Open Access Library Journal
2025, Volume 12, e13401
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Optimizing Agricultural Supply Chain Management Practices to Address Food Security: A Case Study of Agro-Based Small and Medium-Sized Enterprises in Lira City, Northern Uganda

Apio Janet Oyee, Peter Paul Opio

Department of Commerce and Business Management, Lira University, Lira, Uganda
Email: opiopp21@gmail.com

How to cite this paper: Oyee, A.J. and Opio, P.P. (2025) Optimizing Agricultural Supply Chain Management Practices to Address Food Security: A Case Study of Agro-Based Small and Medium-Sized Enterprises in Lira City, Northern Uganda. *Open Access Library Journal*, **12**: e13401.
https://doi.org/10.4236/oalib.1113401

Received: April 7, 2025
Accepted: July 19, 2025
Published: July 22, 2025

Abstract

Background: This study sought to optimize agricultural supply chain management practices to address food insecurity among agro-based SMEs in Lira City. Using a concurrent triangulation research approach, the study relied on quantitative data to provide a comprehensive understanding of how supply chain management practices impact food security. The main focus was on the role of food marketing, transportation, processing and inputs management in predicting food security. **Methods:** A cross-sectional research design was employed, whereupon self-administered questionnaires were deployed for data collection. The study population comprised 377 non-section heads drawn from agro-based SMEs. A proportionate sampling technique was applied to select non-section heads. Data was analyzed using SPSS and descriptive statistics and linear regression was employed to assess the effects of various supply chain practices on food security. **Results:** The study found significant correlations between agricultural supply chain management practices and food security. Food marketing ($r = 0.616$, $p < 0.05$) had the strongest association with food security, followed by food transportation ($r = 0.480$, $p < 0.05$). Similarly, the linear regression analysis revealed that; food marketing (Coef. = 0.447, $p < 0.001$) and food transportation (Coef. = 0.211, $p < 0.001$) were significant predictors of food security, explaining 41.6% ≈ 42% of the variation in food security. The study findings suggest that enhancing food marketing and transportation practices could significantly decelerate and consequently reverse food insecurity. **Conclusion:** Optimizing agricultural supply chain management practices, particularly food marketing and food transportation is crucial in addressing food

insecurity amongst agro-based SMEs in Lira City. The study highlights the significant role of these practices and suggests that while targeted interventions in marketing and transportation are essential, a comprehensive approach that includes broader socio-economic and environmental strategies is necessary for a more effective impact on food security.

Subject Areas

Economics

Keywords

Food Security, Agricultural Supply Chain Management Practices, Agro-Based SMEs, Food Marketing, Food Transportation, Lira City, Linear Regression Analysis, Quantitative Methods Research

1. Background

Agricultural supply chain management (ASCM) plays a critical role in ensuring food security, especially in regions that are heavily reliant on agriculture. Existing literature highlights various aspects of SCM in agriculture, focusing on efficiency improvements, cost reductions and logistical challenges. For instance, some studies have revealed that effective ASCM can significantly reduce post-harvest losses, which are a major concern in developing regions [1]. Research indicates that agro-based small and medium-sized enterprises (SMEs) are pivotal in improving local food systems and thus significantly contributing to food security and economic development [2]. These SMEs, however, often face challenges such as inadequate infrastructure, limited access to technology and fluctuating market conditions [3].

Despite the extensive research on ASCM and food security, several gaps still persist [4]. Firstly, much of the existing literature tends to focus on large-scale agricultural enterprises or developed regions, leaving a knowledge void concerning SMEs in developing cities like Lira. There is also limited research addressing the specific ASCM challenges faced by smaller enterprises and how their unique needs can be better met [5]. Additionally, while technological advancements in SCM have been widely discussed, practical implementations and their impacts on SMEs in low-resource settings remain underexplored [6]. This lack of targeted research confines the understanding of how to tailor SCM practices to the context of small-scale operations especially in developing urban areas.

