

A Review of the Agroecological Farming System as a Viable Alternative Food Production Approach in South Africa

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ABSTRACT

Input-intensive production systems characterise industrial agriculture as an unsustainable means to address food and nutrition security and sustainable livelihoods. Extensive empirical evidence supports the diversification and reorientation of industrial agriculture and incorporates ecological practices, viewed as essential for achieving balanced and productive farming systems. An agroecological farming system is a viable alternative approach that can improve food production, especially for the most vulnerable communities and households. Furthermore, substantial proof and supporting evidence show that such a system is key to increasing dietary diversity at the local level and reducing the multiple health and environmental risks stemming from industrial agriculture. This paper, therefore, aims to demonstrate the benefits of the agroecology food system through an evidenced-based approach that shows how the broader agricultural network structures can play a meaningful role, particularly for impoverished households in today's reality. The methodology is centred on a structured literature review that analyses urban agriculture, agroecology and food insecurity. Notably, ground-truthing, practical experiences and field observation of agroecological farming were deployed. This paper emphasises the practical application of the agroecological approach in urban and peri-urban settings. Several evaluation reports on local and provincial initiatives show that very few households engage in food gardens and urban agriculture. These households do not use their backyards or nearby open spaces for several reasons, such as stringent city by-laws, restricted

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access to land, little or no knowledge of innovative or alternative farming practices, and a general lack of interest. Furthermore, limited resources such as water and energy and lack of capacity building and training implementation are additional constraints hampering small-scale food gardens and farms in other settings. The Agroecology systems approach is viewed as one of the key solutions to tackling these problems.

Keywords: Agroecology Biodiversity, Urban, Peri-Urban, Agriculture, Food Systems, Food Security, Farming, Capacity-building.

1. INTRODUCTION

Several studies show that low input in small-scale agriculture, if effectively harnessed, has enormous potential in addressing and changing the tide of food insecurity in urban, peri-urban, and rural environments, compared to conventional industrialised agriculture (Stringer *et al.*, 2020; Mabhaudhi *et al.*, 2019; & Kremen *et al.*, 2012). Fundamentally, this paper claims that agroecology must retain traditional and homegrown knowledge at its core, which is dynamic, sensitive, and adheres to local indigenous knowledge systems. This paper thus views agroecology to include shared ownership and responsibility of natural resources, including land, seeds, livestock, water, and local indigenous knowledge (the global commons). Such essential resources, thus, require the effective management of collective, democratic control systems that adequately frame public policy discourse of both rhetoric and aligned implementation methods. According to Valenzuela (2016), agroecology incorporates and embraces key factors of importance in building sustainable local food economies that similarly support all stakeholders within the food value chain. Such stakeholder convergence includes notably local producers, processors, and retailers that build the necessary linkages between and among consumers, farmers, and the food business value chain. Decentralised short supply chains, diversified markets based on solidarity and fair prices, and closer local ties between producers and consumers are fast becoming indispensable in increasing food access to the most vulnerable households.

2. PROBLEM STATEMENT

Ongoing distressful and protracted socioeconomic shocks and disasters, as well as emerging and evolving global challenges of climate change and diseases, such as drought, tsunamis, and raging fires, as well as the Corona 2019 (Covid-19) virus, which soon turned into a pandemic, heightened unemployment rates. Poor service delivery at local levels are currently being experienced throughout South Africa ever since 2008, 2010 and the current economic downturns with markets plummeting and raging intra-state wars, particularly in the Democratic Republic of the Congo (DRC) (a Southern African Development Community [SADC] member state with South Africa), Somalia's transnational and terrorist extremism, as well as further afield inter-state conflicts between Israel and Palestine, and Russia and Ukraine. At the heart of these problems are the most vulnerable populations feeling the brunt of global socioeconomic issues impacting South Africa and the world. Thus, in the absence of viable agroecological approaches, food security is being further stifled and compromised. The necessary resilience to these shocks, if correctly harnessed, could have the ability to security increase food security substantially, as well as redress food vulnerability. In South Africa, poor households are burdened with managing daily subsistence and survival from their physical insecurities of access to basic human rights of electricity, water, and sanitation (Mabhaudhi *et al.*, 2019). According to Rudolph *et al.* (2021), at least 34% of households experienced food insecurity in South Africa, and almost 60% spent R1000 (\$57) or less on food monthly. In South Africa, the levels of food insecurity are specifically experienced within informal settlements and in peri-urban areas (Kroll *et al.*, 2012). Since the COVID-19 outbreak, clear evidence shows that food impoverishment has heightened since the Covid-19 pandemic, and this conundrum will likely remain so for several years post-pandemic.

To reverse and adequately address the ailing challenges brought about by the pandemic tide of increased poverty, heightened unemployment, and among other destabilising factors, our fieldwork of data collection and ground proofing confirms that agroecology is the essential apparatus that can turn the tide for impoverished households in South Africa (Chakona *et al.*, 2018) as well as the African continent. Despite many studies on food security in urban agriculture and agroecology, there is still a void in research studies. Thus, this paper is filling a gaping research hole that provides a multidisciplinary nexus programmatic approach that is practical for South Africa's reality and integrates solutions and approaches to addressing the scourge of food

insecurity in urban and rural areas. Therefore, our multi-facet approach is clear, farming only thrives and becomes sustainable when it works with local ecosystems (Rudolph *et al.*, 2020).

Similar scholars note that the challenges facing South Africa, the African continent, and globally include the high prevalence of food and nutrition security threatened by climate change, urbanisation, and ecosystem destruction (Nhamo *et al.*, 2021).

