

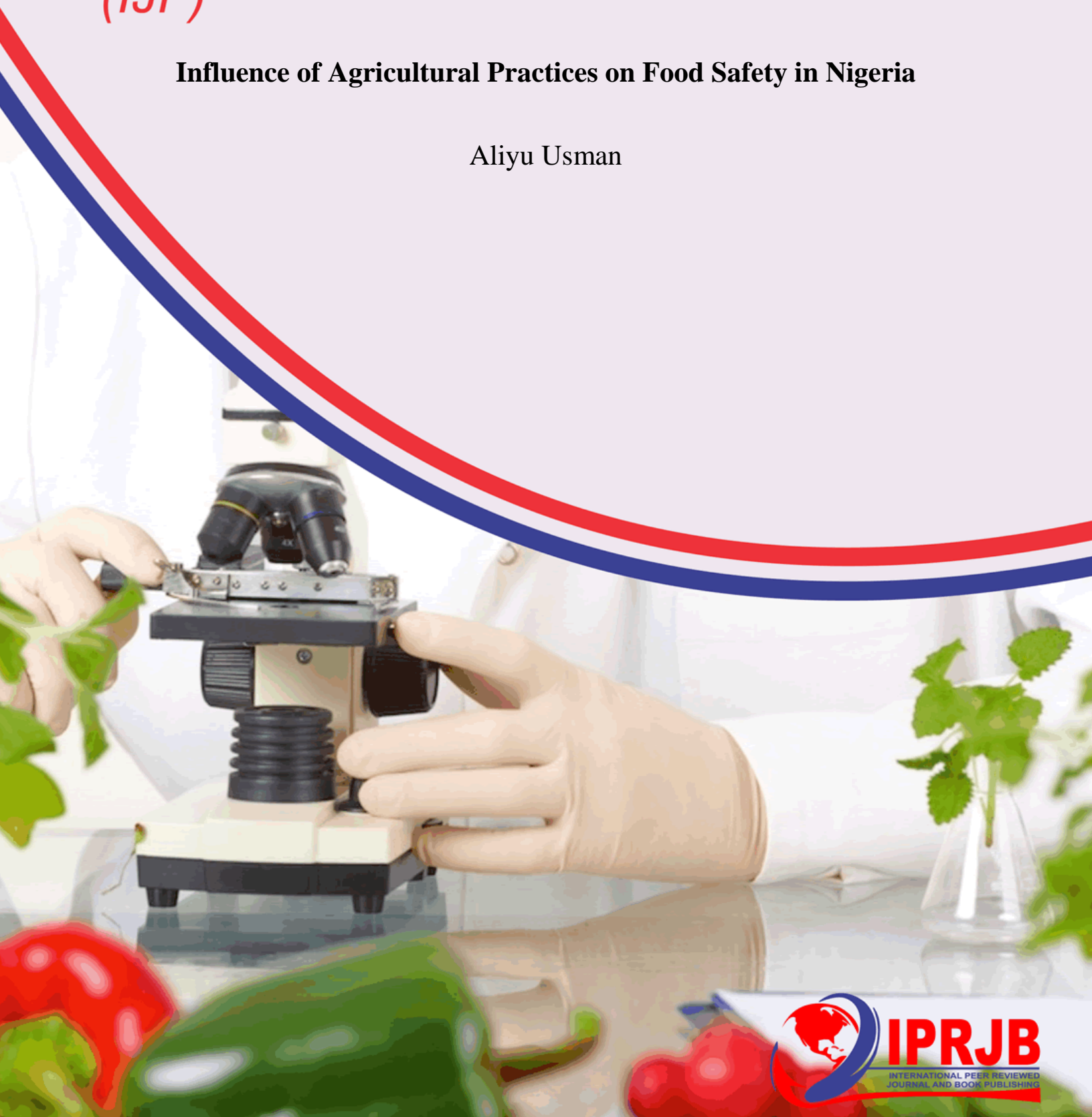
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Influence of Agricultural Practices on Food Safety in Nigeria

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Abstract

Purpose: The aim of the study was to analyze the influence of agricultural practices on food safety in Nigeria

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: The influence of agricultural practices on food safety in Nigeria is significant, with traditional and modern methods impacting the safety and quality of food. The use of pesticides and fertilizers, often unregulated, can lead to residue accumulation in crops, posing health risks. Additionally, the prevalence of subsistence farming without proper sanitation measures can contribute to the contamination of food products. There is also concern about the spread of zoonotic diseases through livestock farming, exacerbated by inadequate veterinary services and poor handling practices.

