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REVIEW ARTICLE

Harnessing Artificial Intelligence in Local Governance for Sustainable Food System Transformation in South Africa: A Review

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Abstract

The intersection of Artificial Intelligence (AI) and local governance represents a powerful frontier for attaining sustainable food systems and addressing the complex challenges of food security, agricultural productivity, and environmental sustainability. Despite growing interest in AI applications within agriculture, research examining the integration of AI into local governance frameworks remains limited, particularly regarding ethical implementation, institutional readiness and practical adoption in developing countries. Focusing on South Africa, this article examines the role of AI in strengthening local governance, identifies the major challenges faced by local governments in supporting food system actors, and explores how AI-driven solutions can enhance governance capacity to promote sustainable, inclusive, and resilient food systems. The article is underpinned by a systematic literature review of 61 peer-reviewed articles retrieved from the Scopus database using the search terms 'local governance' AND 'food system' OR 'agriculture' OR 'agribusiness' OR 'agri-business' OR 'farm' AND 'South Africa'. This review was complemented by a narrative analysis of 17 documents from the grey literature, including policy reports, government publications, and institutional documents, to provide broader contextual insights and capture emerging developments not yet reflected in academic literature. The findings reveal that local governments face several interconnected challenges, including fragmented policy frameworks, limited institutional capacity, high implementation costs, low digital literacy among smallholder farmers, inadequate digital infrastructure, and a shortage of locally relevant, high-quality data for informed decision-making. To address these constraints, the study recommends leveraging AI-driven solutions to improve resource management, strengthen evidence-based policymaking, optimize agricultural production, and enhance coordination among food system stakeholders. Future research should move beyond the current emphasis on AI's potential toward practical implementation and long-term resilience by prioritizing ethical data governance, reducing the digital divide, developing context-specific AI tools for smallholder farmers, and supporting urban food security initiatives across South Africa.

Keywords
Artificial Intelligence, Food Systems, Local Governance, Sustainability, Economic Transformation, South Africa.

1. Introduction

Local governance, comprising municipalities and local districts, is the foundational level of administration responsible for driving sustainable development, service delivery, and democratic participation. Key roles include providing essential services (water, sanitation and roads), fostering local economic development (LED), and ensuring community involvement in planning. The importance of local governance lies in tailoring solutions to local needs, reducing poverty, and enhancing accountability, acting as a catalyst for local economic growth and improved quality of life. In countries such as South Africa (SA), local governments are democratically elected spheres mandated with delivering basic services, promoting social and economic development, and ensuring a safe, sustainable environment (Maziwisa & Stevens, 2026). It serves as a 'developmental' entity, partnering with communities to address poverty and infrastructure, guided by the Constitution (Section 152). Local governments are often structured as municipalities (metropolitan, district, or local). It supports other sectors, particularly rural small-scale farmers, as part of the broader approach to improve food security and increase agricultural output, as seen in Limpopo's Agricultural LED Initiative.

However, the effectiveness of the support provided to farmers shows mixed results, with successful initiatives in improving household food security for beneficiaries, but generally limited impact on fostering sustainable, large-scale commercial success for smallholder farmers. This is because local governance in SA agriculture faces significant challenges, including inefficient service delivery, corruption, and a lack of technical expertise. Rural municipalities, for instance, often struggle with slow, manual, and paper-based processes for handling farmer applications, requests, and licensing (Makunyane et al., 2025). Local planners also often lack accurate, real-time data on soil conditions, weather patterns, and crop health, leading to inefficient land use planning and poor agricultural support (Khumalo & Zenda, 2025). There is also inadequate management of water, electricity, and agricultural inputs, which has severely impacted agricultural production, particularly during droughts. Ndhlovu (2025a) avers that local governments in SA often struggle to provide timely, proactive support to farmers during outbreaks of pests or diseases. SA local governments also struggle with mismanagement of funds, corruption, and a lack of accountability in delivering services directly to rural farmers have hindered development (Khumalo & Zenda, 2025; Nxumalo & Chauke, 2025). In addition, there is also a severe shortage of skilled agricultural extension officers to guide smallholder farmers, and a general lack of technical expertise in rural areas.

Several studies argue that addressing the challenges of South African local governments in supporting farmers requires a multi-faceted approach focusing on strengthening municipal capacity, fostering public-private partnerships, improving infrastructure, and streamlining access to finance and technical training (Bowman & Bennie, 2026; Wale & Mkuna, 2025). This includes implementing the District Development Model for better coordination, upgrading rural roads and water systems, and providing targeted support for small-holder farmers to access markets and reduce post-harvest losses (Nxumalo & Chauke, 2025). Another intervention gaining traction is the integration of Artificial Intelligence (AI) to transform operations and activities. AI is a subdivision of computer science that develops systems that can perform tasks that normally require human-like intelligence, such as learning, reasoning, problem-solving, perception, and decision-making (Rosken, 2025). It uses algorithms and data to simulate cognitive functions, allowing machines to improve their performance over time. This article advances the use of AI-driven solutions to improve local governance so that it can effectively support the efficiency and transformation of food systems in Africa. It aims to highlight the potential of AI to help strengthen accountability, optimise resource allocation, enhance communication with farmers, and thus improve productivity and efficiency in food system operations.

This article (i) examines the role of AI in local governance in South Africa, (ii) identifies challenges of local governance in South Africa in supporting food system actors, and (iii) explores how AI-driven solutions can help local governance effectively support sustainable food systems in South Africa. The significance of this study manifests in several ways. Firstly, understanding how AI can assist local governments in South Africa to support food systems is important for fostering resilience against climate change, addressing significant post-harvest losses, and ensuring equitable access to nutrition in both urban and rural communities. As South Africa grapples with high food insecurity and socioeconomic challenges, AI offers tools to optimise the agricultural value chain, enhance logistical efficiency, and provide data-driven insights that help local authorities manage resources better. For local governments in South Africa, understanding and implementing AI is a vital shift from reacting to food crises to proactively building a sustainable and productive food system. While there is substantial literature on AI in smart agriculture (precision farming) and on AI in national-level e-governance in South Africa, a critical gap exists at the intersection of local-municipality implementation and urban or regional food systems. Current South African food policy often focuses on national security, leaving local governments, who handle municipal markets, zoning, waste management, and fresh water, without clear, localised strategies. Literature rarely addresses how resource-constrained South African municipalities can practically leverage AI for food logistics, urban farming optimisation, or supply chain resilience.

The novelty of the study stems from shifting the AI-food narrative from a purely commercial 'agri-tech' perspective to a public governance tool. It reframes the local municipality not just as a regulator, but as an active algorithmic orchestrator of food security. Investigating this within South Africa, where infrastructure deficits, data scarcity, and socio-economic inequalities (the digital divide) complicate AI deployment, offers a unique alternative to Western-centric smart city frameworks. The scholarly contribution of this article is threefold. Firstly, provides a novel matrix mapping specific AI capabilities, such as predictive analytics for climate shocks and machine learning for waste reduction, directly to local government mandates under the South African Constitution. Secondly, it offers local policymakers a diagnostic tool to evaluate their digital readiness for food system interventions. Thirdly, by identifying systemic barriers, such as municipal data silos, ethical AI governance, and load shedding constraints, the review sets a critical baseline for empirical IT and public policy researchers in Africa.

2. Literature Review

This section comprises two sub-sections focusing on the role of local governments in food systems and the nexus of AI and development.

2.1. Role of Local Governance in Food Systems

The role of local governance is being increasingly acknowledged as the foundation of sustainable food systems. Zerbian et al. (2022) posit that local governance is vital for transforming food systems, as it brings decision-making closer to residents, facilitating tailored solutions for sustainability, food security, and resilience. Vignola and Oosterveer (2025) opine that local authorities, such as cities, play a crucial role in connecting diverse food system stakeholders, promoting equitable resource access, and, through initiatives like food policy councils, implementing practical, localised solutions to food insecurity and environmental challenges. There are several key aspects of local governance in food systems.