However, these interrelated crises are often poorly understood. According to Statistics South Africa (STATSSA), 11% (6.5 million people) out of the 59 million population have suffered from hunger since 2019. An estimated 27% of children under five years old in South Africa are stunted (STATSSA, 2020). According to Rudolph *et al.* (2021), 37% of Gauteng, with a 15.5 million population, is revered as South Africa's most progressive economy, with Johannesburg viewed as the gateway to Africa, but this economic giant has similarly been stifled with half of its 7.5 million people facing food insecurity, and 51% of people with compromised and unsatisfactory diets lacking the most basic nutrients, which are vital for basic human health in accordance with the World Health Organisation's (WHO) basic nutrition standards. Poor diets further negatively impact chronic illnesses such as tuberculosis, diabetes, obesity, and stunting. Food insecurity equates to health crises and is exacerbated by poverty, unemployment, poor sanitation, water scarcity, erratic power and energy disruptions, clean air, water pollution, and soil degradation, which hugely impact the quality of food harvested and invariably decrease the successes of achieving a healthy society at large.

3. OBJECTIVES OF THIS STUDY

This paper fundamentally applies its major objective discussed throughout the analysis provided, which is to provide a constructive and robust methodology and practice that informs research, which demonstrates the benefits of agroecology through improved resource utilisation, plant productivity, creation of sustainable jobs, and addressing food insecurity, especially in urban settings.

4. METHODOLOGY

The study methodology used the ground truthing process by gathering provable data and information through critical literature review analysis, structured observations, practical contact, and experience learned in urban agriculture, agroecology, and food insecurity. The authors identified, appraised relevant studies, collected, and analysed pertinent literature and data on agroecology in urban and peri-urban settings and related applications in South Africa and regionally.

4.1. Conceptual Framework

4.1.1. *Elements of Agroecology in an Urban Setting*

The conceptual study framework is based on the ten elements of agroecology. Agroecology is an integrated approach that applies ecological and social concepts and principles to designing and managing food and agricultural systems (FAO, 2020). Table 1 below provides the agroecology elements which are interlinked, interdependent, and essential for the development of urban agriculture.

TABLE 1: Ten Elements of Agroecology

Diversification	Diversification is a key element in building viable agroecological processes, as it ensures food security and nutrition while conserving, protecting and enhancing natural resources.
Co-Creation and Sharing of Knowledge	The co-creation and sharing knowledge are essential in developing and implementing agroecological innovations that address food systems challenges. Agroecology depends on context applying specific knowledge. It provides tailored solutions to the environmental, social, economic, cultural and political context.
Synergies	Building synergies enhance essential functions across food systems, supporting production and multiple ecosystem services. Attention to the design of diversified systems that combine annual and perennial crops, livestock and aquatic animals, trees, soils, water, and energy,

	can substantially enhance synergies in the context of mitigating climate change risks.
Efficiency	Innovative agroecological practices produce more while using fewer external resources. Thus, increased resource-use efficiency is an emergent property of agroecological systems that supports careful planning and manages diversity to create synergies between different system components.
Recycling	More recycling means lower economic and environmental costs. Therefore, imitating natural ecosystems that support biological processes greatly helps recycle nutrients, biomass and water within production systems.
Resilience	Enhanced resilience of people, communities and ecosystems is key to achieving sustainable food and agricultural systems, which has a greater capacity to recover from disturbances, including droughts and diseases.
Human and social values	Protecting and improving livelihoods, equity, and social well-being are vital to achieving sustainable food and agricultural systems. Agroecology places a strong emphasis on human and social values, such as dignity, equity, inclusion, and justice, all contributing to the improvement of livelihoods, particularly towards achieving the United Nations (UN) Sustainable Development Goals (SDGs) 2030 Agenda: SDG2 “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”.
Culture and food traditions	By supporting healthy, diversified and culturally appropriate diets such as herbs and indigenous vegetables, agroecology contributes to food security and nutrition while maintaining the health of ecosystems. Agriculture and food are core components of human heritage. Hence, culture and food traditions play a central role in society and in shaping human behaviour.

Responsible governance	Sustainable food and agriculture require accountable and effective local, national, and global governance mechanisms. Agroecology calls for accountable and effective governance to support the transition towards sustainable food and agricultural systems.
Circular and solidarity economy	Circular and solidarity economies connect producers and consumers, providing innovative solutions while ensuring the social foundation for inclusive and sustainable development. The circular economy must include growing and strengthening the agricultural value food chain in South Africa and with its regional and continental partners that are cognisant of the modalities of the African Continental Free Trade Area (AfCFTA) towards shifting trade barriers, building agro-industrialisation value chains, and mindful of rules of origin (ROOs) that does not impact small-scale farmers negatively, particularly women.
Policy and legislation	This speaks to appropriate and relevant policy and legislation which supports and promotes agroecology as a viable alternative production system.

5. LITERATURE REVIEW

5.1. Introduction

Studies that contribute to this paper explore the successful application of agroecology as a food system indicate that application should be carried out at both micro-level (household level) and macro-level (local and national level). The micro-level entails supplementing and complementing household food supplies for the most vulnerable food insecure households through innovative gardening techniques, which are simple and allows for the use of available resources from the local levels. At a macro-level, the type of interventions that capitalise on the city's land-use patterns can improve the local food system by leveraging social and economic factors, such as supply chains and collaboration with local farms and other stakeholders, to improve food access and distribution.

