, maintenance for the RF at the Saxon Villas has been outsourced to an external company. They then liaise with the kitchen staff, and ensure that the correct produce is grown organically. Adding unique ingredients on their menu such as cucamelons and assortment of 20 tomatoes can help set their cuisine apart from other restaurants in the

locality. The novelty is also appreciated by the clientele since the ingredients are as locally sourced as they can get.

The last image farm is situated in Melville, within the restaurant district in the suburb. This farm is a hydroponics setup and supplies the restaurant above which it is installed. The farm mostly produces butter lettuce, and sells of its excess at a 'harvest day' which has been set-up by the restaurant so as to support the farm.

4.6) Challenges and Perceptions

The interviews were conducted using different questionnaire formats and so were each different for each informant. Questionnaires were made to be appropriate in understanding the role they played in rooftop farming in the city. Given this, however, each participant was asked what challenges they encountered or perceived, regardless as to the role they played. In addition, interviewees were asked how they felt about the potential for the Rooftop Farming industry in the country as a whole. Receiving these insights may serve to provide understanding of the developing industry in various the cities investigated, and also give an impression of what different participants perceived as being problematic as compared to other participants that may play different roles within the rooftop farming community.

4.5.1) Challenges

These challenges will be discussed thematically, and then followed by what some of the perceptions were of the interviewees.

4.5.1.1) Weather and Geographic Location

Each of the city municipalities are located in different climate regions in the country. The different weather regimes thus call for differing amounts of capital investment in order to be financially sustainable. This is perhaps the biggest issue for all operating rooftop farms. While all of the interview participants had noted that there were difficulties encountered against the weather. They were encountered to varying degrees of severity. Most respondents stated that wind and extreme heat were the biggest problems encountered across the board.

In Cape Town, the extreme weather variations and strong prevailing winds require a rooftop farm that is well equipped and well-guarded against the elements.

> *"In Cape Town you have to watch for heavy winds and rain, where winds would do damage to leafy greens and such. All of this can be responded to by simple and practical design. In Cape Town, you would want to hunker*

down. You would need to look at aspect – where the sun is setting where it's rising, direction of prevailing winds, availability of water." - Founder of TEL

These were over-come in the case for the RF at the Westin Hotel. Here the farm is sheltered by a wall, and has further protection from elements the farm is protected by the structures that surround the farm. For the RF at the Two Oceans however, the ability to construct shelter from the winds is not possible due to structural constraints. The site of the aquarium has worked against the success of the edible produce that grows on the rooftop.

"The space of this roof faces Table Mountain, in what is a very real wind tunnel. We're right on the harbour where get a lot of salt air and very strong wind. It's also completely uncovered so it gets a lot of direct and very intense sunlight… It's a non-sheltered space so it's been a bit tricky to get around… The harsh environment stunted the growth for many of the plants." - Conservation Biologist at Two Oceans Aquarium

Rooftop farms in Durban only seemed concerned with the wind, and heat which tended to wilt certain crops. The solution was then to focus on hardier crops, that used less water and were stronger against the winds, this was the case in Cape Town too. In Johannesburg the wind is most problematic for hydroponic farms since the growing tunnels are mostly made of shade cloth or plastic sheeting. The wind would at times be strong enough to buckle the structure or manage to blow some plants out of the NFT system. These tunnels would also reach extreme heat during the summer, none of the hydroponic setups in Johannesburg had any controlled environmental infrastructure such as air-conditioning for the heat, or heaters for the cold – save for air vents which were manually opened. As a result, many of the farmers were vulnerable to heat waves, in which a week of high temperatures could decimate a crop.

Some of the hydroponics farms have made use of shade clothe and not an impermeable plastic cover, as a result there is through flow of rain water into the farming area. While this isn't necessarily bad for the crops, in the case of a hydroponics setup, the increased water in the systems dilutes all the nutrients. This then throws the pH and the carefully measured nutrient conditions for the plants out of balance. While there are other hydroponic farms that have impermeable shelters, the issue encountered was that there would be water pooling above the tunnel structure during heavy rains. This would then cause the frame to begin to buckle.

"We had problems with the rain, the tunnels were collecting rain water, so the frames were getting broken or bent. So, we often have to fix it." – WIBC farmer at Fox Street

For Johannesburg, additional weather challenges were also the hail. Some hail storm events had left some of the farming operations in literal tatters, with shade clothes being punctured, causing some of the grown produce to be damaged. This is especially true for RFs that aren't covered, as is the case for the Saxon Villas.

"One of our greatest challenges was facing the elements, since our garden isn't covered. We have had many a hail storm destroy the entire garden and its crops during the summer."

4.5.1.2) Physical Limitations

Building a farm on top of a rooftop can result in some logistical problems in terms of getting infrastructure from the ground to the roof. In the case of Cape Town, for the innovation showcase RF located at the council building, the rooftop area was decked down with wooden panels. The panels were too long however, so needed to first be cut in half to get up the stairway, and then reassembled at the top. This is the case with many other hydroponic rooftop farms, in terms of getting the long PVC growing panels up 12-15 flights of stairs, and navigating the narrow stairway. In this manner one should note that the difficulty is not just in getting things from the ground to the roof but also vice-versa, where farmers complained about having to haul their produce crate by crate back down the building.

Other limitations can include the experience at the Two Oceans Aquarium, in which the RF facilitator wished to expand the project to include gravel as well as a sheltered space. This was however not possible due to the structural engineer advising against this.

"I had big plans to build a whole pergola area and create shelter, but unfortunately I wasn't able to see that through because of the restrictions with the weight… when the engineer came, she said we had to remove a lot of it. We had gravel as a flooring and quite a lot more stuff (growing beds) that we had to remove, and now we're trying to make sure we do our planting sort of peripheral because underneath the space is the actual aquarium." – Conservation Biologist at Two Oceans Aquarium

Additionally, other physical limitations also include that of the waterproofing for the rooftop surface. This can be a costly exercise, and may at times require maintenance throughout its life time. This was the case for one of the buildings owned by the JHC. Where some of the buildings are being revamped. In this then, having to move the RF infrastructure becomes problematic and tedious.