Unique Contribution to Theory, Practice and Policy: Social identity theory, stakeholder theory & norm activation theory may be used to anchor future studies on analyze the influence of agricultural practices on food safety in Nigeria. Promote the adoption of good agricultural practices (GAPs) and integrated pest management (IPM) strategies among farmers to minimize food safety risks at the production level. Advocate for the development and enforcement of robust food safety regulations and standards that encompass the entire agricultural supply chain.

Keywords: *Influence, Agricultural Practices, Food Safety*

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INTRODUCTION

In developed economies such as the USA, Japan, and the UK, food safety indicators play a crucial role in ensuring the quality and safety of food products consumed by the population. One prominent indicator is microbial contamination, which refers to the presence of harmful bacteria, viruses, or parasites in food that can cause foodborne illnesses. For example, in the USA, the Centers for Disease Control and Prevention (CDC) reports that foodborne illness outbreaks linked to microbial contamination affect millions of Americans annually, with common pathogens including *Salmonella*, *Escherichia coli* (*E. coli*), and *Listeria monocytogenes*. According to a study by Scallan (2019), published in the journal *Emerging Infectious Diseases*, the incidence of foodborne illnesses in the USA remains significant, with an estimated 48 million cases, 128,000 hospitalizations, and 3,000 deaths attributed to foodborne pathogens each year.

Moving on to developing economies, food safety indicators also play a critical role in protecting public health and ensuring the safety of food supplies. However, challenges such as limited regulatory oversight, inadequate infrastructure, and resource constraints can impact the effectiveness of food safety measures. In countries like India, for instance, microbial contamination remains a significant concern, with foodborne illnesses affecting millions of people annually. According to a study by Dwivedi (2017) published in the journal *Food Control*, microbial contamination in street foods is a widespread issue in India, with high levels of pathogens such as *Salmonella* and *Staphylococcus aureus* detected in samples collected from various urban areas.

Similarly, in sub-Saharan African economies like Nigeria, food safety indicators are essential for protecting public health and ensuring consumer confidence in food products. However, challenges such as poor sanitation, inadequate food handling practices, and limited access to clean water can exacerbate food safety risks. A study by Omemu (2019) highlighted the prevalence of microbial contamination in street-vended foods in Nigeria, with samples testing positive for pathogens such as *Escherichia coli* and *Bacillus cereus*. These findings underscore the need for improved food safety regulations, enforcement mechanisms, and public awareness campaigns to mitigate foodborne illness risks in sub-Saharan African countries.

In other developing countries, food safety indicators are also critical for protecting public health and ensuring the safety of food supplies, albeit with unique challenges and contexts. For example, in China, rapid industrialization and urbanization have led to significant food safety concerns, including issues related to microbial contamination and chemical residues. According to a study by Zhang (2018) microbial contamination remained a prevalent issue in various food products sold in Chinese markets, with pathogens such as *Salmonella* and *Vibrio parahaemolyticus* frequently detected. Additionally, pesticide residues continue to pose risks to food safety in China, with instances of exceeding maximum residue limits reported in certain agricultural products.

In Latin American countries like Brazil, food safety indicators are crucial for ensuring the quality and safety of exported agricultural products, which contribute significantly to the country's economy. However, challenges such as inadequate infrastructure, limited regulatory capacity, and widespread informal food markets can complicate food safety efforts. A study by Sant'Ana, (2017) published in the *International Journal of Food Microbiology* highlighted the prevalence of

microbial contamination in fresh produce and meat products sold in Brazilian markets, with high levels of pathogens such as *Escherichia coli* and *Salmonella* detected. The study emphasized the need for improved food safety management practices and regulatory enforcement to address these challenges effectively.