To this end, several policies and business development services have been advanced and deployed to support agricultural SMEs in enhancing food security. Such policies include; the MSMEs policy (2015), while business development services (BDS) include; subsidies for technology adoption, training programs and infrastructure development [2]. However, these policies and BDS often lack a localized focus, neglecting the specific needs of smaller SMEs, particularly those in low regions such as Lira City. For instance, while broad policies might address

general agricultural issues, they are inept in combating the unique supply chain disruptions or market dynamics faced by SMEs in this locality. There is also a need for more integrated policies that connect various aspects of the supply chain, from production to distribution, and provide targeted support for overcoming local challenges [2].

Lira City, a growing urban center in Northern Uganda [7], presents a unique case for studying ASCM in agro-based SMEs due to its specific economic and infrastructural context. Lira City has registered a high birthrate of small and medium agricultural enterprises, which are very pivotal for accelerating local food security and economic development [8]. To this end, understanding the ASCM practices of these SMEs and the challenges they face is essential for developing effective interventions for addressing food insecurity [9]. By identifying and addressing the gaps in current ASCM practices and policies, this study aims to provide actionable insights that can fast-track food security and support the sustainable growth of agro-based SMEs in Lira City. This localized approach is crucial for crafting policies and practices that are not only effective but also contextually relevant to the needs of small-scale agricultural enterprises.

2. Methods

2.1. Resign Design

The study employed a cross-sectional study design. Given the nature of the study, which aims to capture a snapshot of existing practices, challenges and opportunities for optimization, a cross-sectional approach is both time-efficient and cost-effective. It allows for the simultaneous examination of various variables such as; infrastructure, market access and operational practices, facilitating an understanding of their relationship with food security.

2.2. Study Setting

This study was conducted in Lira City, located in Northern Uganda [10], a region predominantly reliant on agriculture as the main source of livelihood. Lira City serves as a commercial and administrative hub with a vibrant agro-based economy supported by a growing number of small and medium-sized enterprises (SMEs) engaged in food production, processing, and distribution. The area is characterized by fertile land, a favorable climate for diverse crop cultivation, and an active network of local markets. However, despite this agricultural potential, challenges such as inefficient supply chain practices, post-harvest losses, and limited access to storage and transport infrastructure hinder optimal productivity and food security. The study focused on SMEs operating within this context to understand how supply chain management practices can be improved to enhance food availability, accessibility, and sustainability in the region.

2.3. Study Population

The study population comprised non-section heads within SMEs operating in Lira

City, Northern Uganda. These individuals are key operational staff who are involved in the day-to-day supply chain activities but do not hold top managerial positions as heads of departments. Their perspectives and experiences are critical in understanding the practical challenges and inefficiencies in the supply chain management practices of SMEs. Focusing on non-section heads provided valuable insights into the execution of supply chain processes, such as procurement, transportation, storage and distribution of agricultural products. In this study, the total population of non-section heads in these agro-based SMEs is 377. Given their involvement in the operational side of agricultural supply chains, they play an essential role in identifying the gaps and opportunities for optimizing supply chain management practices to address food insecurity in the region.

2.4. Sample Size and Sampling Technique

The sample for this study was 377 non-section heads of SMEs) in Lira City, utilizing a census approach. This method involves including all eligible individuals within the specified population, ensuring comprehensive representation and capturing a wide range of perspectives on supply chain management practices. By employing the census approach, the study aims to achieve a high level of accuracy and reliability in the data collected, which is essential for understanding the specific challenges and practices of SMEs in the context of food security.

2.5. Data Collection Instruments

Data was collected using self-administered questionnaires designed to capture respondents' perspectives on key variables related to agricultural supply chain management practices and food security. The questionnaires employed a five-point Likert scale, ranging from 5 (strongly agree) to 1 (strongly disagree), allowing participants to express their opinions with clarity and precision while providing the flexibility to complete them at their own pace. Organized into three main sections, Section A focused on biodata to collect demographic information, Section B explored agricultural supply chain management practices with subsections dedicated to inputs management, food processing, transportation, and marketing, while section C addressed food security, incorporating subsections on food availability, food accessibility, food stability, and food utilization. The reliability of the questionnaire was confirmed with a coefficient of 0.759, exceeding the acceptable threshold of 0.7, thus ensuring the instrument's reliability and the validity of the study's findings.