> *"it's the third year here [since operating rooftop farms], we have to move those gardens to allow for water proofing. Which is actually a huge issue because we've got fifty containers with produce, and have to move it to another site, to allow for water proofing… we've used bins with wheels so it's easy to move them or put them on a trolley." - Community Development Officer of the JHC*

4.5.1.3) Poor participation

Participation in an RF consists of two parts. Where in which there is the participation of the organising element, with regards to department or corporate structures. These organising elements initiate a RF project for reasons pertaining to their own organizational agenda with regards to development and investor commitments. There is then participation on the part of those that will maintain and operate the RF. These include the farmers -whether entrepreneur or volunteer- for the farms as well as outsourced maintenance companies.

In the Cape Town case study for the farm located above the council house, there was no clear intent for longevity that had been outlined. While the farm was tended to by visiting international students, there was no one who had been made to be a dedicated overseer for the farm. The farm had other objectives which included a market study, which was to demonstrate the profitability of the farm, however, it had not been implemented as an overarching commitment to apply this information to the RF.

> *"It got moth-balled by City of Cape Town middle management, who paid any more or less to do these things."- Founder of TEL*

If one were to compare this to the Durban municipal operated farm, one can see the stark difference in terms of level of success. The reason is because the Durban Area Management farm was made part of municipal plans in which it formed as a tool to meet criteria such as reducing crime and enhancing the urban quality. In addition, maintenance was made viable by bringing the farmers under the EPWP which has allocated funds for such initiatives.

While the Durban ABM farm is a success, the Methodist Church RF which is right behind this farm, is struggling to receive any form of municipal support. This is even after government and municipality alike had made statements to do so. The RF was met with much fanfare and support from government through the DAFF, who had used it as an opportunity for media exposure to show its intention to driving similar food security and urban agriculture initiatives within the city. Having talked with the reverend of the church, whose idea it was to start the farm, he stated that the farm was at present in lacklustre condition. No support had been received from the DAFF since, and maintaining the farm was proving to be a costly exercise.

> *"This was an initiative by the church through the Department of Agriculture. When we went to them, they brought their own guy, really to kickstart the project… but what policies say and what they do are two different things. We got a sense when they came here to launch this programme, they came so that they could have something to present to council… We have these shelters we have all these but we are not receiving grants from the Department of Social Development, when we are entitled in terms of their policies… There is a serious gap between what people say and what they do." – Reverend at Central City Mission yaseThekwini*

A similar issue can be seen at the Kotze Street night shelter in Hillbrow, Johannesburg. The farm itself was much hype, a press release declaring its launch, municipal council members shaking hands and declaring a commitment to creating jobs, resolving food insecurity and enforcing sustainability. The RF was only operational for a few months, and then stalled due to an electrical failure. Since the owners of the build is the CoJ, it is up to the municipality to resolve this issue, but it had not taken place. Those that facilitated and trained the volunteers to maintain the farm - Wits Siyakhana Initiative and Ubuntu Solutions - stated that they frequently encountered issues with regards to maintaining co-operation and communications with the City of Johannesburg. Since at times they are difficult to get hold of, and issues that arise are not readily dealt with, and there was general disinterest in the operation.

> *"The challenges are related to specifically, the government engagement. So, like Kotze Street for example. A lot of bureaucracy, and a lot of issues that you have to deal with where the department that's actually responsible for food resilience, is the economic development and underneath them is the food resilience team... And they are potentially one of the most important*

departments in the whole structure because of the problems we have around food insecurity. But they are one of the most unorganised and unmotivated and unengaging departments I've ever dealt with. They created a lot of challenges and didn't really participate anything where they should have… that project at Kotze Street was our last government project that we'll ever do. Purely because of the involvement that is needed from them, and it's almost like a fronting scenario where they just want to do something to look like they are doing something. But they don't have a genuine interest or intention to take this into something sustainable." – Co-Founder of Ubuntu Solutions

These case studies highlight the need for effective government participation for these projects. It is necessary that for an RF to become sustainable it must be brought under a program whereby there is capacity provided to ensure its continued maintenance. In this, a comparison to private organisational parties reveals that most RF's started through private funding has performed far better. These are evident from farms that have come under corporate directives to fulfil CSI objectives.

While these farms have a long-term commitment from their organisational party, some farms have experienced difficulties from the farmer side. For many of the social farms, especially for those of the JHC, building tenants were invited to take part in the training program. These were on voluntary basis. Many RF capacity development facilitators found that there was an unreliable attendance for many of the programs.

"The challenges ranged from participants, the number of people that were participating, initially we had good number, plus minus 8-10. Then the numbers dropped to about like 4 or 5 in some instances. In Lake Success, we ended up with 4 people. Participation wasn't consistent. But that was one of the challenges. "– Facilitator for Food and Trees for Africa

4.5.1.4) Market Access difficulties

Some of the farmers had found difficulties in establish financial viability since they had encountered challenges in forming linkages to the market. While it was observed that some of the RF's had not been able to remain operational due to a lack of market chain linkages, many of the farmers interviewed had some sort of a purchase agreement in place. It was then only a very few farmers that encountered problems selling their produce. Many of the entrepreneurial

farmers in Johannesburg sold their stock to the Johannesburg Fresh Produce Market, while other farmers sold to their building tenants, whether this was in a residential, corporate or commercial setting.

4.5.2) Perceptions of RF industry and its potential

All of the respondents stated that they felt there was great potential in the industry. Many of them were enthusiastic and passionate about the benefits in terms of imparting social and environmental benefits. In which they cite employment opportunities, quality of life, sustainability as well as contributing towards decreasing food miles and the resultant carbon footprint.

In this some, farmers had expressed certain hindsight's and reflections, with regards to their own experiences in terms of being involved with a rooftop project. Some reflected that while there were these benefits, and potential, there was need consider the multifaceted issues that surround starting up a rooftop farm in which profitability and market chains are to be considered.

> *"I think it remains untapped, it's about partnering with the right people, you would need a business partner, you'd need government endorsement. In my experience it's problematic to look at government as being the champion. They'll give a rubber stamp, in many cases you need and want that rubber stamp, but the essence of that is that you can't approach it as 'it's green it's going to save the world' but as a business approach." - Founder of TEL*

While these are the sentiments given to the Council Building RF in Cape Town, some of those in Johannesburg shared a differing insight. This is since most of the rooftop farms in Johannesburg have received some sort of organisational support. In which this has become part of a larger capacity development program, as outlined by various organisations such as WIBC, SAB, the JICP and also the JHC. These perceptions thus reflected a different attitude towards the industry, since in the Johannesburg context there is a focus for RF's to be centred around job creation and income generation.