5.2. Food Insecurity in the Context of Agroecology

Azunre *et al.* (2019) argue that food security is embedded in the critical features of agroecology that improve productivity over time, particularly centred on the farm level and across the whole food supply chain. This benefits the farmer by providing different sources of income, reducing the risk of crop failures, and providing a more comprehensive range of food that can improve diets. Food security is an essential component when looking at agroecology and eco-agriculture. However, it is necessary to understand the term food security and how it links with agroecology.

Many definitions are used and accepted by academia and practitioners but often, these only scratch the surface of the multi-dimensionality of food security (Gibson, 2012). This paper, therefore, strongly inculcates the definition of Pinstrup-Andersen, (2009) in its use and application:

Food Security is when all people constantly have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Food security further becomes a viable mechanism for solid socioeconomic human capital development growth when farmers at the grassroots level is not left behind that agroecological food value chain.

Although the various elements of agroecology are listed above, as shown in Table 1, several authors provide and apply their unique understanding of this food production approach, which offers equitable and decent livelihoods, healthy environments, and food. These approaches all stem from collaboration with the grassroots stakeholders, with nature and a wide variety of knowledge systems. Appreciating indigenous knowledge systems that leverage the latest technology plays a vital role in the system's study, design, and management. It is used at the farm level and across the global food production, distribution, and consumption network (Pereira *et al.*, 2018).

Schreer *et al.* (2020) and Rudolph *et al.* (2020) assert that food insecurity should be seen in the context of affordability and accessibility and not simply as an issue of how much food is produced but also as addressing its preparation. Thus, a developmental model that encourages agri-business organisations to embrace the concept of food security always allows access to affordable and nutritious food, essential in reducing food insecurity among the most vulnerable households and individuals in our society.

Loker *et al.* (2020) emphasise the need to grow and develop people, jobs, and capacity, expand networks, grow leadership, grow healthy children and youth, and grow high-level partnerships through robust collaboration efforts. At the government level, attention must be placed on the land and agrarian transformation that can give a country the right to thrive and achieve food sovereignty. The feature of this transformation should be on food sovereignty, which includes local production, agricultural prices directly linked to producing costs, the right of countries to protect themselves against dumping of underpriced farm produce, and critical trade mechanisms that avoid trade barriers, as aligned to the AfCFTA.

More than 90% of farms across the globe are categorised as small (usually less than 2 hectares). These farms contribute to agricultural biodiversity by breeding and connecting with over seven thousand animal species and 1.9 million crop varieties (Jepchumba., 2021). According to the Food and Agriculture Organisation of the United Nations (FAO UN) (2022), small farms are more productive than large farms as they are easy to manage. They use locally available resources and inefficient methods and rely on indigenous knowledge systems. Similarly, according to the African Centre for Biodiversity (2017), smallholder farmers are the custodians of agricultural biodiversity, repositories of indigenous knowledge, food producers, and innovators. They use agroecological techniques such as intercropping and other innovative techniques. For challenged economies and countries battling to sustain food security and human capital development growth, the key lies in the extent of the government's abilities and willingness to see the economic value in support of smallholder farmers, intending to achieve viable food security and food sovereignty (Loker *et al.*, 2020).

Millions of people abandon the countryside to escape hunger, poverty, and insecurity. Even when they reach and settle in the cities, they end up poorer, often without employment, living in polluted environments with no secure housing, and having poor access to essential health, water, and sanitation services. The hopes of these people rarely translate into prosperity (Rudolph *et al.*, 2021; & Leventon *et al.*, 2017).

5.3. Urban Agriculture and Food Security: An African and Regional Perspective

Global estimates indicate that out of the current world population of 8 billion people, 2.5 billion people in developing states live in urban areas, with a forecast of 3.5 billion people by 2025 (Crush *et al.*, 2020). Rapid urbanisation transforms vulnerable city environments into degraded and impoverished settlements, resulting in spatially marginalised, social exclusion, and unemployed populations, breeding lopsided and unequal socioeconomic growth. Urban food systems are more challenging to expand into efficient and equitable hubs against these deficits (Leventon *et al.*, 2017) than rural and peri-urban developmental areas.

In Africa, examples of a national development structure for urban and peri-urban agriculture began in the DRC, with municipalities integrating urban agriculture into urban planning (Chitakira *et al.*, 2021). The potential of urban agriculture to upgrade informal settlements and food access and security of urban dwellers is often unrecognised in both agricultural policies and urban planning. This sector could play a vital role in the food system and socioeconomic development growth, with tumultuous prospects. However, it is still hugely understated and unsupported by public institutions within Africa's governments (Frayne *et al.*, 2017).

Although what seemed to be an important step forward in acknowledging urban/peri-urban agriculture potential in 2003 by Zimbabwe, Eswatini (formerly known as Swaziland), Malawi, Tanzania, and Kenya, the most progress has been the Harare Declaration in Urban and Peri-Urban Agriculture sectors. The Harare declaration identified both the institutional and resource obstacles of integrating urban and peri-urban agriculture into urban economies and called for a shared vision within the sector. However, in later years and with new government leadership since the passing of former Zimbabwe President Robert Mugabe, the declaration's translation into practice became stifled (Frayne *et al.*, 2017).

McCordic *et al.* (2017) estimate that 77% of poor households or 100 million people living in urban and peri-urban areas in the Southern African Developing Countries (which include the region of SADC's 16 member states with a total population of 371,845,800 people since 2022) are food insecure (SADC, 2022). Food insecurity overlays poverty, considering that three-quarters of the urban population's income in South Africa is less than 2 dollars a day, with half of this amount

being spent on purchasing food. Although most of these households go to the supermarket to buy food, the informal sector remains highly important, with 70% of people frequently obtaining food from street vendors and two-thirds dependent on smaller outlets (Ringenson *et al.*, 2017).