Local governance provides contextual solutions and ensures sustainability in local food systems. For instance, local governments can address specific local needs, such as supporting peri-urban agriculture (Trevenen-Jones et al., 2025; Vignola & Oosterveer, 2025). For example, in Brazil, Magalhães and Coelho (2023) report that Belo Horizonte operates a dedicated Municipal Secretary of Food Supply, Security, and Nutrition, which integrates food planning into city management. In Argentina, Rosario implements agroecological, food-producing initiatives in peri-urban areas to enhance sustainability and climate resilience (Terrile et al., 2024). In Brussels, Belgium, the 'Good Food Strategy' directly promotes urban and peri-urban agriculture to boost self-sufficiency, while Vancouver, Canada, uses specific policies to support urban and peri-urban agriculture on both public and private lands. In China, Conghua (Guangzhou), known as the backyard garden', is used by local authorities to support modern, technologically advanced agricultural parks in peri-urban areas (Xing & Zheng, 2025). In South Africa, Cape Town maps municipal departments to ensure coordinated support for urban agriculture (Vidal-Merino et al., 2021). Local governments also work on reducing food waste and improving public procurement to promote sustainable, healthy, and locally produced food (Vignola & Oosterveer, 2025).

The literature also shows that local governments enhance food system participation and equity by establishing multi-stakeholder platforms protecting informal food economies, and investing in localised infrastructure like mobile markets (Affre et al., 2024; Slater et al., 2025). They increase equity by providing land for community gardens, implementing school food programs, and using participatory research to include diverse voices in governance (Trevenen-Jones et al., 2025). Key strategies for enhancing participation and equity identified in the literature include inclusive governance mechanisms, such as Food Policy Councils (Affre et al., 2024). These platforms bring together diverse stakeholders, such as civil society, the private sector, and academia, to co-create food policies, ensuring a 'food democracy approach' (Rocha & Pires, 2025). Another strategy is participatory action research. By this, local governments engage residents directly in research, from project design to data analysis, ensuring policies reflect community needs and perspectives (Carloni et al., 2025). Multi-Stakeholder Platforms (MSPs) are another strategy focusing on facilitating dialogue and transparent decision-making, allowing marginalised voices to be heard (Vall et al., 2025). By this, local governance allows for more inclusive decision-making, giving voice to traditionally excluded groups like women, smallholder farmers, and Indigenous communities (Trevenen-Jones et al., 2025).

Local governance also helps strengthen local economies through its support of food systems. This is achieved by creating supportive environments for regional food producers, enhancing market access, and fostering inclusive, multi-stakeholder collaboration (Donner et al., 2024; Galanakis et al., 2025). By implementing tailored zoning, public procurement, and infrastructure improvements, local authorities boost job creation, increase income, and ensure a more resilient food supply (Slater et al., 2025). Key mechanisms through which local governance strengthens local economies include establishing food hubs. Local governments support organisations that manage the aggregation, distribution, and marketing of local products to satisfy institutional and retail demand (Modirapula et al., 2026). They also strengthen local value chains through investing in infrastructure, such as roads and storage. This reduces transportation costs and post-harvest losses, improving the economic viability of rural enterprises (Krautscheid et al., 2025).

Local governance also leverages public procurement through implementing policies that prioritise local food for schools, hospitals, and public institutions provides stable markets for local farmers (Rocha & Pires, 2025). Dzudzor et al. (2025) reveal that local governance supports diverse food system initiatives by providing seed capital and supporting agroecological transitions, helping smallholders, women, and youth to engage in the local economy. Ndhlovu and Dube (2024) argue that integrating agricultural production with tourism can stimulate rural economies and create demand for local products. In addition, Schneider et al. (2025) posit that through food hubs and farmers' markets, local governance supports shorter, more sustainable supply chains, which increase resilience against global shocks. In essence, localised governance acts as the bridge between international, national, and community needs, ensuring that food systems are not only efficient but also equitable, secure, and environmentally sustainable.

However, while powerful, the literature shows local governance of food systems faces significant challenges, including fragmented policies, weak coordination across departments, and top-down approaches that limit stakeholder engagement (Galanakis et al., 2025; Modirapula et al., 2026).

Key obstacles involve managing the nexus of climate change, urbanisation, and socio-economic inequities while struggling to support small-scale actors and the informal sector. AI-driven solutions show much potential to address some of the identified challenges.

2.2. Artificial Intelligence and Development

AI is widely regarded as a transformative tool for global development, driving progress in health, education, agriculture, and economic productivity (Dignum, 2019). It helps bridge development gaps through AI-assisted diagnostics, smart agriculture, and improved public services (Dekeyser & Whitehead, 2025). AI is being used to achieve the United Nations Sustainable Development Goals (SDGs), including optimising energy grids, enhancing climate resilience, and advancing education (Zindi & Ndhlovu, 2024a). In the workplace, generative AI is used to improve productivity by 20% to 40% in specific tasks (United Nations Trade and Development (UNCTAD), 2025). It assists in automating tasks, managing supply chains, and providing financial services, such as credit assessments, to underserved populations (Dekeyser & Whitehead, 2025; Ndhlovu, 2025). In healthcare and agriculture, AI supports disease detection, telemedicine in remote areas, and precision agriculture to improve food security. The AI market is projected to grow from $390.11 billion in 2025 to over $ 3.497 billion by 2033 (UNCTAD), 2025). Future success depends on building local capacity, fostering open-source AI as a public good, and ensuring technology is adapted to specific local contexts.

AI is a computer science subdivision focused on building systems that can perform tasks conventional performed by humans (Dekeyser & Whitehead, 2025). AI does not rely on programming like traditional software. AI systems can learn from data to improve their performance over time. They can deploy logic, probabilistic models, and algorithms to reach conclusions and make informed choices (Rosken, 2025). AI systems use algorithms to manipulate data and develop solutions for specific, often complex challenges. The core components of AI include Machine Learning (ML), Deep Learning (DL), Natural Language Processing (NLP), Computer Vision (CV), robotics, and data and computing power.

ML trains algorithms to find patterns in data. This makes them capable of making learning and making decisions or predictions without being overtly programmed for every task (Dignum, 2019). Essentially, ML enables computers to learn, identify patterns, and apply that knowledge to new situations, as humans do. DL is a subset of ML that uses multidimensional artificial neural networks to mechanically learn complex patterns from data, enabling tasks such as image recognition and natural language processing (Dekeyser & Whitehead, 2025). NLP is an AI field that teaches computers to understand, interpret, generate, and manipulate human language (text and speech) to bridge the communication gap between humans and machines (Köckritz et al., 2025). This powers applications such as virtual assistants, translation services, and sentiment analysis (Ndhlovu, 2025). NLP combines computer science, AI, and linguistics to process language data for practical tasks. It uses ML to establish sense and enable actions. CV is another subfield of AI that trains computers to interpret and understand the visual world (images and videos) like humans do (Kalluri et al., 2025). It uses DL and algorithms to identify objects, classify data, and make decisions. This technology powers applications such as self-driving cars, facial recognition systems, medical diagnosis, and robotics. It is about enabling machines to 'see', process, and establish meaning from visual inputs to perform complex tasks and solve problems (Gao & Agarwal, 2025).

Robotics involves integrating intelligent algorithms, ML, and CV into physical machines to enable them to identify, learn, and operate autonomously or semi-autonomously in real-world environments (Ryalat et al., 2025). While traditional robotics handles repetitive tasks, AI-powered robotics enables robots to adapt to new situations, make decisions, and interact with the world with human-like accuracy (Krejcí et al., 2025). The pillars of AI are data and computing power. These pillars drive ML and algorithmic performance (Furht & Khoshgoftaar, 2026). Data provides the information needed for AI to learn, while computing power provides the hardware to process it rapidly (Almeida & Okon, 2025). Data represents the vast quantities of information (text, images, video, and numbers) that AI systems use to identify patterns, learn, and make decisions.

3. Methods and Materials

This study adopted a combination of systematic literature and narrative review approaches, with the former as the main approach. A systematic review methodology is reputable for providing a transparent and structured approach to reviewing published evidence. It uses defined rules to identify evidence, an a priori protocol for eligibility criteria, and comprehensive search procedures for literature collection. Systematic reviews first emerged in the field of health sciences but are now also used in fields such as economics, agriculture, and education, among others.