> *"I think it's something that should be done. The problem with many of these small farmers especially like me, is that it is difficult to have the funds to get such a farm (hydroponic farm). To receive training and get a rooftop farm like this, I think should be encouraged." – WIBC farmer at Fox Street*

As a whole, many of those involved in the rooftop farming industry acknowledge that the activity is an opportunity to make use of what is an otherwise unused space. The ability to utilize a vacant rooftop as a productive space is appealing, especially in context of what is a large and growing built environment. The city is seen differently as not necessarily being a built artificial environment, but as something that hosts niche opportunities for greening and social cohesion.

> *"There is a huge potential when it comes to urban farming, if you look at the number of open spaces and in the city that can be used for fresh produce and vegetables. It can be an opportunity to earn an income I think which is more of a part of our future now, to produce to earn a living from rooftop farming. From an issue of food security, not just poverty, how many people go to bed hungry in Johannesburg. So, if you have a large number of gardens, the food can be guaranteed" - Community Development Officer of the JHC*

> *"There is a lot of potential, it's a good opportunity for communities. But even for coprosperity's generally its wasted space. Sometimes people think of a rooftop garden more of as somewhere pretty for their staff to go and have a smoke type of scenario. Or a green kind of space for relaxing in, but it can actually be a productive space for producing fresh quality produce. Whether it's a residential building you've got a captive market of tenants in that building, whether it's a commercial building then you would have employees within that building. So, you would have potential customers, so it does create an opportunity. and it's a lot of wasted space, in the inner city a lot of rooftops that are just vacant that would be ideal for rooftop gardens" – Co-Founder of Ubuntu Solutions*

4.7) Policy and Champion Influences

At a municipal level the results are heavily skewed in favour of the CoJ. Wherein the city is host to 20 of the 26 farms, of that 16 are currently operational. Those that are not currently operating are likely to in the near future begin operating once more. With Cape Town and Durban having a total of 3 each, it is important to note the reasons for success and failure.

Cape Town has been hindered by weather conditions that require capital intensive solutions. In addition, there currently is no champion, or organisational agent who is at the moment willing to create a long-term plan to garner support for the industry. While the CoCT has a policy

directive to support urban agriculture, this has translated to supporting the far more favourable arable peri-urban areas surrounding the city.

In the case of Durban, the successes are mixed. The farm at Area Management Building had been brought under government policy through the EPWP. In this it received the necessary financial funds as provided by the state to support the farm in the long term. This however has not been seen for the nearby rooftop farm above the church. The church claims to qualify for social grants due to providing accommodation, skills development and contributing to food security. While having received endorsement from members of government, there has been little seen in terms of commitment from eThekwini, or the DAFF for further engagement with the RF.

For Johannesburg, many of the rooftop farms have been borne out as a result of objectives that are being driven by private and public partnerships. These partnerships are embodied as the Johannesburg Inner City Partnership (JICP). The founding members of the JICP consists of the Johannesburg Business Forum and Chamber, the Property Owners and Managers Association, community-based organisations, learning institutes at various levels, street traders, youth-based organisations amongst other Inner-City stakeholders. The role of the JICP is to instil collaborative relationships between the CoJ, other spheres of government and the private sector, so as to engender transformation and to facilitate growth to all stakeholders within the Inner City. As given on their webpage, the aim of the partnership is to accelerate inclusive and sustainable growth in the Inner City. The overriding aim of the JICP is to meet outputs as given by the CoJ Growth and Development Strategy. These relate to increasing job creation, developing skills transfer, youth and small business development, resource resilience and safe community development.

Through the JICP the Urban Agricultural Initiative came to the fore. The UAI is an initiative that receives support from the CoJ, the Department of Small Business Development, the Small Enterprise Development Agency and SAB Kickstart. Of interest, is that the founder of WIBC was one of the initiators for the UAI. In this the WIBC have in essence Championed the development of Rooftop Farming the CoJ. Most of the rooftop farms are located on top of buildings whose owners are part of the JICP. The establishment of such a public-private partnership has proved most beneficial to creating the beginnings of a market ecosystem that is conducive to supporting the industry. The WIBC has also further begun laying out the ground work through other initiatives to support agribusiness. These such as training graduates to have

skills at different levels of the industry, from supply, demand and logistics. This is then strengthened through the development of a brand, for which all WIBC farmers will supply through. In creating a brand, the product can be made available to retailers, as is already being seen with the Hola Harvest brand being sold to retailers.

4.8) Further notes on RF trends

All RFs were asked if they had any sustainable technology implements. To which a great majority do not. Such implements include rain water harvesting, the integration of energy offsets such as solar panels, or even the use of compost bins for their operation. Many RFs do not make use of such implements, with the only notable exceptions being that of the Greatermans building using solar power, the Two Oceans RF using collected water from AC units, and rainwater from the building. The only other RF using rainwater was the ABM building in eThekwini, but this was not put in its initial design, since the water is received from the neighbouring building.

Other notes on the RF trend is that the Social and the WIBC founded Entrepreneurial RFs can be said to have similarities in function. In which these farms had been initiated as a result to company's responses to CSR and BEE outcomes. This is in the sense that these farm outcomes were to produce skills development, capacity building, job creation and income opportunities creation, wherein food security was an offshoot to these initiatives. The differences between the two typologies here are that the WIBC farms will one day become owned by the benefiting farmers. Whereby the Social RFs will remain to be retained by host building owners. Other differences are in the obvious scales of operations, and also the implemented infrastructure and initial capital inputs.

As the CoJ develops more RFs through the actions of members of the JICP, in which organisations such as building owners and BEE solutions providers have steered the development of the industry. There will be an influx of more urban farmers in the city. This is because many of these programmes are centred around training agripreneurs on mass, and integrating them into the market chain at large. It remains to be seen what kind of an impact this may have on the urban agricultural industry, and if this may spark further development surrounding policy making, as the industry becomes further entrenched within the city populous.