2.6. Data Collection Procedure

The data collection procedure for this study was carefully structured to ensure clarity and ethical engagement with participants. Initially, the researcher developed a detailed plan for reaching out to the 377 non-section heads of SMEs in Lira City, utilizing a census approach to include all eligible individuals within the specified population. Contact with participants commenced two weeks prior to the

distribution of the questionnaires. The researcher, along with trained research assistants, visited the participating SMEs and personally introduced the study to the potential respondents. During these visits, participants were informed about the purpose of the study, which was to investigate the supply chain management practices aimed at addressing food insecurity in the region. They were assured of the confidentiality of their responses and the voluntary nature of their participation. Following the initial contact, self-administered questionnaires were distributed to the participants over a period of one week. The participants were provided with a clear explanation of how to fill out the questionnaires. They were encouraged to complete the questionnaires at their convenience, allowing them the flexibility to reflect on their experiences and provide thoughtful answers. After the completion of the data collection period, the research team collected the completed questionnaires to ensure data integrity.

2.7. Data Management and Analysis

Following data collection, raw data was meticulously reviewed for completeness before being entered into a spreadsheet for organization and analysis. The Statistical Package for Social Sciences (SPSS) version 23 software was subsequently employed for comprehensive data analysis. Initially, descriptive statistics, including means, percentages and standard deviations, were generated to summarize the demographic characteristics of the respondents. This provided a foundational understanding of the sample population.

In addition, regression analysis procedures were undertaken to assess the effects of selected agricultural supply chain management practices on food security, aligning with the study's four research objectives. Specifically, the analysis focused on evaluating how inputs management, food processing, food transportation and food marketing influence food security outcomes. A linear regression model with robust standard errors was deployed to accurately quantify the effects of these agricultural supply chain management practices, ensuring the results were statistically reliable and informative for the study's objectives.

2.8. Ethical Considerations

The ethical guidelines for this study were based on established principles in social research, specifically anonymity or confidentiality and informed consent. To ensure informed consent, the researcher provided each participant with detailed information about the study, including its potential risks and benefits, allowing them time to ask questions before filling a consent form. Informed consent was viewed as an ongoing process rather than a one-time formality. Confidentiality was also a priority, with the researcher ensuring that interviews were conducted at times and locations convenient for participants to encourage open dialogue. Participants were assured that their responses would be treated with the utmost confidentiality and used exclusively for academic purposes. In addition to these measures, the researcher adhered to ethical standards by reporting findings based

strictly on the data collected, without any manipulation or fabrication. To further protect participant privacy, pseudo names were assigned to respondents. Finally, participants were informed of their right to voluntarily participate in or withdraw from the study at any time.

3. Results

3.1. Demographic Information

For the quantitative data collection, 377 questionnaires were distributed and 352 were returned, resulting in a response rate of 93.3%. The results in Table 1 show that the age distribution of respondents shows that 18.79% were between 20 - 25 years, 27.88% were aged 26 - 31 years, 24.55% were between 32 - 37 years, 19.7% were aged 38 - 43 years, and 9.09% were 44 years or older. In terms of gender, 58.79% of the respondents were male, while 41.21% were female. Regarding marital status, the majority of respondents (70.61%) were married, 22.42% were single, 4.55% were widowed, and 2.42% were divorced. In terms of education level, 23.64% had an ordinary certificate, 46.67% held an ordinary diploma, 23.64% had an undergraduate degree, 5.76% had a postgraduate diploma, and 0.3% held a master's degree.

Table 1. Demographic information.