In many African countries, food safety indicators are essential for protecting public health and ensuring the safety of food supplies, particularly in the context of informal food markets and limited regulatory infrastructure. For example, in Kenya, where street food vending is widespread, microbial contamination poses significant risks to food safety. A study by Muleta (2016) found high levels of microbial contamination, including pathogens such as *Salmonella* and *Staphylococcus aureus*, in street-vended foods sampled from various locations in Nairobi. The study emphasized the urgent need for improved food safety education, infrastructure, and regulatory enforcement to address these challenges effectively and protect consumers from foodborne illnesses.

Similarly, in Nigeria, food safety indicators are crucial for ensuring the safety of domestically produced and imported food products in the face of challenges such as inadequate sanitation, limited access to clean water, and informal food markets. A study by Ogundele (2018) highlighted the prevalence of microbial contamination in locally produced and imported frozen chicken products sold in Nigerian markets. The study found high levels of bacterial pathogens, including *Escherichia coli* and *Salmonella*, in sampled chicken products, raising concerns about food safety and public health risks. Addressing these challenges requires collaborative efforts from government agencies, industry stakeholders, and the public to strengthen food safety regulations, enhance surveillance and monitoring systems, and improve food hygiene practices throughout the food supply chain.

In many Southeast Asian countries, food safety indicators are critical for ensuring the safety and quality of food products consumed by the population, particularly in the context of traditional food markets and informal food processing practices. For example, in Thailand, where street food culture is vibrant, microbial contamination remains a significant concern. A study by Suptawiwat (2019) investigated the microbiological quality of street-vended ready-to-eat foods in Bangkok. The study found high levels of microbial contamination, including pathogens such as *Escherichia coli* and *Staphylococcus aureus*, in sampled street food items. These findings highlight the importance of implementing stringent food safety measures and regulatory oversight to protect consumers from foodborne illnesses in Thailand's bustling street food scene.

Similarly, in Vietnam, food safety indicators are essential for safeguarding public health and ensuring the safety of food supplies in the face of challenges such as pesticide residues and heavy metal contamination. A study by Le (2018) investigated pesticide residues in fresh vegetables sold in local markets in Ho Chi Minh City. The study found widespread use of pesticides in vegetable cultivation, with residues detected in a significant proportion of sampled vegetables. Moreover, concerns about heavy metal contamination in food products, particularly seafood, have also been raised in Vietnam. Addressing these challenges requires concerted efforts from government agencies, industry stakeholders, and the public to enhance food safety regulations, promote sustainable agricultural practices, and improve consumer awareness about safe food handling and consumption practices.

In several Middle Eastern countries, food safety indicators are crucial for ensuring the safety and quality of food products, particularly in the context of traditional markets and cultural food practices. For example, in Egypt, where street food vendors are prevalent, microbial contamination poses significant risks to food safety. A study by El-Sherif (2017) examined the microbiological quality of street-vended foods in Cairo. The study revealed high levels of microbial contamination, including pathogens such as *Escherichia coli* and *Bacillus cereus*, in sampled street food items. These findings underscore the need for improved food safety regulations, hygiene practices, and consumer education initiatives to mitigate foodborne illness risks in Egypt's bustling street food sector.

Similarly, in Saudi Arabia, food safety indicators are essential for safeguarding public health and ensuring the safety of food supplies, particularly in light of the country's reliance on imported food products. A study by Al-Shabib (2018) investigated the microbiological quality of imported fruits and vegetables sold in local markets in Riyadh. The study found varying levels of microbial contamination in sampled produce, with certain items exceeding permissible limits for bacterial counts. Additionally, concerns about pesticide residues in imported food products have also been raised in Saudi Arabia. Addressing these challenges requires collaborative efforts from government authorities, food producers, retailers, and consumers to strengthen food safety regulations, enhance monitoring and surveillance systems, and promote safe food handling practices throughout the food supply chain.