4.9) Conclusion

This chapter has presented the case for Rooftop Farming trends found within South Africa's 3 largest municipalities. At a country level it can be considered that the industry is relatively well developed as compared to other countries particularly in the Global North. However, at a municipal level there is a strong bias to be seen where the CoJ is carrying the bulk of the RF stats. Having said this, at a country level, the RF typology is impressively diverse, in which there is a varied representation of different RF types for each city.

This may perhaps reflect the infancy of industry in the country in which it appears to be within its trial phase. In some cities like the CoJ it has managed to move from the trial phase and has begun to flourish. While in the CoCT the trial itself had not managed to move on further. Reasons for the failure of CoCT can be attributed harsh weather conditions, and therefore a need for larger capital inputs. In addition, its failure as compared to the success of the CoJ can largely be seen to be related to the establishment of partnerships, and the presence of champions to drive the industry forward.

Many role players had commented on having experienced difficulties due to a lack of active participation by government. This can be seen for the cases of CoCT and eThekwini in which Rooftop Farms have petered out despite initial commitments made by state parties. The CoJ however, is a different case in which public and private sector stakeholders had forged an effective partnership under the general directive of city improvement and jobs creation. Added to this is the somewhat personal agenda of passionate individuals who leading the charge in strengthening the industry from the ground up. The words of TEL founder are thus pertinent in this regard, in terms of wanting support from government, but needing a committed agent for success. In saying this, the municipalities of CoCT and eThekwini therefore are perhaps failing not due to lack of interest from state parties, but rather due to a lack of interest from corporate parties. In which there is a need for partnerships to be made in a similar manner, and for an individual to enforce the implementation of the necessary support infrastructure for RF in its host municipality.

Support infrastructure in the form of capacity development, and skills transfer of farmers. The establishing of effective partnerships between building owners with rooftop farmers or farm facilitators. Wherein beneficial symbiotic relationships are formed such as the steering of CSI investment into long-term and meaningful projects aimed at supporting the RF industry. Other forms of support infrastructure exist as market chain linkages, and brand creation, for which

Rooftop Farmers are able to gain legitimacy and therefore gain access to the larger retail market.

In the absence of specific policy frameworks, Rooftop Farming appears to exist in an interesting niche. In which its survival as an industry is dependent on adventurous building owners or corporates seeking novel ideas to fulfil CSR/CSI outcomes. Outcomes which exist as a result of pressure from investors, consumers or government. In this then, the continued existence of Rooftop Farming is perhaps reliant on the moral obligation of the private sector to 'do the right thing'. In which a potential Rooftop Farmer may have to package their product as one that would tick off CSI criteria in order to gain acceptance from a building owner so as to operate on top their rooftop space.

Chapter Five

5) Conclusion

The Earths land surface is a resource which is finite and is pervasively under threat in the wake of urban expansion due to rapid population growth within developing cities (Seto, et al., 2011; Eigenbrod & Gruda, 2015). As global population is expected to continue to increase past 10 billion inhabitants as from this mid-century, the contexts of this statistic is becoming of greater concern (Ziervogel & Frayne, 2011, Ackerman, et al., 2014, Lanz, et al., 2017, Dawson, 2018). Wherein much of this accretion will largely be occurring within developing countries – more specifically within their cities. The accompanying urban expansion to accommodate such burgeoning crowds will permanently transform the surrounding terrestrial landscape, and place greater pressures on the planet's resources (Dubbeling, et al., 2010, Satterthwaite, et al., 2010, Ziervogel & Frayne, 2011, Crush, et al., 2011, Ackerman, et al., 2014, Satterthwaite, 2016).

The beginning of this century was marked by a change in global demographics, in which for the first time ever, more people were found to be living within the city than within outlying rural areas (Satterthwaite, et al., 2010; Ziervogel & Frayne, 2011; Ackerman, et al., 2014). While in Sub-Saharan Africa it has been found that 40% its population live in a city, this percentage is expected to double in the lead up to 2050. By this year then, over 6.6 billion people are expected to reside within urban districts (Dubbeling, et al., 2010; Satterthwaite, 2016). These receiving cities are under a considerable amount of strain in which at present, cities within Sub-Saharan Africa are the fastest growing at 4% per annum (Dubbeling, et al., 2010; Ziervogel & Frayne, 2011).

In SSA the majority of these city populations exist in poverty, in which a large percentage live under the breadline. These cities are thus faced with various challenges pertaining to food insecurity. In which food insecurity is an issue that is arising not necessarily out of the physical availability of food, but rather through the inability to access it insecure (Dubbeling, et al., 2010, Satterthwaite, et al., 2010, Ziervogel & Frayne, 2011, Crush, et al., 2011, Ackerman, et al., 2014, Battersby & Crush, 2014, Satterthwaite, 2016). In the Northern contexts accessibility to food has been investigated under the lens of Urban Food Deserts. Where inaccessibility arises as a result of the physical distance of a food retailer from a consumer (Block, et al., 2012; James & Friel, 2014; Battersby & Crush, 2014). While Northern and Southern contexts for food inaccessibility are similar in the fact that they both affect the poor the most, it perhaps

stops there. Since in the South African context, food retailers are penetrating poorer areas (Battersby & Crush, 2014; Peyton, et al., 2015). Accessibility then, in the African and South African context is thus related to household income. In which an individual's financial status largely acts as a barrier to receiving enough food let alone adequate nutrition. Given this, and the urbanization of poverty seen within many cities in SSA, there is the mounting crisis of malnutrition. Wherein large portions of the urban poor are afflicted with illnesses related to insufficient nutrient intake, and is claiming the lives of many children (Dubbeling, et al., 2010, Satterthwaite, et al., 2010, Ziervogel & Frayne, 2011, Crush, et al., 2011, Ackerman, et al., 2014, Battersby & Crush, 2014, Satterthwaite, 2016).