Renwick *et al.* (2019) say urban agriculture is not new. Agriculture was closely linked to the origin of cities and allowed people to settle permanently into organised hubs. It has always been practised in the North and South of the world. Agroecology has constituted a strategy of self-sufficiency that allowed people to survive during wars of economic depression. The value of urban agriculture is thus recognised by non-governmental organisations (NGOs), community-based organisations (CBOs), as well as grassroots movements, which have launched projects in cities and peri-urban areas (Ringenson *et al.*, 2017). International agencies, national governments, and local municipalities in Latin and South America and Africa are sustaining urban agriculture projects involving agroecology practices. The FAO, for example, in collaboration with city municipalities involving 20 countries in Latin and South America and Africa, have been promoting irrigated commercial market gardening in urban peripheries, hydroponic micro-gardens in slums, and green rooftops within city centres (Hellebuyck, 2018). Examples of national plans and policies promoting urban agriculture come predominantly from Latin America, Cuba, Argentina, Brazil, Bolivia, and China (McCordic *et al.*, 2017).

The informal sector remains the most frequent source of purchase among Southern African urban poor inhabitants, followed by smaller outlets and supermarkets, which only contribute 5% of households everyday food supply. Street vendors have higher prices than supermarkets but remain the easiest way to purchase food because of geographical proximity and minimal transportation needs (Kroll *et al.*, 2016) and thus beneficial to meeting the needs of an already impoverished community.

Furthermore, the lack of refrigeration and the continuation of power outages with households having no alternative means, besides affluent communities where generators are purchased and solar panels installed, the outlook of the real world looks very different for the ordinary person. Thus, in many informal areas, the possibility to buy bulk fresh food provisions is extremely limited to the confines of the day. Finally, urban agriculture for self-subsistence constitutes an essential

food source for nearly a quarter of poor households and a viable source of income for many poverty-stricken people (Filho *et al.*, 2021). Despite urban agriculture playing a minor role in the food supply, its practice is spreading rapidly among the urban poor in Africa. It can become a viable market towards trade prospects in building small, medium and micro enterprises (SMMEs), but it requires the correct government and business industry propelling mechanisms. Urban agriculture is carried out by those with access to land and inputs and those lacking a regular income source who cannot purchase food. Millions of slum dwellers have turned to agriculture, growing their food (illegally) in every scrap of available land along rivers, roads, railways, and backyards (Leventon *et al.*, 2017) to feed themselves and sell whatever produce is available.

5.4. State of Urban Agriculture in South Africa

Almost two-thirds of South Africa's population now live in urban areas, while those living in rural areas have dropped to 38%. Food insecurity is rising in urban areas because of increased urban population movements (Schreer *et al.*, 2020). The urban poor spend most of their income on food, and thus they become highly vulnerable when food prices increase, with multiple effects negatively impacting their health (Moseley *et al.*, 2020). Also, the urban poor people rely on the purchase of cheap food, which is highly caloric, deficient in vitamins and minerals, rich in starch, and containing hydrogenated fats and simple sugars, while their daily intake of fruit and vegetables is under half the minimum level as recommended by the WHO (2020) and Moseley *et al.* (2020).

Kroll *et al.* (2016) assert that the reasons for diminished food access and nutritional inequalities among the urban poor include the gradual reduction of fresh produce markets caused by urban development pressures and the so-called "super marketisation" phenomenon. Furthermore, land use is allocated to industry and housing, producing fresh food from peri-urban to rural areas. The cost of packaging, transport, refrigeration, and food losses affect food availability and final value in urban markets. In contrast, the marketplace activities of corporate chains displace local food retailers (Leventon *et al.*, 2017).

In addition, small food producers and retailers need to meet food safety standards established by international agencies and corporate policies in the context of world commodity trade and national food, health, and safety regulations (Loker *et al.*, 2020). Hence, the lack of facilities and hygiene

programmes to meet the requirements often results in them closing their activities and further resulting in loss of income. An important consideration in urban planning is that food outlets are primarily accessible by car, limiting food procurement for poor dwellers without transportation. In contrast, fresh food outlets disappear to accommodate private vehicles (Ringenson *et al.*, 2017).

Frayne *et al.* (2017) indicated that in South Africa, very little had been done to include urban/peri-urban agriculture in the economic sector. In some provinces and municipalities, initiatives are slowly reintroducing urban agriculture in health promotion and community programmes (Drescher *et al.*, 2021). For example, the City of Cape Town supplied community gardening groups with tools, seeds, compost, and access to skills training in 2016. In 2005 and 2012, Msunduzi Municipality in Kwazulu-Natal, in partnership with Children in Distress Network and The Institute of Natural Resources, established a key programme, namely, the African Root Project, which promotes the creation of food gardens across the municipality and fundamentally addresses nutritional needs of communities affected by the Human Immunodeficiency Virus (HIV), and the Acquired Immunodeficiency Syndrome (AIDS) infectious diseases. The Department of Education launched Gauteng's Health Promoting Schools programme, including developing food gardens in several province schools. During 2008 and 2009, the National Household Food Production Programme distributed 80000 "starter packs" to learners, which provided essential inputs like seeds, seedlings, fertilisers, and pesticides to support food garden production (Frayne *et al.*, 2017).

Several similar programmes in the country are conducted by NGOs, CBOs, and other non-profit entities, often with the support received from international cooperation. Despite these well-motivated initiatives, food gardens are not sufficiently replicated or scaled to have the meaningful and desired impact of uplifting communities and providing food security.