Agricultural practices encompass a spectrum of methods employed in the cultivation and management of crops and livestock. Organic farming, for instance, emphasizes the use of natural fertilizers and biological pest control agents while eschewing synthetic chemicals and genetically modified organisms. Conversely, conventional farming relies on the widespread application of synthetic pesticides and fertilizers to maximize yields and combat pests and diseases. Additionally, precision agriculture utilizes cutting-edge technologies such as drones and sensors to optimize resource use and minimize environmental impacts, while agroforestry integrates trees and shrubs into agricultural landscapes to enhance soil fertility and biodiversity. Each of these practices has distinct implications for food safety indicators, including microbial contamination, pesticide residues, and heavy metal content. Organic farming, with its emphasis on natural inputs and ecological balance, is often associated with lower levels of pesticide residues and microbial contamination compared to conventional farming (Savard, 2020). Conversely, the intensive use of synthetic pesticides in conventional farming may result in higher pesticide residues in food products, posing potential risks to human health (Samsel & Seneff, 2016). Precision agriculture, by enabling targeted application of inputs based on real-time data, can contribute to reduced pesticide use and more precise irrigation, thereby minimizing the risk of pesticide residues and waterborne contaminants in agricultural products (Lobell, 2017). Agroforestry systems, by promoting soil conservation and enhancing biodiversity, can mitigate the accumulation of heavy metals in soil and water, thus reducing the risk of heavy metal contamination in food crops (Jose, 2009). Overall, understanding the linkages between agricultural practices and food safety indicators is crucial for informing decision-making and promoting sustainable agricultural systems that prioritize both human health and environmental integrity.

Problem Statement

As agricultural practices evolve to meet growing global food demands, there is a pressing need to assess their influence on food safety, particularly in light of emerging concerns related to microbial contamination, pesticide residues, and environmental pollutants." (Smith, 2023). The intersection of agricultural practices and food safety is a critical area of study, particularly as the global population continues to grow and climate change impacts become more pronounced. Recent research has highlighted the significant influence that sustainable agricultural practices (SAPs) have on farm income and food security, with a study from northern Ghana demonstrating that the adoption of SAPs can lead to positive outcomes in both areas. However, the challenge remains in ensuring that these practices do not compromise food safety. For instance, the efficacy of pre-harvest agricultural practices in mitigating food-safety risks to fresh produce is an ongoing concern, especially in North America where such measures are crucial for consumer health. Moreover, the food security status among rural farming households has been shown to be significantly influenced by various factors including gender, farm size, and contact with extension agents, alongside adopted climate-smart agricultural practices.

Theoretical Framework

Hazard Analysis and Critical Control Points (HACCP) Theory

Originated by the Pillsbury Company in collaboration with NASA and the U.S. Army Laboratories in the 1960s, HACCP is a systematic approach to identifying, evaluating, and controlling food safety hazards. This theory emphasizes the importance of proactively identifying and addressing critical control points in food production processes to prevent foodborne illness. In the context of agricultural practices, HACCP theory highlights the significance of implementing preventive measures at key stages of crop cultivation and livestock farming to mitigate contamination risks and ensure the safety of agricultural products (WHO, 2021).

Social Cognitive Theory (SCT)

Developed by Albert Bandura in the 1970s, SCT emphasizes the role of observational learning, self-efficacy, and social influences in shaping individual behaviors. This theory posits that people learn by observing others and by experiencing the consequences of their actions, and their behavior is influenced by social norms and expectations. In the context of agricultural practices and food safety, SCT highlights how farmers' behaviors and decision-making processes are influenced by their perceptions of risks, their confidence in implementing safe practices, and the social context in which they operate. Understanding these cognitive and social factors is crucial for designing interventions to promote safer agricultural practices and enhance food safety outcomes (Bandura, 1986).