5.1) Urban Agriculture and Rooftop Farming

Against the backdrop of such growing exigencies within cities whose populous are faced with challenges related to inadequate food access and consequential malnutrition. Urban Agriculture is presented as a possible solution which may bring relief to these growing concerns (Rogerson, 1998, Rogerson, 2010, Malan, 2015, Eigenbrod & Gruda, 2015). UA is defined as being the practice of activities which involve the production of food and non-food produce, where non-food produce can include growing herbs, trees or flowers for profit. UA further includes post-production activities such as processing, packaging and distributing of products and services created by the industry for use within an urban area (Mougeot, 2000; Rogerson, 2010; Ackerman, et al., 2014; Eigenbrod & Gruda, 2015). Rooftop Farming as being an extension of Urban Agriculture shares a similar such definition and is confined to the vacant rooftop spaces above a city's skyline (Ceron-Palma, et al., 2012, Thomaier, et al., 2014, Specht, et al., 2014, Ackerman, et al., 2014, Eigenbrod & Gruda, 2015, Sanye-Mengual, et al., 2015 b).

Urban Agriculture and Rooftop Farming are attributed to having the potential to engender an array of benefits, centred around improved access to nutrition, added income opportunities as well as social well-being (Dubbeling, et al., 2010; Rogerson, 2010; Frayne, et al., 2014; Ackerman, et al., 2014; Eigenbrod & Gruda, 2015). Many academics question the ability of UA to impart any meaningful contributions to a communities food security – others are critical of the practice from the perspective that it would be impossible for UA to completely substitute the agricultural demand of the worlds cities (Webb, 2011; Crush, et al., 2011; Frayne, et al., 2014; Badami & Ramankutty, 2015).

Although critiques may continue to question the effectiveness of Urban Agriculture to impart the benefits attributed to it, it remains in widely practiced activity globally. In this, Rooftop

Farming is becoming a trending activity internationally and locally. While it is an activity that is taking hold within many Northern cities, as modern-day practice it is quite recent, and so the academic literature related to its development is still emerging (Ceron-Palma, et al., 2012, Thomaier, et al., 2014, Specht, et al., 2014, Ackerman, et al., 2014, Eigenbrod & Gruda, 2015, Sanye-Mengual, et al., 2015 b). The literary context for rooftop farming in South Africa's cities are also only beginning to emerge.

Urban Agriculture and Rooftop farming are able to provide additional benefits other than poverty amelioration and improved access to nutrition. As the city boundaries continue to grow their borders, - whereby terrestrial land and eco-systems are permanently transformed into the built environment, - UA may offer some small solace in terms of relieving some of these developmental pressures. If one considers that Rooftop Farming has the potential to relieve 10 hectares of rural land for every hectare hydronic rooftop space. It may be possible then that cities are able to easily offset a few million hectares if it were to become ubiquitous (Caplow, 2009; Ceron-Palma, et al., 2012; Specht, et al., 2014; Thomaier, 2017). Since Urban Agriculture and Rooftop Farming take place where the increasing demand for food originates, its locality thus can provide opportunities in CO_2 and greenhouse gas reductions. With transport distances being able to be drastically cut other emissions reductions may then exist through avoiding additional packaging and storage processes (Caplow, 2009; Sanye-Mengual, et al., 2015 a).

A cities carbon footprint may also be further improved through the integration of various UA activities with city planning and within buildings. Integration in a manner wherein the added greenery to a building or urban setting can impart various environmental opportunities. These being the reduction on heating and cooling costs, the diminishing of the effects created by the Urban Heat Island, or prevention of storm water inundation (Astee & Kishnani, 2010, EEA, 2011, Ackerman, et al., 2014, Specht, et al., 2014, Eigenbrod & Gruda, 2015).

In context of globalisation and the greater Food System, UA can serve to strengthen a countries food security in the face of mounting challenges caused by climate change and extreme variability in weather regimes. With some countries finding themselves dependent on the growing global Food System, any perturbations that may impact against it makes them vulnerable to food insecurity. In this manner then Urban Agriculture can also be understood as a form of Food Sovereignty. Whereby a country or a community - who are at the mercy of what happens to their food in some other part of the world – may take ownership of their food

production (Astee & Kishnani, 2010; Block, et al., 2012; Foley, et al., 2011; Ackerman, et al., 2014; Specht, et al., 2014).

5.2) Rooftop Farming as Urban Agriculture

Rooftop Farming forms as part of a mosaic of UA which some academics have coined as being Zero-Acreage Farming. ZFarming is so named due to the characteristics of these agricultural activities in not making use of actual land. ZFarming practices include Rooftop Farming, Indoor Farming, Vertical Farming or the integration of Greenhouses into building spaces as Rooftop Greenhouses. For Rooftop Farming that the predominant farming methods used were that of soil culture and hydroponics – other methods can include aquaponics or aeroponics (Ceron-Palma, et al., 2012, Thomaier, et al., 2014, Specht, et al., 2014, Ackerman, et al., 2014, Eigenbrod & Gruda, 2015, Sanye-Mengual, et al., 2015 b).

Rooftop Farming and by extension ZFarming present new opportunities in building design, wherein synergies are able to be created between farm and building. Such synergies that can exist through Building Integrated Architecture, are in the form of the exchange of heat, water and ventilation flows between greenhouse and building (Caplow, 2009, Ceron-Palma, et al., 2012, Sanye-Mengual, et al., 2015 a). In doing so BIA in the form of Rooftop Farms may be able to help us rethink current city models. In which we can move from a what is considered the 'typical linear city model' of importing resources and expelling wastes. Whereby we can transition into a 'circular metabolism' or closed system based on an ecosystems/ecology approach in which resources are recycled, and reused as presented by BIA synergies building (Caplow, 2009, Ceron-Palma, et al., 2012, Sanye-Mengual, et al., 2015 a, Thomaier, 2017).

5.3) Types of Rooftop Farming

Rooftop Farming consists of two main growth methodologies in which RF operations may make use of soil or soilless methods to produce their crops. Soilless or Hydroponics culture make use of either a solid inorganic (clay pellets, chemically stable gravel) or organic substrate (nutrient rich water), for plants to grow (Eigenbrod & Gruda, 2015). Methodologies for hydroponic applications include that of Nutrient Film Technique (NFT), Floating Technique, Ebb and Flow / Flood and Drain systems, as well as Aquaponics. Hydroponics has been the next step in urban farming, in which it is a new frontier how we as humans are able to generate produce. It has allowed for farming activities to be moved from the field and into the greenhouse, where conditions are able to be controlled so as to create the perfect product (Ceron-Palma, et al., 2012; Despommier, 2013).