Variable	Number	Percent
Age Category		
20 - 25 Years	62	18.79
26 - 31 Years	92	27.88
32 - 37 Years	81	24.55
38 - 43 Years	65	19.7
44 Years and above	30	9.09
Gender		
Male	194	58.79
Female	136	41.21
Marital Status		
Married	233	70.61
Single	74	22.42
Widowed	15	4.55
Divorced	8	2.42
Education Level		
Ordinary Certificate	78	23.64
Ordinary Diploma	154	46.67
Undergraduate Degree	78	23.64
Postgraduate Diploma	19	5.76
Master's Degree	1	0.3

3.2. Pairwise Correlations between Food Security and Agricultural Supply Chain Management Practices

The results from the pairwise correlation analysis in Table 2 revealed significant relationships between food security and various agricultural supply chain management practices. Food security was positively correlated with inputs management ($r = 0.252$, $p < 0.05$), indicating a modest positive relationship. Food security also showed a stronger correlation with food processing ($r = 0.391$, $p < 0.05$) and food transportation ($r = 0.480$, $p < 0.05$).

Similarly, the results in Table 2 again contend that the highest correlation was registered between food security and food marketing ($r = 0.616$, $p < 0.05$), suggesting that food marketing had the strongest association with food security. Finally, the correlations between agricultural supply chain practices themselves were significant, such as the relationship between inputs management and food processing ($r = 0.390$, $p < 0.05$) and between food transportation and food marketing ($r = 0.538$, $p < 0.05$). All correlations were significant at $p < 0.05$.

Table 2. Pairwise correlations between food security and agricultural supply chain management practices.

Variables	(1)	(2)	(3)	(4)	(5)
(1) Food Security	1.000				
(2) Inputs Management	0.252*	1.000			
(3) Food Processing	0.391*	0.390*	1.000		
(4) Food Transportation	0.480*	0.389*	0.385*	1.000	
(5) Food Marketing	0.616*	0.384*	0.497*	0.538*	1.000

*$p < 0.05$.

3.3. Linear Regression for Predicting Food Security

The results of the linear regression analysis presented in Table 3 indicate that food transportation and food marketing are significant predictors of food security. Inputs management had a negative but insignificant effect on food security (Coef. = −0.062, $p = 0.325$). On the other hand, food processing showed a positive effect on food security although this effect was marginally significant (Coef. = 0.112, $p = 0.067$). Food transportation had a significant positive effect on food security (Coef. = 0.211, $p < 0.001$), indicating that effective food transportation practices are associated with higher levels of food security. Similarly, food marketing had the strongest positive effect on food security (Coef. = 0.447, $p < 0.001$), suggesting that improvements in food marketing can significantly decelerate food insecurity. The constant in the model was also significant (Coef. = 0.981, $p = 0.001$), showing a baseline level of food insecurity. The overall regression model explains 41.6% ≈ 42% of the variation in food security, as indicated by the adjusted R-squared value. The F-test result ($F = 57.804$) further supports the overall significance of the model.

Table 3. Linear regression for predicting food insecurity.

Food Security	Coef.	St. Err.	t-value	p-value	[95% CI]
Inputs Management	−0.062	0.063	−0.98	0.325	−0.185 - 0.062
Food Processing	0.112	0.061	1.84	0.067*	−0.008 - 0.231
Food Transportation	0.211	0.053	3.95	<0.001***	0.106 - 0.316
Food Marketing	0.447	0.052	8.67	<0.001***	0.345 - 0.548
Constant	0.981	0.294	3.33	0.001**	0.402 - 1.559
Mean Dependent Var	4.055				
Adjusted R-Squared	0.416				
F-Test	57.804				
Akaike crit. (AIC)	310.279				