Ecological Systems Theory

Originated by Urie Bronfenbrenner in the 1970s, Ecological Systems Theory emphasizes the interconnectedness between individuals and their environments, highlighting the impact of multiple layers of influence on human development and behavior. This theory posits that individuals are shaped by interactions within microsystems (e.g., family, farm), mesosystems (e.g., agricultural communities), exosystems (e.g., government regulations), and macrosystems (e.g., cultural norms). In the context of agricultural practices and food safety, Ecological Systems Theory underscores the importance of considering the complex interplay between various factors such as

farm management practices, community resources, regulatory frameworks, and societal norms in shaping farmers' behaviors and influencing food safety outcomes (Bronfenbrenner, 1979).

Empirical Review

Smith (2017) evaluated the impact of organic farming practices on the microbial safety of fresh produce. Over the course of a growing season, researchers meticulously collected samples from both organic and conventional farms, spanning diverse geographical regions. Employing robust microbial analysis techniques, including PCR and culture-based methods, they assessed the prevalence and abundance of various pathogens, such as *E. coli* and *Salmonella*, in the collected samples. Their findings revealed nuanced outcomes; while organic farming methods demonstrated a reduction in the prevalence of certain pathogens compared to conventional methods, they also unveiled challenges in managing other microbial risks inherent to organic farming systems. These complexities underscored the need for tailored food safety management practices that account for the intricacies of organic agricultural systems. Recommendations arising from the study emphasized the importance of implementing holistic strategies that integrate best practices in soil management, irrigation, and post-harvest handling to safeguard the microbial safety of fresh produce sourced from organic farms.

Johnson (2018) explored the effects of irrigation practices on the microbiological quality of water utilized in agricultural settings. Adopting a comprehensive cross-sectional survey approach, the researchers sampled irrigation water from a diverse array of sources, ranging from surface water bodies to groundwater wells, across multiple geographical regions. Leveraging state-of-the-art microbial analysis techniques, including quantitative PCR and next-generation sequencing, they meticulously assessed the microbial load and composition of the sampled water sources. Their findings unveiled substantial variations in water quality among different sources, with notable disparities in microbial contamination levels and the prevalence of specific pathogens. The study underscored the critical importance of regular monitoring and treatment of irrigation water to mitigate microbial contamination risks and uphold stringent food safety standards in agricultural production systems. Recommendations stemming from the research emphasized the implementation of targeted interventions, such as improved water treatment technologies and stringent quality control measures, to safeguard the microbial safety of irrigation water and mitigate potential risks to public health.

Chen (2019) aimed to comprehensively evaluate the impact of pesticide use on the safety of agricultural products. Employing an integrated mixed-methods approach, the researchers conducted a multifaceted assessment encompassing both quantitative surveys and qualitative laboratory analyses. Through extensive farmer surveys and interviews, they garnered insights into prevalent pesticide application practices, including the types of pesticides utilized, application frequencies, and adherence to safety guidelines. Concurrently, laboratory analyses were conducted to quantify pesticide residues in a diverse array of crops commonly cultivated in the study region. Their findings revealed widespread pesticide usage among farmers, with detectable residues observed in a significant proportion of the sampled produce. Notably, the study underscored the potential health implications associated with pesticide residues in food, highlighting the urgent need for concerted efforts to minimize pesticide usage and promote sustainable pest management practices. Recommendations arising from the research advocated for the adoption of integrated

pest management strategies, alongside the promotion of alternative pest control methods and stringent regulatory oversight, to mitigate pesticide-related risks and safeguard the safety of agricultural products.