2.1. Literature Search and Coding

The PRISMA 2020 criteria were followed when conducting this review. Articles for review were obtained from the Scopus databases. It is one of the leading and most comprehensive databases containing peer-reviewed texts. Scopus is particularly valued for its comprehensive coverage of the social sciences and humanities, as well as STEM fields. The initial search used the words 'local governance' AND 'food system' OR 'agriculture' OR 'agribusiness' OR 'agri-business' OR 'farming' AND 'South Africa' as keywords. The search for articles was conducted on March 11, 2026, and was limited to the title, abstract, and keywords only to exclude specific irrelevant articles. The initial search yielded 1551 documents. A refined search was then conducted using the retrieval limits in Table 1. This resulted in the identification of 148 documents

Table 1: Article Retrieval Limits from Selected Databases

Item	Description
Database	Scopus
Search field	Title, Abstract, Keywords
Keywords	'local governance' AND 'food system' OR 'agriculture' OR 'agribusiness' OR 'agri-business' OR 'farming' AND 'South Africa'
Accessibility	All
Years	01/01/2015 - 28/02/2026
Author name	Exclude undefined names
Subject area	All
Publication stage	Final
Country	South Africa
Source type	All
Document Type	All
Language	English

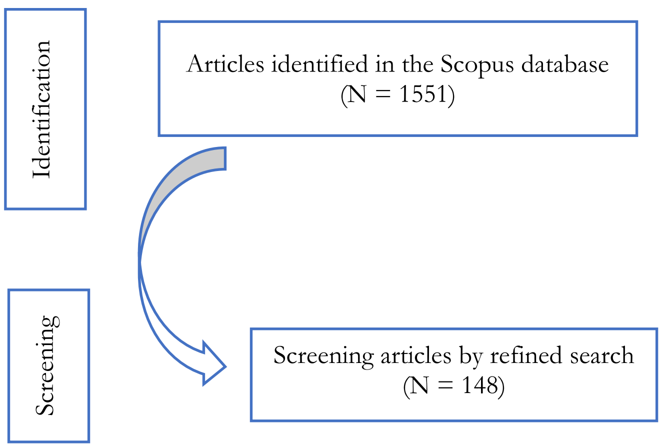
2.2. Inclusion and Exclusion Criteria

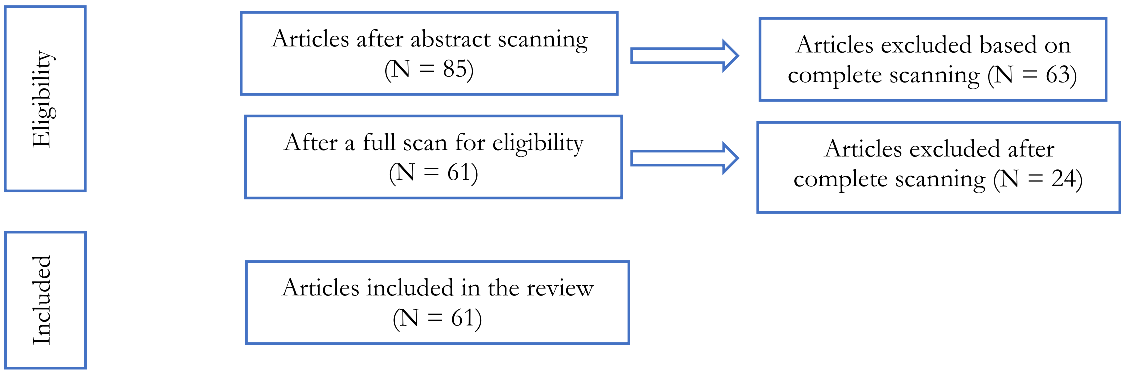
The identified 148 texts were exported to CSV for manual screening and duplicate removal. 63 articles were eliminated through abstract screening. After full-text screening, 24 articles were eliminated. Only 61 articles were deemed relevant and, therefore, were considered for analysis. Table 2 shows more details on the exclusion and inclusion criteria adopted in the study. The ensuing flowchart summarises how the texts were identified for analysis.

Table 2. Article Identification Criteria

Inclusion criterion	Exclusion criterion
Peer-reviewed articles from Scopus	Grey reviewed literature and articles found outside the database.
Articles published between 2010 and 2026	Articles published before 2010 and after February 2026
Articles from both open-access and subscription-based publishers.	Articles from outside these open-access and subscription-based publishers.
Final papers	Articles in press
English journal articles.	Articles written in other languages
Articles with the selected search terms only.	Journal articles discussing other issues outside the 'beyond GDP' concept

Flowchart Summarising the Identification of Texts





2.3. Data Analysis

Content analysis - the study of the contents of a text- was used in this article. The analysis was done manually. During analysis, texts were first coded into classes. Segments of interest (quotations) were extracted from the relevant texts, focusing on local governance, food systems, farming, or agriculture, and each segment was coded. Coding of the segments of interest was done manually. The quotations and codes were generated concurrently. The article employed both deductive and inductive coding for all identified segments of interest in the articles. Deductive coding was based on frameworks on the role of local governance in food systems. The frameworks included the Urban Political Ecology (UPE) framework that analyses the power dynamics, winners, and losers in local food policies, focusing on how local authorities use resources to shape food system 'metabolism' and 'circulation.' Deductive coding also drew from the Adaptive Governance framework. This is a flexible, multi-scalar approach that balances centralised and decentralised decision-making to promote resilience, learning, and local empowerment.

The Alternative Food Networks (AFNs) and Short Food Supply Chains (SFSCs) frameworks were also used due to their emphasis on the importance of shortening the distance between producers and consumers, often supported by local government to increase food security and sustainability. Deductive coding also utilised the City-Region Food Systems (CRFS) approach. This approach treats the city and its surrounding rural hinterland as a single unit, helping to reduce fragmentation, strengthen local economies, and manage food waste. In addition, deductive coding benefited from the Collaborative Governance Theory, which examines how multiple actors (governments, NGOs, and the private sector) interact to manage complex food systems, highlighting the need for trust, leadership, and shared goals.

In using inductive coding, themes were allowed to emerge from the reviewed texts rather than pre-existing theories. The author read the articles identified for analysis, identified patterns, and generated codes. This was ideal for this study, as the aim was to explore how AI can be used to support the transformation of the South African food system landscape. In using content analysis, latent coding was adopted to generate an in-depth understanding of the issues under investigation. The author read the entire text to gain an overall understanding of the argument and the text's position. Thematic analysis, a method in which themes are developed from available data, was then employed. Six key themes focusing on the role of local governance in supporting food systems were identified.

2.4. Narrative Review

A narrative review was also conducted to complement the systematic literature review. This was to avoid methodological monotheism (hegemonic reliance on a single method). A narrative review is an all-inclusive, critical, and subjective analysis of existing literature on a specific topic, designed to provide a broad overview, summarise current knowledge, and identify research gaps. Unlike the systematic review, it uses flexible methodologies and is often story-driven, qualitative, or theoretical narrative, rather than a strict, quantitative data-driven one. For this approach, the population for this study was defined as all literature on local governance and food systems in South Africa. The author used a non-comprehensive, flexible sampling method to synthesise literature on the role of local governance in food systems. The author used purposive sampling based on expert judgment, focused on specific themes on the role of local governments, and employed snowball sampling to identify additional relevant literature, thereby ensuring that the studies directly addressed the research objectives.

Pre-defined inclusion and exclusion criteria were used to select texts. For instance, the terms 'local governance', 'local government', 'farming', 'local food systems', 'agriculture', and 'agribusiness' were used as search terms. These search terms had to be in the title, abstract, or keywords. To be selected, an article had to be published between January 2015 and January 2026, written in English, and focus on South Africa. Texts that did not meet this inclusion criterion were not selected for review. Both academic and gray literature were considered for analysis. This was crucial for conducting comprehensive, unbiased, and current research. While academic literature provided validated, in-depth theoretical analysis of the role of local governance in South Africa's food systems, grey literature filled gaps with practical, real-world, and up-to-date data that were often overlooked by traditional publishing, especially in emerging areas such as AI. The identified studies were then reviewed to determine whether they represented specific details on the role of local governance in South Africa's food systems. The Google Scholar database was used because it is a free, user-friendly, and comprehensive search engine for academic literature across all disciplines. It provided links to institutional library subscriptions for full-text access and enabled the author to find grey literature like government reports, research reports by research institutions, and conference proceedings. A total of 16 articles were eventually selected for analysis.