***p < 0.01, **p < 0.05, *p < 0.1.

4. Discussion

This study aimed to optimize agricultural supply chain management to address food security among agro-based SMEs in Lira City using a concurrent triangulation research design. To this end, significant pairwise correlations were found between food insecurity and agricultural supply chain management practices, with the strongest association being with food marketing ($r = 0.616$, $p < 0.05$). These findings align with existing literature emphasizing the critical role of effective food marketing in enhancing food security [11] who assert that robust marketing strategies can significantly impact food availability and accessibility by optimizing market reach and reducing food wastage. However, our findings are alien to those of some studies which contend that food processing and transportation play more central roles in addressing food insecurity [12]. This incongruity could be attributed to context-specific factors or variations in supply chain conditions. The strong association with food marketing underscores its vital role in mitigating food insecurity, suggesting that agro-based SMEs should focus on improving marketing strategies to better connect food supplies with consumer demand, thereby enhancing overall food security. To this end, the other factors that might influence food security in the context of Lira City include; gender and household dynamics (These influence resource access and utilization). For instance; female headed households in northern Uganda often face constrained access to land due to regressive cultural beliefs. Similarly, limited access to credit and market linkages affect how food marketing and transportation influence food security outcomes.

Relatedly, the linear regression analysis revealed that food transportation (Coef. = 0.211, $p < 0.001$) and food marketing (Coef. = 0.447, $p < 0.001$) were the core predictors of food security outcomes, indicating that enhancing these practices could substantially decelerate food insecurity. The study findings in this regard are consistent with existing literature [13] that underscores the importance of these supply chain management practices. Similarly, research by Deaton & Deaton

(2020) also supports the notion that efficient food transportation systems are crucial for reducing food insecurity by minimizing delays and supply chain losses in thus creating place and time utility [14]. Similarly, some studies [15] highlight the impact of effective food marketing on improving food availability and consumer access. However, the relatively higher coefficient for food marketing in our study compared to transportation contrasts with some studies, such as those by Rejeb & colleagues, which emphasize the equal significance of effective food transportation in combating food insecurity [16]. This difference suggests that in the context of Lira City, enhancing marketing strategies may have a more immediate impact on food security compared to transportation improvements. The implications are that the targeted interventions in food marketing and transportation are essential for addressing food insecurity in agro-based SMEs, with a particular emphasis on optimizing marketing strategies to bridge gaps between food supply and demand.

However, the study indicates that inputs management has a negative insignificant effect on food security (Coef. −0.062, $p = 0.325$). This finding is akin to that of; Dirisa (2023) which revealed that the NAADs input subsidy government program in Uganda largely failed to reach the intended small holder famers thus accelerating food insecurity [17]. Similarly, Mutegi *et al.*, [18] and also Ricome *et al.*, [19] postulated that inputs substitution alone could not prevent food insecurity in Kenya and Senegal respectively. This unfortunate predicament could perhaps be attributed to numerous factors including; supply chain disruptions and environmental constraints (soil quality, intermittent rainfall patterns, pest and disease infestation etc.) and cashflow constraints in most SMEs. These factors not only undermine agro-SMEs ability to purchase high quality agricultural inputs, but also hinder the effective utilization of agricultural inputs and accelerate low input responsiveness in equal measure.

Again, the regression model reports that agricultural supply chain management practices account for 41.6% ≈ 42% of the variation in food insecurity, highlighting the effectiveness of the targeted agricultural supply chain management strategies in addressing food security. These results are concomitant with those of other studies [20] who postulated that effective supply chain management can significantly influence food security outcomes by improving efficiency and reducing food wastage. However, our model's explanatory power is somewhat lower compared to studies like those by Martínez-Martínez and colleagues, which suggest that other factors beyond supply chain management practices may also play crucial roles in predicting food insecurity [21]. The implication is that while targeted interventions in supply chain practices, such as enhancements in marketing and transportation, are vital, they should be complemented with broader strategies addressing additional dimensions of food security to achieve a more comprehensive impact. This indicates a need for integrated approaches that combine improved supply chain management with policies addressing other socio-economic and environmental factors affecting food security. Therefore, since 58% of the variation in food security remains unexplained, the likely factors that account for this

predicament might include; farm size and crop diversity (larger or diversified farms are more likely to achieve food sufficiency enabling them to withstand market shocks), the variability in weather patterns and gaps in the policy environment (poor coordination and corruption etc.) and finally, underfunding in public agricultural intervention programs in Uganda (operation wealth creation and parish development model). Therefore, since food prices and productivity are highly sensitive to rainfall patterns, this reduces the quality and quantity of food harvests while disrupting market access. This can undermine the competency of these programs thus negatively affecting food security outcomes.