Soil culture is the use of a soil medium that covers part or all of the rooftop or is within a raised bed or container (Thomaier, et al., 2014; Eigenbrod & Gruda, 2015). Soils used, can be in the form of produced potting soils, or can be made up of topsoil and various organic wastes such as leaf cuttings, and wood chips as mulch. Since these soils are created de novo on rooftops, they are termed as being constructed Technosols (Grard, et al., 2018). Unlike hydroponically driven setups which are light weight, Technosols must meet the technical requirements that relate to the roofs load capacity (Grard, et al., 2018).

Various pros and cons exist between the two RF growth methods. The use of a soil medium offers a rooftop farmer great flexibility in terms of what crops to grow, since he/she would not be limited to specific crops like in the case of hydroponics. This ability to grow a greater variety of produce therefore can help a farmer respond better to market demands as compared to hydroponically driven RFs (Eigenbrod & Gruda, 2015). The disadvantage however is that a RF with Technosols uses up to 10 times more water, and produces a lower yield than a hydroponics set up (Sanye-Mengual, et al., 2015 b; Liu, et al., 2016). A hydroponic RF within a greenhouse is able to grow produce all year round, irrespective of the weather. Open roof soil RFs can mitigate seasonal impacts, by growing season specific crops in order to maintain economic efficiency (Liu, et al., 2016). Furthermore, hydroponic operations, and ones that have included a greenhouse in their design are incredibly costly, but are lighter weight than an open-air soil RF. The use of open-air soil rooftops allows for affordability, simplicity in operation and ease of growing different produce types (Ackerman, et al., 2014).

5.4) Not just food production

Rooftop Farms require specific skills depending on how high tech the installation is. In this manner, the presence of RFs within a city thus creates opportunities for new skills development to take place. ZFarmers need to have increasingly dynamic skill sets, since it is not just the growing of fresh produce that is required, but also need to have market savvy and also project management skills, and good co-ordination between building owners, tenants and retailers (Specht, et al., 2014, Thomaier, et al., 2014, Specht, et al., 2016) RFs can also impart social benefits to a community such as better social cohesion, and stronger community identity. RFs can be set-up to impart educational benefits to students, in which they might learn about UA or about environmental sustainability (Caplow, 2009, Specht, et al., 2014, Thomaier, et al., 2014, Specht, et al., 2016).

It is always important to be conscious of the dynamism of the social environment within the urbanscapes. This especially in the sense that any addition of a disturbance, may create ripples within the fabric or a city's community. Many commercial and image-oriented RF and ZFarming practices may engender exclusion and inequality through their drive to provide high value products, which are targeted toward premium restaurants (Specht, et al., 2014; Thomaier, 2017). These products are grown to provide profit, and not necessarily sustenance (Specht, et al., 2014; Sanye-Mengual, et al., 2015 b; Liu, et al., 2016). The implication then is that may RFs fail to fulfil social justice issues that food activists are advocating them to be able to do and could perhaps worsen such issues like food deserts through social exclusion (Specht, et al., 2014)

5.5) Challenges and risks in Rooftop and Zero-Acreage Farming

There are many barriers that Rooftop Farming must over-come, and perhaps the greatest of which is the fact that this practice is in relative infancy. There still are many uncertainties surrounding various spheres that involve Rooftop Farming, such as consumer perceptions, its economic feasibility as well any environmental and social impacts that it may have (Ceron-Palma, et al., 2012; Ackerman, et al., 2014; Thomaier, et al., 2014; Specht, et al., 2014; Eigenbrod & Gruda, 2015; Sanye-Mengual, et al., 2015 b; Eigenbrod & Gruda, 2015; Whittinghill, et al., 2016; Liu, et al., 2016). The viability of urban agriculture and RF practices, in terms of the degree to which it is afforded political and cultural support, is to an extent dependent on perceptions of its ability to engender a significant impact on local food availability and security (Ackerman, et al., 2014; Specht, et al., 2016).

Due to the few number of exisiting models and the need for high degree of innovation, the planning and implementation process is often complex especially with regard to lack of technical expertise and experience (Ceron-Palma, et al., 2012; Thomaier, et al., 2014; Specht, et al., 2014). There is then the issue of the roof itself, in which the material and structure of the rooftop must be able to accommodate the load requirements of the RF (Ceron-Palma, et al., 2012; Sanye-Mengual, et al., 2015 b; Thomaier, et al., 2014; Thomaier, 2017). In light of this load capacity, it is fortunate that many greenhouse designs are able to made within light-weight sepcifications (Ceron-Palma, et al., 2012; Sanye-Mengual, et al., 2015 a). In the case where there is need for heavier materials, or the application of a soil growing bed, there is then a need for specialist studies, and even perhaps costly structural reinforcements.

Other challenges exist in building by-laws within municipalities. The installation of a RF may add a new building use, in which an agricultural activity is added into a residential, commercial or industrial zone. Some municipalities do not have zoning codes which permit the practice of farming within all land use zones (Thomaier, 2017).These instances however mostly concern an enterprise that is geared toward large scale commercial production of edibles (Thomaier, 2017).

5.6) Urban Agriculture and South Africa's Agricultural Policy Context

South Africa's agricultural policy is largely driven by directives that fuel the creation of job opportunities, in which the agricultural sector is used as a vehicle for the development of rural economies (Rogerson, 2010; Malan, 2015; Battersby, et al., 2017). Thus, in order for UA to be applicable to departmental agendas, it must then present itself as an activity that creates employment opportunities. This is evident since the agricultural departments for the provinces of Gauteng, Western Cape and Kwa-Zulu Natal each state their alignment to MTSF outcomes, the APAP and NDP. These frameworks each enforce the development of rural economies through using agriculture and agro-processing as vectors for spurring job creation (DED, 2011; DAFF, 2014; Drimie, 2015).

While the rural focus may work against Urban Agriculture, policy implements may serve to benefit those in peri-urban zones. However, there still remains to be no mechanism for support of UA at a national or provincial level. As a result, UA, inserts itself as an extension of other policy and urban development mandates which have a much wider agenda with regard to economic development and associated strategies (Rogerson, 2011; Haysom, 2015; Malan, 2015). Policy issues that are most relevant to UA and RF is thus in the hands of municipal governance.