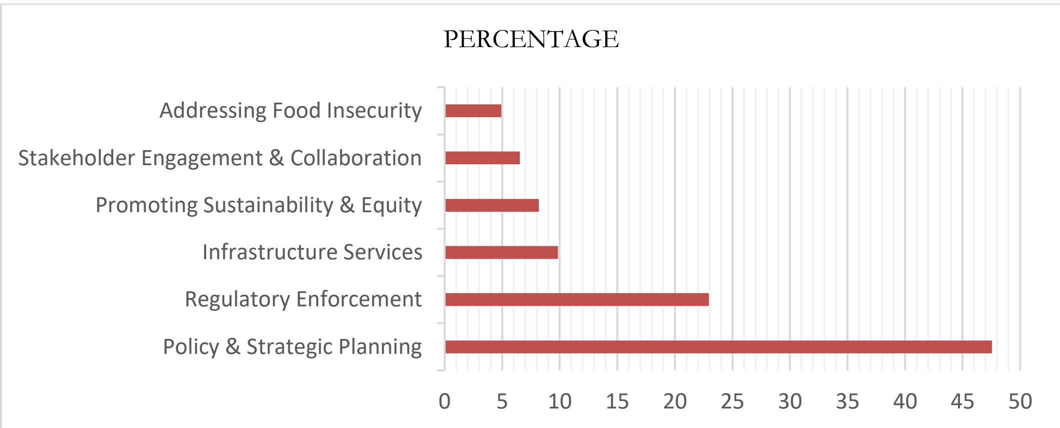
2.5. Limitations

Although the systematic review approach is designed to minimise bias in the review process, the effectiveness of systematic reviews depends on the availability of high-quality research. The sample used in this article may be subject to 'publication bias', particularly since studies reporting positive results are more likely to be published than studies reporting negative results. Only explicitly on food systems were accepted for analysis. As a result, some contributions, such as those not using any of the selected search words, were excluded. The author also acknowledges that reliance on manual processes in content analysis can lead to inconsistencies in data interpretation. The author, therefore, believes that the peer review by colleagues helped minimise such inconsistencies. Reliance on a single database also presents a particular limitation affecting the prospects of generalisability.

The narrative review also presented specific limitations. For instance, it has low reproducibility and a lack of rigorous, systematic methodologies, often leading to subjective, non-exhaustive, and potentially skewed summaries of the role of local governance in South Africa's food systems. The reviews were more descriptive than quantitative, making them less suitable for drawing definitive, evidence-based conclusions or for informing food system policy. These limitations make narrative reviews less suitable for evidence-based decision-making but helpful in providing a broad overview or background information. However, the author believes a combination of the systematic literature review and the narrative review helped in reducing the limitations inherent in both approaches.

4. Findings and Discussion

Six key themes emerged from the analysis. These are the roles that local governance plays in South African food systems. The reviewed articles placed diverse emphasis on particular roles played by local governance in food systems. The following figure shows that 47.54% of the articles emphasised the role of local governance in food system policy formulation and strategic planning, 22.95% emphasised regulatory enforcement, and 9.85% highlighted the role of local governance in providing infrastructural services. Another 8.19% emphasised the role of local governance in promoting sustainability and equity, and 6.55% emphasised its central role in stakeholder engagement, while 4.95% mentioned its role in addressing food insecurity in the country.



4.1. Policy and Strategic Planning

The analysis shows that South African local authorities are responsible for initiating urban food governance processes, setting priorities, and allocating resources to influence the direction of local food systems. They can also play a key role in developing, for instance, sustainable food strategies. However, local governance in the country's food systems is characterised by fragmented, top-down policies that often fail to address the root causes of food insecurity, which affects over 13 million people (Adeniyi et al., 2021; Barnes et al., 2026; Phali et al., 2022). While national policies, such as the National Development Plan, exist, local implementation is viewed as weak due to limited coordination, focusing heavily on production rather than, for instance, urban, equitable access (Hara, 2014). The review shows that South African policies are often siloed within departments (agriculture, social development, and health), with little, if any, coordination.

This results in conflicting strategies where, for instance, agricultural policy fails to align with nutritional or health needs (Dama et al., 2024; Sinthumule, 2022). While South Africa has progressive policies, they often fail to translate into action due to a lack of strategic, actionable roadmaps and poor monitoring and evaluation (Bisaga et al., 2019). There are also limited, inconsistent, and under-resourced strategies for climate change adaptation, which threaten the stability of the entire food chain through droughts, floods, and water scarcity (City of Johannesburg, 2023; Mashamaite et al., 2022; Nel & Lewis, 2022; Orimoloye et al., 2021).

Policy often fails to account for the entire food value chain, from production to consumption, neglecting the role of informal food markets, such as street vendors and local shops, which are critical for low-income households (CSIR, 2024; eThekwini Municipality, 2022; Ncube, 2020). In addition, there is a lack of localised data to inform evidence-based policy, particularly concerning smallholder farmers and informal food environments (Hlahla et al., 2023; Mbhenyane & Tambe, 2024). The strategic policy areas needing improvement include creating formal, enforced structures for collaboration between departments; shifting policy to reduce the cost of nutrient-dense food and address the malnutrition burden; and bridging the divide between commercial and smallholder agriculture through better land reform and support services.

4.2. Regulatory Enforcement

Local governments are also responsible for ensuring food safety compliance by monitoring businesses, specifically checking, for instance, food handling, storage, and preparation practices (Mphaga et al., 2023; Mpofu et al., 2023). The review shows that South African local governments (municipalities) face substantial challenges in enforcing, for instance, food safety regulations, primarily driven by resource constraints, fragmented governance, and the rapid growth of the informal food sector (Menon et al., 2023). These challenges have been highlighted by recent foodborne illness outbreaks and the explosion of 'fake food' (fraudulent or adulterated food products).

The key challenges for South African local governments in food system regulatory enforcement include a severe shortage of environmental health practitioners. Municipalities across the country face a critical shortage of practitioners, with an estimated shortfall of over 4,000 practitioners. In many areas, one practitioner serves over 30,000 inhabitants, far exceeding the UN-recommended ratio of 1 to 10,000. A major gap also exists in monitoring food safety within the informal sector, particularly in townships and rural areas where many residents rely on spaza shops (Brandl et al., 2023; Paganini et al., 2025; Phali et al., 2022). These businesses often operate without proper oversight, certificates of acceptability, or compliance with hygiene standards (Battersby et al., 2016; Republic of South Africa (RSA), 2020). There is an insufficient number of government laboratories for testing food samples (Mabhaudhi et al., 2026; Mashamaite et al., 2022; Mashamaite et al., 2024; Zindi & Ndhlovu, 2024b). In addition, laboratories are unevenly distributed, with only two provinces (Gauteng and Western Cape) equipped to conduct a range of food safety tests, complicating the prosecution of food fraud. There is also a lack of proper training and information systems in South African municipalities. Some Environmental Health Practitioner departments lack efficient, modern record-keeping and data management systems, making tracking, auditing, and following up on compliance difficult. The key recommendations include strengthening laboratory capacity, increasing the number of Environmental Health Practitioners, modernising legislation to include stricter penalties, and addressing e-commerce and informal sectors.

4.3. Infrastructure and Services

Local governments provide essential infrastructure and services that support local food systems. This includes, for example, managing public markets and facilitating urban agriculture. However, this review shows that South African local governments struggle to provide food system infrastructure due to poor maintenance, financial constraints, and siloed, top-down planning that fails to integrate food security (Nontu et al., 2025; RSA, 2024). Key challenges include crumbling market facilities, poor transport links, water scarcity, energy crises, and limited capacity to manage infrastructure, which disproportionately affect vulnerable, low-income communities. The review shows that most South African municipalities suffer from a lack of machinery, aging infrastructure, and poor maintenance of critical facilities like fresh produce markets (Mashamaite et al., 2024). Poor road conditions in rural areas also limit access to markets, while water scarcity and unreliable electricity hinder agricultural production and food storage (Ramarumo & Maroyi, 2020). A lack of technical skills and staff, and poor accountability within municipalities, reduces service efficiency. There is also a limited ability to raise revenue, especially in rural areas, leading to high reliance on grants and poor service delivery.