However, these projects are constrained by the Corporate Social Investment (CSI) contexts of the business industry, which frequently result in conceptualised programmes for short-term outcomes. Some entities also use this community as a way for corporations to bolster their corporate image. However, it can be more effective when business and community development invests more in sustainable methodologies. The supply of agricultural inputs and training is a significant step in urban and rural contexts. However, in CSI-based and government-led initiatives, strategies

typically remain mired in centralised, top-down extension models, which consist of installing infrastructure and little or inadequate training, leaving projects to flounder after the short funding timeframe concluded. What is desired is, thus, solid and sustainable models in agroecology. Such initiatives can be cocreated to achieve the requisite sustainability (Renwick *et al.*, 2019) as recommended throughout this paper: food security programmes should receive more resources within collaborative partnerships with local stakeholders. Thus, government and civil society should share the responsibility to ensure their success in policy agendas to build self-sufficiency as alternative measures to emergency-response strategies like grants or food subsidies. Furthermore, such programmes should fully realise the potential of successful producers in moving from a self-subsistence production to a larger scale, thereby generating income. For sustainability, it is essential to develop enduring local resource and demonstration hubs staffed by extension and support teams who can provide training, advice, organisational development, access to inputs, and appropriate financial products such as microfinance and insurance (Frayne *et al.*, 2017).

The Siyazondla report (2012), which assessed the impact of household gardens in Gauteng, shows that agriculture projects should be linked to value add products and incorporate food system components such as processing, packaging, distribution, and retailing via local food markets to ensure longer-term survival. Establishing these links in urban and peri-urban hubs could create thousands of job opportunities and livelihoods. In the urban context, cultivation is often isolated from the urban food supply. This is based on the misconception that food insecurity is mainly the inadequate availability of food, a belief that frequently informs food security policy. This leads to the mistaken assumption that food insecurity can be resolved by increasing food production in rural areas and food-insecure households (Leventon, 2017).

For the same reason, responsibility for food security policies resides primarily with the National Department of Agriculture, Land Reform and Rural Development. The problem is aggravated in the Gauteng Province, where the commercial and industrial sectors push and pull the economy while agriculture is marginalised. Consequently, other departments do not adequately acknowledge food security planning (2011). The lack of alignment and collaboration of different departments and the need for coordination between government and civil society are also

experiencing significant limitations in implementing integrated policies concerning food security (Renwick *et al.*, 2019).

The Gauteng Integrated Food Security Strategy (2011), launched by the Gauteng Department of Agriculture and Rural Development, was a good example to incorporate into current policy. It was the first provincial strategy in South Africa to deal exclusively with food insecurity issues. Although it advocated an interdepartmental collaboration approach, it needs to specify how this could be succinctly achieved and thus sway away from the province that remains focused on a rural and agricultural paradigm (Frayne *et al.*, 2017).

Rudolph *et al.* (2016) explained that food insecurity in the Gauteng region is of great concern as it challenges the most vulnerable population's socioeconomic and health conditions. Almost two-thirds of Johannesburg's urban population was food insecure and susceptible to malnutrition. Such factors similarly severely affect health, society, and the economy. Attempts to address hunger and poverty within a segregated approach will not be feasible and thus fail to accomplish a well-entrenched agroecology food and further only result in short-term solutions. A resilient food security system can only be achieved through a holistic vision, which includes all the elements of the agroecological system: from the production to the consumption stages, and one which considers the implications for, and impact on, society, health, and the environment. Furthermore, the spatial scale is another feature that needs to be understood to address food security policy coherently and correctly.

Cities are highly complex environments of many intersecting settings; no single blanket approach can effectively manage this complex interplay of settings. The necessity of specific interventions is required to be implemented in South African cities, particularly a province that is growing at a very fast pace and leaving a trail of a backlog of services and spatial isolation left by racial segregation and post-apartheid remedial attempts at mass housing delivery, accompanied by rising violence and cultural fragmentation (Loker *et al.*, 2020).

The complexity of modern urbanisation needs to be carefully studied in terms of its components and disparities. Food security cannot be approached by applying a unique “downscaling” model extended to the broader city. Food insecurity hot spots need to be identified and addressed in a

tailored based approach centred on spatial patterns and location, which leverages the power of agency and entrepreneurship (Mcata, 2019). For example, in the City of Johannesburg, which is based on spatial marginalisation, one might expect levels of food insecurity to be higher in impoverished settlements on the urban fringes than in the more diverse inner city. Indeed, within Gauteng, 34% of households in the informal settlements of Orange Farm were severely food insecure, followed by 26% in the inner city and 21% in Alexandra. The urban dwellers are not spared from food insecurity, and a significant proportion of moderately food-insecure households were found in the inner city. Food security at the local level in Johannesburg and Gauteng is largely related to a lack of viable household income and access to food. These food insecurity issues are compounded by the dietary transition mentioned earlier, which is characterised in South Africa by changes in nutritional habits accompanying urban lifestyles, including increased consumption of coffee, carbonated beverages, sugar, meat, offal, and potatoes (Rudolph *et al.*, 2016).

6. RESULTS AND KEY POLICY AND RESEARCH PRACTISE RECOMMENDATIONS

6.1. Interventions

From our experience and observations, the current agricultural production system is not delivering on the promise to feed the world (Skinner *et al.*, 2018). It is clear that the limitations of agriculture are becoming more dire and damaging to human and environmental health.