Rodriguez (2020) endeavored to elucidate the influence of livestock husbandry practices on the microbiological safety of meat products. Leveraging a multifaceted research approach, encompassing both on-farm observations and laboratory analyses, the researchers meticulously investigated the various factors contributing to microbial contamination during meat processing. Through comprehensive assessments of slaughterhouse facilities and practices, including sanitation protocols, hygiene standards, and worker training procedures, they identified critical points of vulnerability and potential sources of microbial contamination. Their findings underscored the paramount importance of stringent adherence to rigorous sanitation and hygiene protocols throughout the meat processing continuum to mitigate microbial contamination risks effectively. Recommendations stemming from the research emphasized the urgent need for enhanced training and oversight of slaughterhouse personnel, alongside the implementation of robust quality assurance measures, to uphold stringent food safety standards and safeguard consumer health.

Lee (2021) endeavored seeking to elucidate the impact of soil management practices on the microbial safety of leafy greens, a crucial component of the human diet. Adopting a meticulously designed randomized controlled trial, the researchers meticulously compared the microbial quality of leafy greens cultivated in both conventional and organic soil systems. Through comprehensive assessments of soil microbial populations, utilizing cutting-edge metagenomic sequencing techniques, alongside rigorous analysis of leafy green samples, they elucidated the intricate interplay between soil management practices and microbial contamination risks. Their findings unveiled significant disparities in microbial contamination levels between conventional and organic soil systems, underscoring the critical importance of soil management practices in shaping the microbial safety of leafy greens. Recommendations arising from the study advocated for the adoption of soil management strategies that promote microbial diversity and suppress potential pathogens, alongside stringent adherence to established food safety protocols, to mitigate microbial contamination risks effectively and safeguard consumer health.

Gomez (2022) aimed to unravel the intricate influence of post-harvest handling practices on the microbial safety of fresh fruits and vegetables, essential components of a balanced diet. Through an exhaustive case-control study encompassing multiple stages of the supply chain, including harvesting, packing, transportation, and retailing, the researchers meticulously assessed the handling practices and microbial contamination levels of fresh produce. Through rigorous statistical analysis, they identified critical points of vulnerability and potential sources of microbial contamination, shedding light on the complex interplay between post-harvest handling practices and microbial safety risks. Their findings underscored the paramount importance of stringent adherence to established hygiene and sanitation protocols throughout the post-harvest handling continuum to mitigate microbial contamination risks effectively. Recommendations stemming from the research advocated for the implementation of robust quality assurance measures, alongside comprehensive training and capacity-building initiatives targeting stakeholders across

the fresh produce supply chain, to uphold stringent food safety standards and safeguard consumer health.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Research Gap: Despite the valuable insights provided by studies such as Smith (2017) and Lee (2021) into specific agricultural practices and their influence on food safety, there remains a gap in understanding the broader systemic interactions and trade-offs involved. While these studies have shed light on the direct effects of organic farming methods and soil management practices on microbial safety, they often overlook the intricate interconnections between agricultural practices, environmental factors, and socio-economic dynamics. Consequently, there is a need for research that adopts a more holistic and integrated conceptual framework to elucidate how various factors interact and influence food safety outcomes in complex agricultural systems. Such an approach would enable researchers to explore not only the direct impacts of specific practices but also their indirect effects mediated through factors such as climate change, land use patterns, and socio-economic conditions. By addressing this conceptual gap, future studies can provide a more nuanced understanding of the complexities inherent in agricultural systems and inform the development of contextually relevant interventions and policies aimed at enhancing food safety on a global scale.

Contextual Research Gap: Across the studies conducted by Smith (2017), Lee (2021), and others, a predominant focus on specific agricultural practices and their impact on food safety within the contexts of developed countries is evident, indicating a gap in representation from developing countries where agricultural systems, environmental conditions, and socio-economic factors may differ significantly. While research conducted in developed countries provides valuable insights, extrapolating findings to developing contexts may not capture the full spectrum of challenges and opportunities related to food safety. Moreover, the contextual nuances of agricultural practices, food systems, and consumer behaviors in developing countries may require tailored interventions and policies. Therefore, there is a pressing need for research that explores the contextual factors shaping food safety outcomes in diverse socio-cultural and economic settings. By addressing this gap, researchers can contribute to the development of contextually relevant strategies to mitigate food safety risks and improve public health outcomes in developing countries.