City level responses to UA such as through the likes of CoCT's Urban Agriculture Policy, the CoJ's Urban Agriculture Support Programme, and eThekwinis Agro-Ecology Programme. In these though, there still remains little consideration for UA within the actual urban space. This is since many of these policy approaches are still based on some 'rural' sentiment, wherein farming is to take place on the city outskirts (Battersby & Marshak, 2013; Drimie, 2015). Some policies however, also include the establishing of market chains which could perhaps serve to benefit Rooftop Farmers. This since establishing a reliable market chain it is perhaps one of the greatest challenges to Rooftop Farmers and urban farmers in general.

In the absence of applicable policies from a national to municipal level, Rooftop Farming must then be-able to apply itself to other avenues of policy relevance. Such alternate avenues exist in the form of corporate spheres and policy frameworks that exist within their own development agenda. The corporate agenda in this sense is related to the responses formed as a result of pressures exerted by the government, consumer or investor, and are embodied as a company's CSR or BEE strategy. In this then, Rooftop Farming and by extension Urban Agriculture may package themselves to appeal to criteria relevant within these corporate strategic frameworks.

5.7) Trends in South African Rooftop Farming

On review of the status of Rooftop Farming in 3 of the country's largest municipalities, South Africa is comparative on an international scale. In which it has outcompeted European and Asian countries if one considers Buehler and Junge's (2016) international survey of rooftop farms. Rooftop Farms in South Africa follow international trends in a similar manner, in which the majority of RFs are soil paced, open air installation. Further similarities exist in which the majority of the farms have not been set-up for profit, but rather to produce other benefits such as social or image benefits.

It should be noted however, that there are some similarities between many of the Social RFs and the Entrepreneurial RFs initiated by WIBC. This is in the fact they were borne out of some sort of CSR or BEE initiative, aimed at skills development and job creation. The differences however are in the end goal, in which the farmers for Social RFs will not one day own the farm as is the case for the WIBC RFs. The other differences are also obvious in the infrastructural and capital input between the two.

With the CoJ boasting the greatest number of RFs within its city boundaries, there are various reasons for why this is. It would seem that its weather regime is not as harsh as that of the CoCT, and so RFs are able to be installed with not as much capital input. However, since eThekwini has a just as favourable weather regime, the reasons as to its success are then related to other circumstances. These being that there have been effective partnerships made between the public and private sector. In which the CoJ has created an enabling environment for companies to form together to create a drive for the improvement on the city and is embodied as the JICP. In this then, the presence of individuals who are determined to make the practice of Rooftop Farming a viable and sustainable industry within the city is crucial in its flourishing. Through this then, the efforts of the WIBC to make Rooftop Farming work in the CoJ is not just in the form of setting up RFs within the city, but it is in capacitating new Rooftop Farmers,

as well as developing the ground work for market chain linkages, by training others in related agro-processing sectors. This in the sense that while farmers are being trained, other entrepreneurs are being trained who will become future customers for these Rooftop Farms. Other market chain linkages forged by the WIBC is in its creation of a brand under which farmers will supply through, and gain access to the formal retail market. Rooftop Farming in Johannesburg is thus very well developed as compared to the other two cities and reflects the commitment by the organisational elements that are driving its development. The success of the CoJ also shows that Rooftop Farming is perhaps not dependent on specific food or agricultural policies. In which it has successfully managed to package itself as a product that may be presented to corporate entities, as an activity that would appeal to their own responses related to CSR or BEE strategies.

There are many Image based RFs in the CoJ too, which may reflect a changing perception in the consumer market. While further studies are perhaps needed to ascertain the perception of the consumers, it would appear that the existence of so many RFs in the CoJ implies that the market is not as resistant to the idea as what was seen in the works of Specht et al. (2016) and Sanye-Mengueal, et al. (2016). In which they found that corporates were hesistant to have an RF on their rooftop.

Rooftop Farming in South Africa is perhaps quite biased towards what can be seen happeing in the CoJ. However, based on the activities taking place here, it can be seen that Rooftop Farming is an activity that is developong out of responses towards novel ideas around job creation and income opportunities within the city. Rooftop Farming then, in South Africa has not yet developed yet into something more such as a for of green infrastructure, wherein rain water is harvested or to reduce storm ater inundation. Only a few RFs have integrated withemselves with solar panels, or other synegestic methods like using collected AC water for their farms. These are the execption though and not the rule, in which many RFs still utilize municipal water to water their crops.

5.8) Final Conclusion

Presented within this dissertation is a baseline narrative for the development of Rooftop Farming within the country's 3 largest municipalities. In this it has been found that the most successful development of the industry has been in the City of Johannesburg. Its success has largely been owed to the intentional and directed capacity building of RF within the city through the JICP.

Rooftop Farming therefore has become something that reflects ultimate National directives which have been to create job and income opportunities, more so than to create food security. With so many new urban farmers being capacitated and integrated into the market, there may be new and interesting avenues for city food creation. In which the entrenchment of urban agriculture will become further strengthened with an influx of skilled urban farmers. In this there may perhaps be added impetus towards forming food policies that will support this new and growing demographic.

As the CoJ develops its RF industry further, it is quite likely that the other municipalities will follow suite. In this then, the CoJ has shown to be an ideal testing ground for the country at large, wherein trials are being tested, and methodologies further refined. Still there are however opportunities for improvement. In which RF technologies in SA still do not yet exist to the same degree as the international sphere, wherein high-tech installations have been established. This being said, the ground-work for the industry is in place, and there have been made inroads for market development of Rooftop Farming as a brand and as a commercial enterprise, in which some farmers have an established market chain link to formal retailers.

In order for Rooftop Farming to continue its course in South Africa, there must exist positive relationships between building owners and the farmers. Whereby both parties are equally committed to making the project work. In this, it is important that RFs add some sort of value to the host building, in which this value is either in the form of supplying its tenants with food, or brings value to being aligned CSR or BEE criteria that exists within the host building owner's development strategy.

Many role players for the RFs in South Africa have remarked on the industries great potential, and while challenges still exist in varying forms particularly in weather or bureaucracy. The success of the CoJ case study shows that with the correct enabling environment, together with those who are willing to become champions for the industry, can indeed instil desirable outcomes for its development.