Therefore, agroecology is increasingly being recognised as the way forward for agriculture, and several studies confirm its relevance towards achieving sustainable development goals, as was attested throughout this paper (Crush *et al.*, 2020; Barrios *et al.*, 2020 & Zantsi *et al.*, 2019). Agroecology is a proven and better alternative to the destructive practices and unhealthy food produced by industrial agriculture.

The ten elements of the agroecology system (see Table 1 above) are being applied in part and or in full at the Siyakhana Organic Food Garden (SOFG), a 2.4 Ha garden in the University of Johannesburg's research implementation structures. Siyakhana is an example of a prosperous small urban agroecology garden which applies diversification by growing a wide range of vegetables, herbs, grains, nuts, fruit trees, and edible shrubs. Co-creation and knowledge sharing

are key aspects of research and implementation with a track record of proven practices, partnering and creating synergies with knowledge generation institutions such as the University of Johannesburg, its academic peers at national, continental and global Higher Education Institutions (HEIs), the private sector, local, provincial, national, continental and global government entities and international agencies. Our established production system uses efficient recycling systems, incorporating Artificial Intelligence and becoming a greenhouse agroecology fourth industrial revolution frontier system that addresses current climate change challenges, increasing resilience and leaving no one behind. Promoting human and social values with responsible governance has remained an essential objective of our flagship project. The revenue streams at the garden include selling a wide range of vegetables, seedlings, fruit and nuts, compost, worm tea, and income from school visits, with several youths streaming through its doors being empowered academically and providing learnership skills for sustainable future employment creation. The potential for showcasing a viable sustainable small-scale urban farming model remains our top priority. Various aspects of the Siyakhana model have been replicated in several sites, including schools, early childhood centres, campuses, community sites and clinics, at local, provincial, and national government priority fora, and among other global events with peer institutions, funders, and like-minded groups who are willing to change the tide of food insecurity and poverty (Rudolph *et al.*, 2021).

There is overwhelming evidence proving agroecology is an important next step in solving food crises in both urban and rural areas. Growing food in urban settings is well documented in South Africa, but much more needs to be done, particularly in implementing the agroecological elements. Pereira *et al.* (2018) share the same views and maintain that more support is required, primarily through legislation and financial support. Numerous agro-based systems are offering to boost both local and national food economies in South Africa. These include farmers, markets, farm-gate sales, box delivery schemes, mobile shops, community-supported agriculture, consumer-producer cooperatives and collective catering and canteens (Crush & Si, 2020). However, these initiatives need support, replication, amplification, and fundamental monitoring, evaluation and reporting frameworks that show how risks are effectively mitigated within our agroecology approach.

For a paradigm shift to an agroecological approach within our food system, policy and support structures at the national, provincial, and local levels are necessary, and grassroots campaigning is required to educate and empower our communities. These policies are not easily understood by the ordinary people who are the primary beneficiaries. Policy changes should support the supply and demand of local, sustainable foods, production of appropriate foods for local markets, improved infrastructure, small-scale food processing facilities, farmers' co-ops, and coordinated marketing initiatives. More research into local agroecological production and local food economies is essential (Mcata, 2019). At a community level, local authorities should provide support through interventions/planning policies, which can be used to revitalise local shops, provide fiscal measures to support local sourcing, and funding to specific initiatives to develop farmers' markets, community-supported agriculture, fair trade schemes and other similar initiatives (Rudolph *et al.*, 2020).

The City of Johannesburg's Food Resilience Programme Evaluation Report (2017) proposed interventions to address food insecurity in Johannesburg. The report highlights that connecting several small farms to markets and government food supply contracts managed through a government food procurement company can hugely assist small urban farmers. Mcata (2019) states that short supply chains are not just about reducing the number of intermediaries in the supply chain nodes but a sustainable way of distributing food. From our research practice experiences, distributing food from one intermediary node to another, putting the consumer and the producer at the heart of deciding what is produced, how it is produced, and how to define the value, improves food production and establishes local markets. Therefore, what is key is who produces and manufactures and how this convergence happens, ultimately creating a larger effective circular economy with the correct apparatuses applied. Zantsi *et al.* (2019) agree that short distribution nodes are crucial and are embedded in agroecology principles. Structured support and collaboration between farms close to the city are needed, especially nearby farmers around Johannesburg and the Gauteng region. These authors also show that through short supply chains in local markets, food distribution can increase income for producers, add value and generate greater autonomy for farmers, and strengthen local economies by supporting more small-scale businesses.

Agroecology improves urban resilience and creates economic opportunities integrated into urban planning as part of multifunctional urban landscape systems. The ecosystem services benefit human populations directly or indirectly (Frayne *et al.*, 2017). Agroecology can improve the viability of small farms and fundamentally reduce the carbon footprint in the distribution chain. Thus, agroecology is a priority methodology to address food insecurity, climate change, encouraging healthy diets and customer loyalty. Households are also encouraged to grow their food to supplement or complement their dietary requirements. Due to a shortage of land, many schools have demonstrated their potential to provide enough land to carry a sizeable garden. A community-based garden situated at schools and tertiary institutions throughout Africa can contribute to the local food system of an area with practical means of creating arable land where land has been degraded, including mining dumps which Gauteng is in an abundance of (Rudolph *et al.*, 2020/2023).

Patel (2009) argues that by protecting and preserving urban infrastructure from climate-change impacts, multifunctional urban landscape systems have the potential not only to reduce expenditures for the maintenance of infrastructure but can actively accommodate and contribute toward economic, social, and cultural activities that enhance urban resilience. As poverty always brings about further scarcity and deficiency, on the other hand, creating jobs and greater self-reliance in terms of food and livelihoods sufficiency in the urban areas could mitigate the trend of migration to urban settlements (Rudolph *et al.*, 2020) and thus places less strain on local municipalities.