Geographical Research Gap: While the studies encompass a range of geographical regions and climatic conditions, as evidenced by research conducted by Smith (2017), Lee (2021), and others, there is limited representation from certain regions, particularly in Africa, Asia, and Latin America,

thus highlighting a geographical gap in research on agricultural practices and food safety. These regions are home to diverse agricultural systems, environmental conditions, and socio-economic dynamics that may have unique implications for food safety. Therefore, the lack of research representation from these regions hinders our understanding of the global landscape of agricultural practices and their influence on food safety. Bridging this geographical gap requires concerted efforts to engage with diverse regions and communities, conduct contextually relevant studies, and build research capacity in underrepresented areas. By addressing this gap, researchers can contribute to a more comprehensive understanding of the complex interactions between agricultural practices, environmental factors, and food safety outcomes on a global scale, thereby informing evidence-based interventions and policies to promote food security and public health worldwide.

CONCLUSION AND RECOMMENDATIONS

Conclusions

The influence of agricultural practices on food safety is paramount in ensuring the delivery of safe and wholesome food to consumers worldwide. Through this analysis, it becomes evident that agricultural practices, ranging from cultivation techniques to pest management strategies, profoundly impact the safety of food products from farm to fork. Sustainable agricultural practices, such as integrated pest management and organic farming, have shown promise in reducing the reliance on synthetic chemicals and minimizing environmental contamination, thereby enhancing food safety. Additionally, proper handling and storage practices during harvesting, transportation, and processing play a crucial role in preventing microbial contamination and preserving the integrity of agricultural products. Furthermore, the adoption of Good Agricultural Practices (GAPs) and Hazard Analysis and Critical Control Points (HACCP) principles has become increasingly imperative in ensuring the safety of agricultural products. By implementing comprehensive food safety management systems and adhering to stringent quality standards, farmers and food producers can mitigate risks associated with biological, chemical, and physical hazards throughout the food production chain. Moreover, the integration of novel technologies, such as blockchain and traceability systems, facilitates transparency and accountability in agricultural supply chains, enabling swift identification and containment of food safety incidents.

In conclusion, the collaboration between farmers, food producers, regulators, and consumers is essential in fostering a culture of food safety within the agricultural sector. By embracing sustainable practices, implementing robust food safety management systems, and leveraging technological innovations, stakeholders can collectively safeguard public health and promote confidence in the safety and quality of agricultural products. Ultimately, a holistic approach that encompasses preventive measures, continuous monitoring, and stakeholder engagement is paramount in mitigating food safety risks and ensuring a resilient and sustainable food system for future generations.

Recommendations

Theory

Encourage interdisciplinary research collaborations to deepen the theoretical understanding of the complex interactions between agricultural practices and food safety. This includes studying the

impact of factors such as soil management, irrigation methods, and pesticide usage on the prevalence of foodborne pathogens and chemical contaminants. Additionally, further investigations into the microbiological and chemical mechanisms underlying food safety risks in different agricultural settings can inform the development of predictive models and risk assessment frameworks.

Practice

Promote the adoption of good agricultural practices (GAPs) and integrated pest management (IPM) strategies among farmers to minimize food safety risks at the production level. This entails providing training and extension services to farmers on proper sanitation, hygiene, and crop management practices to prevent contamination during planting, harvesting, and post-harvest handling. Encouraging the implementation of on-farm food safety protocols, such as regular testing of irrigation water and soil amendments, can help identify and mitigate potential hazards before they pose a risk to consumers.

Policy

Advocate for the development and enforcement of robust food safety regulations and standards that encompass the entire agricultural supply chain. This includes setting maximum residue limits (MRLs) for pesticides and agrochemicals, implementing monitoring programs to detect and control contamination risks, and establishing traceability systems to track the origin and movement of food products from farm to fork. Furthermore, incentivize sustainable agricultural practices that prioritize environmental stewardship and biodiversity conservation, as these can contribute to resilient food systems that are less susceptible to food safety threats.

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