4.4. Promoting Sustainability and Equity

The review also shows that local governments help in fostering food security by, for example, providing vouchers for low-income residents to access fresh produce. They also support, for instance, local, sustainable food production. However, it is revealed that South African local governments face significant, interconnected challenges in promoting sustainable and equitable food systems, driven by high urban poverty, legacy spatial inequalities, and a reliance on a concentrated, corporate-dominated food retail system (Dlangalala & Mudhara, 2020; Hitayezu et al., 2016). The key challenges for local municipalities include policy fragmentation, mismanagement, and corruption (Nzabamwita & Ndhlovu, 2024). It is reported that food security initiatives, including the distribution of food parcels, have been compromised by corruption and mismanagement, with funds often diverted from intended beneficiaries (Malan, 2021; Mashamaite et al., 2024). There is also a lack of capacity, with municipal officials often lacking the training and scientific data required to implement effective food safety measures and monitor the food system.

The review also highlighted sustainability challenges, particularly water and energy scarcity. South Africa is water-scarce, and a crisis in the coal-fired energy sector is hindering the processing and storage of food. In addition, the country is also recording high food waste. A staggering 10 million tonnes are wasted annually, with significant losses occurring during the processing and packaging stages, partly due to inadequate storage infrastructure in lower-income areas. Erratic rainfall, droughts, and floods, accelerated by climate change, also significantly disrupt food production and supply chains, particularly impacting small-scale farmers and poor communities. These challenges mean that food insecurity remains endemic, particularly in township areas, and requires a shift from viewing food as solely an agricultural issue to one involving urban planning, economic development, and social welfare.

4.5. Stakeholder Engagement and Collaboration

The review showed that South African local governments also act as platforms for, for example, collaboration between various actors in the food system. This involves, for instance, connecting with other local authorities and engaging with, for instance, community members. However, the review also revealed that South African local governments face significant, multi-layered challenges in fostering stakeholder engagement and collaboration in food systems. These challenges stem from historical legacies, institutional capacity constraints, and a complex, often top-down, governance approach that struggles to address the systemic nature of urban and rural hunger. Key challenges include weak institutional capacity and resources (Dlangalala & Mudhara, 2020). Municipalities often lack the technical, financial, and legal capacity to facilitate complex, multi-stakeholder partnerships (Ramarumo & Maroyi, 2020). They frequently struggle with staff skills gaps, outdated processes, and a lack of data to accurately map and address local food insecurity (Nontu et al., 2025). There is a lack of alignment between different government departments and levels of government, resulting in fragmented policies, poor communication, and duplication of efforts (Phali et al., 2022). The informal food sector, which is critical for food access among the urban poor, is frequently ignored or negatively impacted by restrictive bylaws, hindering collaboration with crucial local food providers (Mashamaite et al., 2024). These challenges are worsened by high levels of poverty, inequality, and unemployment, which put immense pressure on local government to deliver immediate, often ad hoc, interventions rather than long-term, sustainable food systems.

4.6. Addressing Food Insecurity

Local governments play a role in addressing food deserts by, for example, improving access to fresh food in underserved neighbourhoods. However, the review shows that South African local governments are struggling to address food insecurity due to several reasons, including policy and governance fragmentation (Battersby et al., 2016). There is weak coordination between different government departments, leading to incoherent policies and a lack of a clear, unified strategy for food security at the local level. Small-scale farmers often lack access to necessary resources, training, and markets, reducing the effectiveness of municipal urban farming initiatives. Although South Africa has one of the best social protection systems, food security interventions are often marred by maladministration and corruption, undermining their essence. Climate change significantly affects food production, with droughts directly impacting local food supplies and increasing food prices (Mabhaudhi et al., 2026). The 'triple burden of malnutrition' (undernutrition, micronutrient deficiencies, and obesity) is worsened by economic disparities, meaning that even when food is available, it is not always accessible or nutritious. These challenges are intensified by a 'tick-the-box' approach to participation, where community engagement is not always effectively utilised to create sustainable, long-term solutions. This study argues that AI has the potential to enhance the capacity of local governments in supporting food systems in South Africa by leveraging predictive data, automating, and optimising, particularly through 'small AI' tools tailored for smallholder farmers and informal traders. In addition, by integrating AI into municipal planning, local governments can reduce food waste, improve food security, and enhance agricultural productivity in the face of climate change

5. Leveraging AI in Local Food Governance

AI can offer specific tools to help municipalities manage these complex systems, potentially improving local food systems. It can significantly improve the capacity of local governments in South Africa to support food systems by boosting agricultural productivity, improving supply chain logistics, and enabling data-driven policy decisions. By leveraging AI-powered tools, municipalities can transition from reactive, traditional methods to proactive management of food security, particularly in resource-constrained rural and urban areas. There are several ways through which AI can be used to improve local governments' support for food systems in South Africa.

5.1. Enhanced Agricultural Extension Services

South African local governments often struggle with capacity in agricultural extension services (Maka, 2025; Ndhlovu & Majova, 2023). AI can augment these services to better support food system stakeholders, such as smallholder farmers and small agribusinesses. AI chatbots and virtual advisors that communicate in local languages, such as Mkulima GPT, used in East African countries like Tanzania, Kenya, and Rwanda, can help South African smallholder farmers diagnose crop and animal diseases, identify pests, and receive advice on planting, fertiliser, and irrigation. In the Limpopo Province, particularly the Vhembe District, digital diagnostic tools and AI systems have been identified to help smallholders diagnose plant diseases, supporting the functionality of traditional extension services. However, implementation remains very slow due to the fragmentation of responsibilities among different authorities. In addition, while 92.1% of households own a mobile phone, significant hurdles remain to adopting advanced digital tools due to infrastructural and literacy challenges (Von Maltitz et al., 2024).

Crop diseases and pests have a profound, multi-faceted impact on South African farming, affecting food security, economic stability, and international trade. In addition to reducing yields by 20–40% on average, they trigger trade restrictions, increase production costs, and cause significant job losses in rural communities. The impact is often worsened by extreme weather conditions such as drought, followed by excessive rain (Tshikhudo et al., 2025). South African farmers, especially in the grain and citrus industries, often rely on a mix of chemical control (fungicides and pesticides) and Integrated Pest Management (IPM) to mitigate these risks. The government and private sector also engage in strict surveillance and phytosanitary measures to manage quarantine pests like *Tuta absoluta* (Tomato Leaf Miner) and Banana Bunchy Top Disease. However, this article argues that municipalities can also use satellite and drone analytics to analyse satellite imagery (for instance, using platforms like Aerobotics) to detect early signs of pest infestations, disease outbreaks, or drought stress across regional farmland using CV. Drones are used for controlling pests in citrus orchards by identifying infected trees, and also for releasing sterilised, parasite-killing insects (e.g., in citrus pest control). AI solutions for crop and disease detection are highly effective, often surpassing human expert accuracy (90–99% range) in controlled and field-based studies (Ibrahim et al., 2025). The effectiveness of AI solutions is highest when combined with high-quality, diverse data and when deployed via edge devices for immediate field action.

5.2. Smart Food Supply Chains and Post-Harvest Loss Reduction

South Africa faces a significant paradox: while it is generally food-secure at a national level, nearly 45% of the available food supply is wasted, with about 10 million tonnes of food going to waste annually (Opara et al., 2026). This crisis is driven by high post-harvest losses in the early stages of the supply chain, particularly for fruits and vegetables, and significant waste at the consumer level. Post-harvest losses for fresh produce (fruits and vegetables) can reach 30%–40% (Belemu, & Oluwatayo, 2025). These losses have profound economic, social, and environmental consequences, particularly in a country with high levels of food insecurity. Despite sufficient overall food production, up to 63% of South African households experience varying levels of food insecurity (Opara et al., 2026). The loss of nutrient-rich produce (fruits and vegetables) contributes to malnutrition, stunting, and diet-related health issues. Research has emphasised improving cold chain infrastructure and using technology (like machine learning) to predict and reduce waste (Ndhlovu, 2025). AI solutions wield potential to deal with post-harvest losses in South African food systems.