Food safety and standards, trade and development policies must be refocused to benefit local communities. Appropriate health and safety, food hygiene, environmental health, and practical regulations are needed but should not unduly affect smaller producers and enterprises. Policymakers need to develop effective and suitable national and local strategies to support the development of sustainable food economies, covering the whole food chain to encourage sustainable food production (Frayne *et al.*, 2017).

6.2. Contribution to Agriculture Extension And Technology Support

Despite the proven advantages of resource-conserving technologies and practices such as the agroecology food system, farmers' adoption can be challenged despite the apparent benefits. These technologies involve substituting management skills, knowledge, and labour for external inputs. Participatory extension support can assist in technology transfer. However, if it is imposed on farmers, they will not adopt this technology. The agroecology food system capitalises on local knowledge because it is a valuable and under-used resource. Agriculture extension has long been grounded in the diffusion model of agricultural development with minimum farmer participation. The adoption results have been negligible. The agroecology food system incorporates farmer participation and the utilisation of indigenous knowledge in practice, with robust support mechanisms put in place.

7. CONCLUSION

A participatory extension support system that uses indigenous knowledge is essential to realising the benefits of the agroecology food system. These benefits are derived from the diversification of the ten elements of agroecology, as provided in Table 1 earlier. From our experience and within structured interviews, field observations, and a combination of supported research data and numerous studies, agroecology can successfully address food insecurity and promote food resilience in urban and peri-urban environments. The successful process of agroecology must be based on the application of ecology, from the design and management stages with clear linkages of creating sustainable agroecosystems informed by robust engineering practices supporting water systems, for example, traditional knowledge, alternative agriculture systems, and local food system experiences. In this nexus, the local, provincial and national governments should institute policies and legislations which promote agroecology at the household and community levels. The most crucial aspect of agroecology is linking ecology, culture, economics, and society to sustain agricultural production, healthy environments, and viable food and farming communities. This paper has highlighted the vast opportunities agroecology presents as an alternative food system that can offer a solution to food insecurity, robust food nutrition security alternatives, and food resilience as a buffer to the threats of climate change in today's reality of the real world.

REFERENCES

- AZUNRE, G.A., AMPONSAH, O., PEPRAH, C., TAKYI, S.A. & BRAIMAH, I., 2019. A review of the role of urban agriculture in the sustainable city discourse. *Cities.*, 93: 104-119.
- BARRIOS, E., GEMMILL-HERREN, B., BICKSLER, A., SILIPRANDI, E., BRATHWAITE, R., MOLLER, S., BATELLO, C. & TITTONELL, P., 2020. The 10 elements of agroecology: Enabling transitions towards sustainable agriculture and food systems through visual narratives. *Ecosyst. People.*, 16(1): 230-247.
- CHAKONA, G. & SHACKLETON, C.M., 2018. Household food insecurity along an agroecological gradient influences children's nutritional status in South Africa. *Front Nutr.*, 4: 72.
- CRUSH, J. & SI, Z., 2020. COVID-19 containment and food security in the Global South. *JAFSCD.*, 9(4): 1-3.
- CRUSH, J., FRAYNE, B. & HAYSOM, G., 2020. *Handbook on urban food security in the global South*. Edward Elgar Publishing.
- DRESCHER, A.W., ISENDAHL, C., CRUZ, M.C., KARG, H. & MENAKANIT, A., 2021. Urban and peri-urban agriculture in the Global South. In C.M. Shackleton, S.S. Cilliers, E. Davoren & M.J. Du Toit (eds.), *Urban Ecology in the Global South*. Cham: Springer, 293-324.
- FILHO, W.L., AZEITEIRO, U.M., BALOGUN, A., SETTI, A.F.F., MUCOVA, S.A., AYAL, D., TOTIN, E., LYDIA, A.M., KALABA, F.K. & OGUGE, N.O., 2021. The influence of ecosystems services depletion on climate change adaptation efforts in Africa. *Sci. Total Environ.*, 779: 146414.
- FRAYNE, B. & CRUSH, J., 2017. Food supply and urban-rural links in Southern African cities. In B. Frayne, J. Crush & C. McCordic (eds.), *Food and Nutrition Security in Southern African Cities*. London: Routledge, 34-47.
- FRAYNE, B., CRUSH, J. & MCCORDIC, C., 2017. *Food and nutrition security in southern African cities*. London: Routledge.