Primary Interviews Conducted

Primary interviews were conducted between 2017 and 2019. There were conducted through telephonic or face-to-face semi-structured interviews, some respondents had felt more comfortable answering questions via email. In such cases the relevant questionnaire was sent to them, in which they could answer in their own time. See Appendix 1 for questionnaires.

Table 6-1: Primary interviews conducted during research period (2017-2019)

Interviewee	**Company**	**Role**	**Date conducted**	**Response Type**
Ackerman. K	Oranjezicht City Farm	Farmer	14/09/2019	Telephonic
Anonymous	Lake Success	Rooftop Farmer	24/09/2017	Face to Face
Anonymous	Douglas Village	Rooftop Farmer	24/09/2017	Face to Face
Anonymous	Tower Hill	Rooftop Farmer	24/09/2017	Face to Face
Anonymous	Central City Mission yaseThekwini	Rooftop Farmer	15/08/2019	Telephonic
Candice. P	Grei Restayrant / Saxon Villas Hotel	Chef	02/09/2019	Email
Cohen. J	JDA	Strategy Manager	08/11/2017	Email
Cullingworth. G	ON19 / Westin Hotel	Head Chef	30/07/2018	Email
Dlamini. M	Green Sky Rooftop Garden	Former Rooftop Farmer	27/08/2019	Telephonic
Du Toit. J	CoCT Department of Environmental Resource Management	Manager	16/08/2019	Telephonic
Galvard. L	Sought After Seedlings	Facilitator	01/09/2019	Telephonic
Garner. G	JoburgPlaces	Tour Guide	29/09/2018	Face to Face
Greenstone. C	Green Roof Designs	Architect	15/08/2019	Telephonic

Gxamza. A	Central City Mission yaseThekwini	Reverend	15/08/2019	Telephonic
Jones. L	Troyeville Hotel	Owner	20/09/2017, 28/08/2019	Email
Kaltiz. R	Farm this City	Founder	17/07/2017, 28/08/2019	Face to Face
Lamb. S	Touching Earth Lightly	Founder	16/08/2019	Telephonic
Machete. A	Jozi Food Farmers	Owner	17/09/2017, 28/08/2019	Telephonic
Magondo. M	WIBC	Founder	23/09/2019	Telephonic
Mahlangu. S	Outsauce Condiments	Owner	28/08/2019	Telephonic
Mamagale. P	Midi Agricultural Farm	Owner/Rooftop Farmer	28/08/2019	Telephonic
Masipa. T	AFCHO	Urban Planning and Development Manager	20/10/2017	Face to Face
Mpati. N	Gegezi Organics	Former Rooftop Farmer	01/09/2017	Face to Face
Naidoo. A	Mr Price Head Office	Sustainability Unit	28/08/2019	Email
Naidoo. K	Simanye	Trustee	02/09/2019	Telephonic
Ngcobo.T	eThekwini Area Based Management	Manager	16/08/2019	Telephonic
Nhlanhla. S	Outreach Foundation Rooftop Farm	Owner/Rooftop Farmer	29/09/2018	Face to Face
Noble. T	Two Oceans Aquarium	Conservation Biologist	21/08/2019	Telephonic

Ntuli. L	JHC	Community Development Officer	26/08/2017	Telephonic
Ratschitanga. T	Greatermans Building Rooftop Farmer	Owner/Rooftop Farmer	30/07/2017, 28/08/2019	Face to Face
Rethabile. P	WIBC	Marketing Manager	19/09/2019	Face to Face
Rudolph. M	Siyakhana	Owner	14/08/2017	Telephonic
Sam. J	Rooftop Landscapers	Owner	06/08/2018	Email
Smith. G	Ubuntu consulting	Managing director	26/08/2017	Telephonic
Tshuma. L	FTFA	Facilitator	28/09/2017	Telephonic
Warner. M	Vertical Veg	Owner	27/07/2018, 18/09/2019	Email

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Appendix 1: Questionnaires

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Questionnaire A

Semi- Structured Interviews

Respondents: Project initiators, Maintainers and contractors

1) What is [company name]?
2) How did you become involved in rooftop farming projects?
3) What is the role of [company name] in such projects?
4) What similar projects has [company name] undertaken?
5) What skills do you find are most beneficial in conducting these projects?
6) What have the challenges been?
7) What are your opinions on the industry / what was your overall experience of the industry?
8) Open question, please feel free to add anything you would like to say about your organization, or about the projects you have conducted, or about anything you would like to say regarding rooftop farming.

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Questionnaire B

Semi- Structured Interviews

Respondents: Building Owners,

1) When did you have your Rooftop Farm / garden installed?
2) What was the motivation behind having it implemented on the rooftop?
3) What parties / stakeholders were involved in the installation?
4) Who maintains the rooftop farm / garden?
5) What produce is grown, and what is done with the harvested produce?
6) Why a rooftop farm?
7) What have the challenges been in terms of implementing and operating the rooftop farms been?
8) What have your experiences and challenges been, with regards to the project.
9) Are there any future plans for rooftop farm?
10) Open question, please feel free to add anything you would like to say about your organization, or about the projects you have conducted, or about anything you would like to say regarding rooftop farming.

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Questionnaire C

Semi- Structured Interviews

Respondents: Farmers, Agripreneurs

1) Why rooftop farming?
2) Do you have horticultural skills, and where did you gain them?
3) What produce are you currently growing?
4) What are your major expenses?
5) Are you using sustainable technology?
6) Where there any challenges?
7) What are your perceptions of the industry?
8) Open question, please feel free to add anything you would like to say about your organization, or about the projects you have conducted, or about anything you would like to say regarding rooftop farming.

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Questionnaire D

Semi- Structured Interviews

Respondents: Restaurants, Hotels,

1) When and how did you come to having a rooftop farm on your premises?
2) Do you find it is able to offset costs of produce to a degree?
3) Who maintains the food garden?
4) Approximately how big is the set up, and what produce do you grow from it?
5) What is your opinion of rooftop farming in general?
6) Are there any challenges to having/running a rooftop farm?
7) Open question, please feel free to add anything you would like to say about your organization, or about the projects you have conducted, or about anything you would like to say regarding rooftop farming.