South African local governments can use AI to optimise the distribution and marketing of food, reducing the high levels of post-harvest losses. AI can optimise transportation routes for distributing produce from rural farms to municipal markets, reducing fuel consumption and preventing spoilage of perishable goods. AI tools can also predict market demand based on historical data and real-time trends, assisting local governments in optimising inventory levels in school feeding programmes or municipality-supported food banks, reducing waste substantially. In addition, AI can help map and better connect informal food vendors (spaza shops) to local producers, increasing market access for small farmers (Ndhlovu & Majova, 2023).

5.3. Data-Driven Urban Agriculture and Planning

Agricultural planning in South Africa faces significant challenges, primarily rooted in the need to bridge the gap between commercial and emerging farmers, crumbling infrastructure, and severe environmental constraints. Key issues include land reform, energy shortages, poor municipal services, and the need for improved biosecurity to secure the export market. To address these, agricultural planners are focusing on accelerating land reform *via* the new Agricultural Development and Land Reform Agency, strengthening public-private partnerships, and focusing on climate-smart agriculture to ensure long-term food security (Nxumalo & Chauke, 2025). AI can assist in planning and supporting several agricultural initiatives to boost food systems.

AI can optimise environmental factors (temperature, humidity, and light) for urban hydroponic projects, such as those in Johannesburg, significantly increasing output in small spaces (Ndhlovu, 2025). Using AI-powered Geographic Information Systems (GIS), municipal planners can also map agricultural potential, track urban agricultural expansion, and protect valuable agricultural land from inappropriate development. Municipalities can use AI-powered GIS to analyse high-resolution satellite imagery. This enables tracking land-use changes, identifying optimal areas for specific crops, and managing the expansion of high-value crops like avocados and citrus, ensuring this does not negatively affect water resources or soil health. With agriculture consuming over 60% of South Africa's water, AI-driven irrigation systems can analyse soil moisture, weather data, and crop requirements to optimise water usage. Local governments can use this to promote efficient irrigation in their districts. In addition, AI tools can be deployed to monitor water infrastructure, identify pressure drops or hidden leaks in agricultural water supplies, and reduce the high percentage of treated water lost to inefficiencies. Initiatives such as the South African Systems of Systems for Agricultural Modernisation in the Eastern Cape, which utilises AI for soil and suitability analysis, represent a practical step toward integrating these technologies.

AI can also significantly reduce maladministration and corruption in South African agricultural planning by increasing transparency, automating procurement, and enabling data-driven oversight. By leveraging AI for monitoring, analysing large datasets, and automating administrative tasks, local governments can curb fraudulent activities and improve resource allocation to farmers. AI algorithms can analyse millions of transactions, payment records, and procurement data to detect anomalies, bribery, or conflicts of interest that human auditors might miss. AI can assist in verifying beneficiaries of land reform by cross-referencing agricultural activity data (derived from satellite imagery) with official records, helping to curb 'ghost farmers' or fraudulent land claims. AI can manage and monitor water usage and agricultural infrastructure, reducing maladministration in water allocation and identifying inefficiency in infrastructure projects. AI tools can also analyse crop yields and soil quality, providing objective data to guide agricultural policies and investments, preventing decisions based on political convenience rather than economic viability.

5.4. Improving Food Safety and Regulation

Food safety and regulation in South Africa face significant hurdles, characterised by a fragmented governance structure, weak enforcement in the informal sector, and increasing incidents of food fraud (Mkhwanazi et al., 2024). Recent high-profile foodborne illness outbreaks, such as the 2017-2018 listeriosis crisis and the 2024 fatalities linked to spaza shops, have highlighted critical gaps in the country's ‘farm-to-fork’ safety systems. Food safety in the country is governed by a fragmented, multi-agency system involving the Departments of Health, Agriculture, Land Reform and Rural Development, and Trade, Industry and Competition. This causes overlapping responsibilities, miscommunication, and inefficient use of resources. The country currently lacks a comprehensive national food safety policy. There is also rising food fraud and contamination, and infrastructure and technical gaps. Experts and researchers suggest establishing a single, independent National Food Control Authority to streamline oversight, boosting the number of inspectors (Environmental Health Practitioners), and implementing tougher penalties for violations (Mkhwanazi et al., 2024; Nxumalo & Chauke, 2025).

In response to recent food safety crises in South Africa, AI can enhance compliance and monitoring through several ways, including traceability systems. AI paired with blockchain can trace food from farm to fork in seconds rather than days, allowing municipalities to precisely identify and recall contaminated produce from specific sources. This ensures the authenticity of products and allows for incredibly fast recalls if a contaminant is found, protecting consumers and minimizing economic loss for businesses. AI systems can scan and update food businesses on new health regulations. They can also automate documentation, audit preparation, and record-keeping, reducing human error and improving compliance with local standards. AI systems can also detect inconsistencies in supply chain data, such as anomalies in ingredients or labelling, to prevent fraud and adulteration in products like spices, olive oil, and honey.

Through CV, AI-powered cameras can inspect food products on production lines, identifying foreign objects, defects, and packaging failures (such as in meat or processed food industries) faster and more accurately than manual inspectors. Internet of Things (IoT) sensors, when integrated with AI, can also monitor the temperature and humidity of perishable goods throughout the supply chain in real-time. This is critical for preventing foodborne pathogens and reducing spoilage, particularly during transportation and storage in hot climates. AI cameras can monitor kitchen environments and food processing facilities to ensure workers follow hygiene protocols, such as hand washing, proper use of gloves, and wearing personal protective equipment (PPE). The development of locally tailored AI solutions, combined with public-private partnerships, is crucial to building a more resilient, transparent, and safe food system in South Africa. However, as detailed above, the adoption and strategic implementation of AI to support food systems by South African local governments are hindered by a combination of foundational infrastructure deficits, severe skill shortages, and budgetary constraints. While viewed as a potential tool to improve service delivery, combat corruption, and increase efficiency, AI adoption faces significant barriers, particularly in rural municipalities.

6. Challenges of AI Integration

The integration of AI into South Africa’s local governance and food systems is often framed as a leap forward for state efficiency and food security. However, deploying these technologies within a society shaped by deep historical inequalities, fractured digital infrastructure, and a fragile institutional landscape introduces profound socio-economic risks.

6.1. Algorithmic Bias and Data Inequity

A foundational risk in deploying AI within South African public systems is the ‘myth of technological neutrality,’ the false assumption that automated systems are inherently objective. AI models are heavily dependent on the data used to train them. In the South African context, algorithms are frequently trained on datasets imported from the Global North or disproportionately harvested from wealthy, highly digitized urban hubs like parts of Gauteng or Cape Town. Additionally, predictive algorithms used to optimise supply chains or evaluate creditworthiness for agricultural inputs often rely on metrics from large-scale, industrialised commercial farms. When applied to smallholder or subsistence farmers in rural areas, such as Limpopo or the Eastern Cape, these models systematically misclassify risks, fail to understand localized crop cycles, and inadvertently restrict access to essential resources. Furthermore, algorithmic bias can manifest in automated service delivery systems. For instance, predictive profiling models used by municipalities to allocate maintenance budgets or identify areas prone to utility theft can replicate historical apartheid spatial planning data. If an algorithm associates historical non-payment or infrastructure decay solely with specific low-income townships, it creates a feedback loop that continues to starve those communities of development resources (Pasipamire & Muroyiwa, 2024).

6.2. Privacy, Surveillance and Citizen Trust

The deployment of automated systems in local municipalities raises serious concerns under the Protection of Personal Information Act (POPIA). As South African municipalities move toward ‘smart city’ frameworks, the collection of data expands exponentially. This includes biometric data for municipal access, localised geographic data, and financial records for automated billing. The ethical risk lies in the lack of robust data governance protocols within local authorities. Many municipalities function as a regulatory ‘black box’ where citizens have little to no visibility into how their data is stored, processed, or shared with third-party tech vendors. In food systems, the consolidation of supply chain data by massive agricultural corporations gives them asymmetric market power over smallholder farmers, raising critical ethical questions regarding data sovereignty and corporate surveillance.