- KREMEN, C., ILES, A. & BACON, C., 2012. Diversified farming systems: An agroecological, systems-based alternative to modern industrial agriculture. *Ecol. Soc.*, 17(4).
- HELLEBUYCK, C., 2018. *Cultivated edge: Mediating rural and urban gaps in informal settlements*.
- KROLL, F.J., RUDOLPH, M.J. & SIMATELE, D., 2015. *Food Security Working Paper 1: A systemic review of food security in the Gauteng City Region*.
- JEPCHUMBA, K.E., 2021. Link between farm enterprise diversity and dietary quality among small-scale farmers households in Makueni and Nyando Sub-Counties, Kenya. Doctoral dissertation, Egerton University.
- LANDINI, F., GALLARDO LOPEZ, F., RAMIREZ VALVERDE, G., AGUILAR CALEGARE, M. & KELLEN ONOFRE DOS SANTOS, D., 2021. How much do extension agents and advisors value agroecology in different countries? Contributions to the understanding of their potential role in scaling up agroecology. *Agroecol. Sustain. Food Syst.*, 1-25.
- LEVENTON, J. & LAUDAN, J., 2017. Local food sovereignty for global food security? Highlighting interplay challenges. *Geoforum.*, 85: 23-26.
- LOKER, A. & FRANCIS, C., 2020. Urban food sovereignty: Urgent need for agroecology and systems thinking in a post-COVID-19 future. *Agroecol. Sustain. Food Syst.*, 44(9): 1118-1123.
- MABHAUDHI, T., CHIBARABADA, T.P., CHIMONYO, V.G.P., MURUGANI, V.G., PEREIRA, L. M., SOBRATEE, N., GOVENDER, L., SLOTOW, R. & MODI, A.T., 2019. Mainstreaming underutilised indigenous and traditional crops into food systems: A South African perspective. *Sustain.*, 11(1): 172.
- GIBSON, M., 2012. Food Security-A Commentary: What Is It and Why Is It So Complicated? *Foods.*, 1(1): 18-27.

- MCATA, B. (2019). Garden ownership as a solution to food insecurity in urban areas of South Africa: Case of food gardens in Alice town, Eastern Cape province. *AJARD.*, 3(53): 215-224.
- MCCORDIC, C. & FRAYNE, B., 2017. Measuring urban food security. In B. Frayne, J. Crush & C. McCordic (eds.), *Food and nutrition security in Southern African cities*. London: Routledge, 24-33.
- MOSELEY, W.G. & BATTERSBY, J., 2020. The vulnerability and resilience of African food systems, food security, and nutrition in the context of the COVID-19 pandemic. *Afr. Stud. Rev.*, 63(3): 449-461.
- NHAMO, L., RWIZI, L., MANDEL, S., BOTAI, J., MAGIDI, J., TAZVINGA, H., SOBRATEE, N., LIPHADZI, NAIDOO, D., MODI, A.T., SLOTOW, R. & MABHAUDHI, T., 2021. Urban nexus and transformative pathways towards a resilient Gauteng City-Region, South Africa. *Cities.*, 116: 103266.
- OLUWATAYO, I.B., 2019. Towards assuring food security in South Africa: Smallholder farmers as drivers. *AIMS Agric. Food.*, 4(2): 485-500.
- PATEL, R., 2009. Food sovereignty. *J. Peasant. Stud.*, 36(3): 663-706.
- PINSTRUP-ANDERSEN, P., 2009. Food security: Definition and measurement. *Food Sec.*, 1(1): 5-7.
- RENWICK, K. & POWELL, L.J., 2019. Focusing on the literacy in food literacy: Practice, community, and food sovereignty. *J. Fam. Consum. Sci.*, 111(1): 24-30.
- RINGENSON, T., ERIKSSON, E., BÖRJESSON RIVERA, M. & WANGEL, J., 2017. The limits of the smart sustainable city. In *Proceedings of the 2017 Workshop on Computing within Limits* (pp. 3-9).

- RUDOLPH, M. & KROLL, F., 2016. *City of Johannesburg Food Resilience Programme Evaluation Final Report*. Wits Commercial Enterprise, Wits Siyakhana Initiative, School of Geography, Archaeology and Environmental Studies (GAES).
- RUDOLPH, M., KROLL, F., MUCHESA, E., PAIKER, M. & FATTI, P., 2021. Food security in urban cities: A case study conducted in Johannesburg, South Africa. *J. Food Secur.*, 9(2): 46-55.
- RUDOLPH, M., MUCHESA, E. & KROLL, F., 2020. Towards an eco-social food system: The shift from industrial agriculture to agroecology in South Africa. *Int. J. Sustain. Dev. Res.*, 6(2): 22.
- RUDOLPH, M., MUCHESA, E. & KROLL, F., 2020. Use of urban agriculture in addressing health disparities and promotion of ecological health in South Africa. *IJNREM.*, 5(1): 26-30.
- SAMUEL, O.O. & SYLVIA, T.S., 2019. Establishing the nexus between climate change adaptation strategy and smallholder farmers' food security status in South Africa: A bi-casual effect using instrumental variable approach. *Cogent Soc. Sci.*, 5(1): 1656402.
- SCHREER, V. & PADMANABHAN, M., 2020. The many meanings of organic farming: Framing food security and food sovereignty in Indonesia. *Org. Agric.*, 10(3): 327-338.
- SKINNER, C. & HAYSOM, G., 2018. *Informal Food Retail and Food Security in Africa: Myths and Facts. Consuming Urban Poverty Policy Brief 1*. Cape Town: African Centre for Cities, University of Cape Town.
- SOUTHERN AFRICAN DEVELOPMENT COMMUNITY (SADC)., n.d. Available from [SADC - Southern African Development Community | countryeconomy.com](https://countryeconomy.com).
- STRINGER, L.C., FRASER, E.D., HARRIS, D., LYON, C., PEREIRA, L., WARD, C.F. & SIMELTON, E., 2020. Adaptation and development pathways for different types of farmers. *Environ. Sci. Policy.*, 104: 174-189.

VALENZUELA, H., 2016. Agroecology: A global paradigm to challenge mainstream industrial agriculture. *Horticulture.*, 2(1): 2.

ZANTSI, S. & BESTER, B., 2019. Revisiting the benefits of animal traction to subsistence smallholder farmers: A case study of Ndabakazi Villages in Butterworth, Eastern Cape Province of South Africa. *S. Afr. J. Agric. Ext.*, 47(3): 1-13.