6.3. Digital Divide and Structural Exclusion

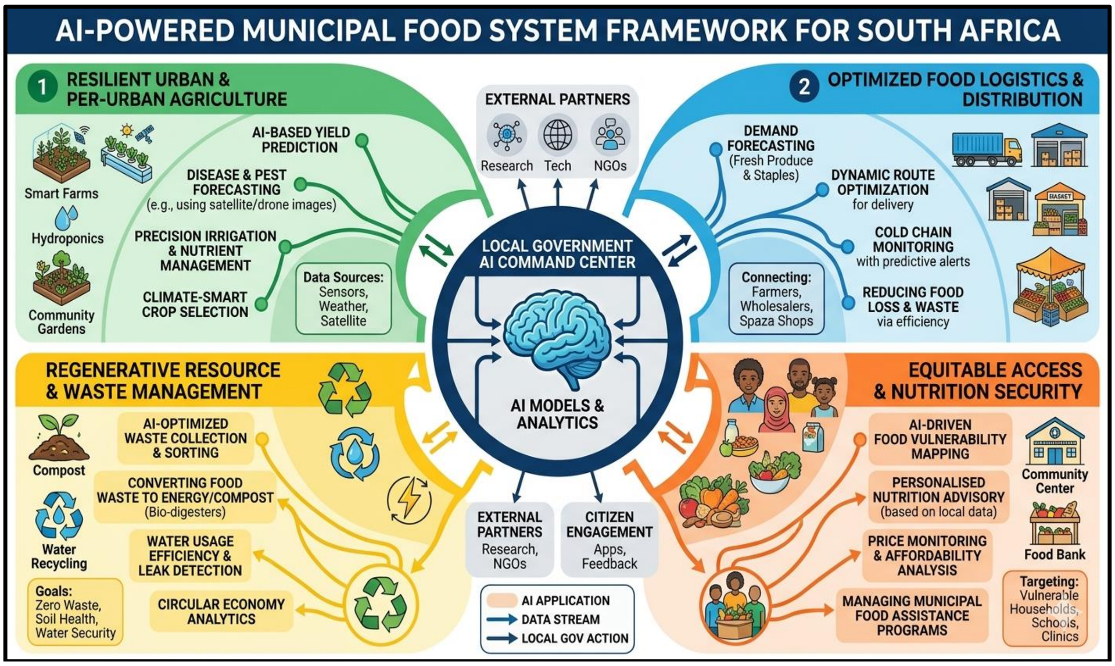
Technology does not deploy into a vacuum; it mirrors the ecosystem it enters. In South Africa, the digital divide acts as an accelerator of exclusion. When a local government digitizes its interface without keeping traditional channels fully functional, it effectively disenfranchises its most vulnerable citizens. Informal food vendors, who form the backbone of urban food security for the poor, are routinely excluded from digital municipal planning tools because they operate outside formal, trackable data loops.

6.4. Governance Challenges and Implementation Failures

The primary challenge for responsible AI in South Africa is not a lack of technological interest, but a severe deficit in institutional capacity and oversight frameworks. For instance, when an AI tool fails, whether it is a corrupted automated municipal billing system that overcharges thousands of residents or a faulty automated crop-yield model, the chain of responsibility is modified. Local authorities often lack the technical literacy to audit these 'black box' systems, leading to a reliance on private contractors who operate without public accountability. Additionally, many local municipalities are already facing fiscal constraints and skills shortages. Introducing complex machine-learning tools into an environment that struggles with basic database management leads to systemic implementation failures. Rather than solving service backlogs, poorly integrated software layers obscure decision-making, leaving citizens with no clear path for redress when an algorithm makes an error.

7. A Proposed Framework

In view of the findings and discussion made in this study, the following figure presents a conceptual framework for how South African local governments (municipalities) can integrate AI solutions to create a more resilient, efficient, and equitable food system. The system is centred on a Local Government AI Command Centre and organised around four main pillars.



AI-Powered Municipal Food System Framework

Source: Generated using AI-based Tool (Google Gemini)

Four Pillars of AI in a Municipal Food System

Resilient Urban and Peri-Urban Agriculture (Top Left - Green)

This pillar focuses on boosting local food production within and around cities. It shows that AI-based tools, using historical data, weather patterns, and satellite imagery, can be used to forecast harvests, helping local farmers plan. AI applications can also be used to analyse images from drones or satellites to identify early signs of outbreaks, such as fall armyworm or tomato leaf miner, and issue targeted alerts. For example, the Cape Town-based Aerobotics company uses high-resolution drone imagery combined with machine learning (Aeroview platform) to detect pest and disease hotspots, nutrient deficiencies, and water stress in fruit orchards. The PlantVillage Nuru app also uses machine learning to identify Fall Armyworm damage on maize, as well as diseases in cassava and banana, simply by scanning with a smartphone. It works offline and provides immediate diagnostics and recommendations to farmers in countries like Kenya and Mozambique (Nasaka & Ndhlovu, 2026). In Zambia, Agripredict uses AI and machine learning to analyse weather data and historical crop performance to provide early warnings of pests and diseases to farmers.

In addition, local governments can also help farmers to use AI and IoT sensors to optimise water and fertiliser use, crucial in water-scarce regions. AI-based tools can also empower smallholder and community farmers, reduce reliance on long-distance supply chains, and increase urban climate resilience. This can be achieved by using predictive analytics, drones, and digital platforms to directly connect with buyers, optimise logistics, and reduce post-harvest waste. These tools enable direct-to-market sales, reducing reliance on intermediaries and lowering transportation costs in a complex, infrastructure-challenged environment. For example, Twiga Foods in Kenya uses AI-powered algorithms to connect smallholder farmers directly with informal retail vendors in urban areas. By bypassing traditional, inefficient wholesale markets, the platform reduces food waste and ensures faster, fresher delivery. In Ghana, the AgroCenta platform provides rural farmers access to a wider market for their produce, removing intermediaries and ensuring fair pricing. These technologies are estimated to have increased farm incomes by 30-45% for those using them and lowered supply chain expenses by 20%. They are especially effective when combined with mobile money to create a complete, digital supply chain (Abate et al., 2023).

Optimised Food Logistics and Distribution (Top Right - Blue)

This pillar aims to connect producers to consumers efficiently, reducing loss and cost, and AI applications are used for demand forecasting. Predicting fresh produce and staple food needs to prevent shortages or gluts, especially for municipal-run fresh produce markets. Algorithms can also be used to plan the best delivery routes, considering traffic, road conditions, and vehicle type, saving fuel and time. In addition, AI tools can be used to analyse sensor data to predict and prevent temperature failures, crucial for meat, dairy, and fruits. This helps to lower transport costs, stabilise food prices, and ensure a more reliable supply for formal and informal retailers, such as spaza shops. In Nigeria, Kobo360, an AI-powered freight platform, optimises truck allocation for agricultural products. It uses predictive algorithms to reduce empty miles (idle time) by up to 25%, significantly cutting logistics costs for transporting food. In South Africa, Nile.ag, a B2B marketplace for fresh produce, uses data analytics and AI to manage the logistics of trading food from farmers to buyers, focusing on transparent pricing and efficient distribution.

Equitable Access and Nutrition Security (Bottom Right - Orange)

This pillar focuses on ensuring all residents, especially vulnerable ones, have access to healthy, affordable food. In this pillar, AI applications are used for AI-driven food vulnerability mapping. This entails identifying households and neighbourhoods at the highest risk of food insecurity using multi-layered data (income, employment, and health). AI tools can also be used for personalised nutrition advice, with mobile applications using local data to provide tailored nutrition advice, promoting healthy eating with affordable local foods. AI solutions can also be used for price monitoring and affordability analysis. AI tools are able to track prices across different markets and retailers, alerting the municipality to sudden spikes. This allows targeted and proactive food assistance (for schools and clinics, for instance), improves public health outcomes, and informs local economic policies.

In Zimbabwe, the government, in partnership with the Food and Agriculture Organisation, has utilised AI-powered satellite technology to monitor rainfall and soil conditions, supporting smallholder maize farmers by enhancing yield forecasting and improving food access. In Nigeria, the government has supported AI-enabled mobile platforms such as AgroCenta, which provide real-time agricultural advice, market prices, and weather alerts to local farmers. AI significantly improves food access by optimising agricultural production, streamlining supply chains to reduce waste, and providing personalised nutrition strategies, directly tackling food insecurity for individuals. By processing massive datasets, AI enables more efficient, sustainable food systems that increase food availability and affordability. However, while promising, the integration of AI in food access faces obstacles, including the need for robust infrastructure, data privacy concerns, the potential for algorithmic bias, and the need to close the digital divide for small-scale farmers.

Regenerative Resource and Waste Management (Bottom Left - Yellow)

This pillar connects food to the circular economy, focusing on sustainability. In this pillar, AI applications are used to optimise waste collection and sorting. AI solutions use CV and robotics to better separate food waste for composting or energy conversion. They can also be used to optimise the conversion of food waste into biogas and fertiliser. In addition, AI analyses network data to detect leaks and optimise municipal water distribution to urban farms. This helps to divert waste from landfills, produces sustainable energy and organic fertilizer, and conserves scarce resources. AI in waste management is highly effective, with AI-powered systems improving sorting accuracy to 72.8%–99.95%, increasing recycling rates by 20%–30%, and reducing operational costs for waste collection by 10%–15%. AI-driven technologies optimize logistics, improve sorting quality, and reduce reliance on landfills (Fang et al., 2023). AI-powered robotic systems can identify, categorise, and sort materials (plastics, paper, and metals) with high speed and precision. These systems can achieve near-100% precision in distinguishing recyclable materials, significantly reducing contamination. AI-enabled sensors and IoT devices can track bin fill levels, allowing for dynamic, on-demand routing.

This reduces transportation distances by up to 36.8% and collection time by up to 28.22%. AI also significantly decreases operational expenses by reducing the number of vehicles required for collection. In recycling facilities, AI can decrease labour costs by as much as 59% while increasing efficiency by 60%. In addition, by enhancing sorting accuracy and efficiency, AI boosts the overall recovery of materials, with potential increases in recycling rates of 20%–30%. AI also improves safety in recycling facilities by automating the sorting of hazardous materials. It supports the circular economy by optimizing waste-to-energy processes. However, despite high performance, challenges include the high cost of implementing new technologies, the need for high-quality data, and the potential for generating e-waste from AI infrastructure.

The Central Role of Local Government

The Local Government AI Command Centre acts as the brain. It is not just about technology; it is a collaborative hub that makes data-driven decisions. It ingests and analyses vast amounts of data from local sensors (farms and waste bins), external sources (weather, national statistics), and citizens (through apps/feedback). It connects the municipality with external partners (universities, tech companies, NGOs) for expertise and solutions. It also ensures the food system remains responsive to the needs of residents, gathering ground-level insights. By implementing this framework, South African municipalities can move from reactive food management to a proactive, integrated, and sustainable system that improves nutrition, creates local jobs, and builds resilience against climate shocks and economic instability.

Local governments in South Africa, however, face significant, interconnected challenges in adopting AI to improve local food systems, with barriers particularly high in rural and under-resourced municipalities. While AI offers potential for enhancing smallholder productivity, supply chain management, and food security, its implementation is hindered by infrastructural, financial, and regulatory obstacles. Key challenges facing local government AI adoption include poor digital and physical infrastructure. Persistent electricity shortages (loadshedding) and unreliable internet connectivity, especially in rural areas, make deploying real-time AI solutions difficult. There is also an absence of foundational IT systems, sensor networks, and data storage required for AI, which limits the scalability of any AI-enabled platforms.

There are also financial and resource constraints that South African local municipalities have to deal with. Municipalities often face severe financial distress, leaving little budget for the high initial investment costs of AI infrastructure, hardware, and software. For instance, in the 2025-2026 financial year, the Emfuleni Local Municipality operated with severely unfunded budgets, posting a R987 million deficit in 2023-24 and owing over R2 billion to Eskom. The Ditsobotla Local Municipality in the North West Province also operated under a recovery plan due to near-total collapse and significant debt. Key indicators of distress include massive, unpayable debt to Eskom, with many entering the Eskom debt-relief programme. Specific examples include the Vhembe District (Limpopo) not billing for water, resulting in a R92 million loss. There is also a significant shortage of internal capacity and skilled personnel within local government to manage, operate, and maintain AI technologies.

South African local governments also face data and technological gaps. AI models often rely on data from high-income regions. There is a shortage of locally relevant data, such as indigenous crops, specific soil types, or local climatic patterns, to train AI models to be effective in the local context. Many AI solutions are not tailored for small-scale farming contexts, making them difficult to integrate into existing agricultural practices (Ndhlovu, 2025). Excessive data and device costs are significant barriers for most small-scale farmers. There are also low levels of digital skills among farmers, which limit the effective use of agricultural apps, sensors, and digital platforms. In addition, there is a lack of integrated data systems, which leads to disjointed decision-making, poor monitoring, and inefficient supply chain management. Insufficient high-level skills and underfunding in research also significantly hinder the scaling of new food technologies. These gaps significantly hinder the transformation of South Africa's food systems, perpetuating a 'dual' agricultural structure where high-tech commercial farms thrive while smallholder farmers lag. These challenges directly impact food security, sustainability, and the ability of the agricultural sector to adapt to climate change. Addressing these challenges is critical for strengthening food security and enabling sustainable agricultural growth in South Africa.

South African local governments also face policy, regulatory, and ethical gaps. South Africa lacks dedicated, clear, and comprehensive legislation specifically addressing AI risks in public sectors, such as data privacy, algorithmic bias, and accountability for decisions. There is also fear of job displacement for municipal employees, particularly among those lacking digital skills, which is a significant issue for rural municipalities where employment opportunities are scarce. Stakeholders (including local farmers and municipal officials) often trust human-delivered information (like traditional extension officers) over AI-driven, automated recommendations, leading to resistance to adoption.

There are also socio-economic and educational gaps that hamper AI integration in South Africa. The 'digital divide' means many farmers and local officials lack basic familiarity with smartphones, apps, or online services, which hinders the adoption of AI-enabled tools. Many AI tools are designed primarily in English, lacking support for local languages, which limits their accessibility and usability for smallholder farmers. To address these, South African municipalities must focus on 'small AI' solutions, such as SMS-based tools, build public-private partnerships for funding, and prioritise the development of local data sets to improve the relevance of AI tools

8. Conclusion

This article examined the role of AI in local governance in South Africa, identified challenges of local governance in

South Africa in supporting food system actors, and explored how AI-driven solutions can help local governance effectively support sustainable food systems in South Africa. It argues that the integration of AI into South Africa's local governance framework offers a transformative, data-driven pathway toward building resilient, equitable, and sustainable urban and rural food systems. AI technologies, ranging from predictive analytics for climate-smart agriculture to machine learning algorithms for supply chain optimisation, can significantly enhance how municipalities monitor food security, manage resource allocation, and mitigate the systemic inefficiencies that currently plague local food networks. By shifting municipal operations from a reactive stance to a proactive, predictive posture, local governance can play a pivotal role in achieving sustainable food systems while simultaneously navigating the unique socioeconomic complexities inherent to the South African landscape.

However, realising this potential requires navigating significant institutional, infrastructural, and regulatory hurdles. Moving forward, a structured approach is essential to convert technological potential into public value. For policy recommendations, the article suggests that local governments design clear, ethical guidelines for AI adoption that prioritise data privacy, inclusivity, and algorithmic transparency to ensure community trust. National and provincial authorities must also co-fund localised digital infrastructure, including reliable broadband and cloud data centres, specifically targeting secondary cities and rural municipalities where food insecurity is highest. Additionally, policymakers should incentivize public-private partnerships that unite tech developers, local farmers, civil society, and municipal authorities to co-design context-specific, open-source AI tools.

Future scholarship must examine how AI tools interface with existing bureaucratic structures and assess the specific capacity-building paradigms needed to upskill municipal workforces. Rigorous empirical research is also required to evaluate how AI predictive models behave across diverse agro-ecological zones and to ensure these algorithms do not inadvertently disadvantage smallholders or informal food traders. In addition, long-term cost-benefit analyses are crucial to measure the exact return on investment for municipal AI implementations, helping to create scalable templates for local governments across the country. Ultimately, harnessing AI for food system transformation in South Africa is not merely a technical upgrade but a governance imperative. By aligning technological innovation with localised policymaking and robust empirical research, South African municipalities can spearhead a food system that is structurally sound, climate-resilient, and capable of sustaining all citizens.

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No potential conflict of interest was reported by the authors.

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Grammarly and Google Gemini were used for supplementing clarity and readability to the article.
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