5. Conclusion

This study highlights the critical role of optimizing agricultural supply chain management to address food insecurity among agro-based SMEs in Lira City. Our findings reveal significant pairwise correlations between food security and agricultural supply chain practices, particularly highlighting food marketing as a crucial factor. The linear regression analysis further identifies food transportation as a key predictor of food security, suggesting that improvements in these areas can substantially decelerate food insecurity. The higher impact of marketing compared to transportation in our study suggests a context-specific dynamic in Lira City. The model's ability to explain 41.6% of the variation in food security reflects the effectiveness of targeted supply chain strategies but also indicates the need for a more comprehensive approach that includes additional socio-economic and environmental considerations. Ultimately, optimizing both marketing and transportation practices is essential, but it should be integrated with broader strategies to address the multifaceted issue of food security fully.

6. Strengths and Limitations

The study employed well-designed self-administered questionnaires with a reliability coefficient of 0.759, ensuring that the data collection tools are dependable for capturing relevant information on agricultural supply chain practices and food security. The research identifies food marketing and transportation as the major predictors of food security, with a model explaining 41.6% of the variation in food security. This highlights the effectiveness of targeted supply chain management strategies and aligns with existing literature emphasizing the importance of these practices in enhancing food security.

However, the study's findings, particularly on the impact of food marketing compared to food transportation, may be specific to the context of Lira City, limiting the generalizability of the results to other regions or those with analogous supply chain conditions. Although the model accounts for 41.6 ≈ 42% of the variation in food security, a substantial portion remains unexplained, suggesting that other socio-economic, environmental, or policy factors play significant roles in determining the level of food security. Furthermore, the study's cross-sectional design offers a snapshot of current practices but does not capture changes over

time or the long-term impact of interventions. To this end, a longitudinal approach is proposed to provide deeper insights into the sustainability and evolving nature of supply chain improvements.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Nekmahmud, M. (2022) Food Consumption Behavior, Food Supply Chain Disruption, and Food Security Crisis during the COVID-19: The Mediating Effect of Food Price and Food Stress. *Journal of Foodservice Business Research*, **27**, 227-253. https://doi.org/10.1080/15378020.2022.2090802

[2] Abdul-Azeez, O., Ihechere, A.O. and Idemudia, C. (2024) SMEs as Catalysts for Economic Development: Navigating Challenges and Seizing Opportunities in Emerging Markets. *GSC Advanced Research and Reviews*, **19**, 325-335. https://doi.org/10.30574/gscarr.2024.19.3.0230

[3] Endris, E. and Kassegn, A. (2023) Analysis of Growth and Constraints of Agricultural Micro- and Small-Scale Enterprises in North Wollo Zone, Amhara Regional State, Ethiopia. *Cogent Social Sciences*, **9**, Article ID: 2197291. https://doi.org/10.1080/23311886.2023.2197291

[4] Albizua, A., Rahman, H.M.T., Corbera, E. and Pascual, U. (2024) Rural Livelihoods Displacement and Maladaptation Due to Large-Scale Modern Irrigation in Navarre, Spain. *Environmental Development*, **50**, Article ID: 100987. https://doi.org/10.1016/j.envdev.2024.100987

[5] Nguyen, V.A.T., Hoang, T.T., Mai, T.D., Lam, T.H. and Pham, H.N. (2023) The Factors Affecting Digital Transformation in Small and Medium Enterprises in Hanoi City. *Uncertain Supply Chain Management*, **11**, 1705-1718. https://doi.org/10.5267/j.uscm.2023.6.019

[6] Rauf, A.R., Inanka, A.P., Anwar, A. and Dewi, F. (2023) Smart Technology Adoption in Food Supply Chain to Tackle Climate Change: Practice in Small-Holder Farmers and SME. In: *Proceedings of the Business Innovation and Engineering Conference*, Atlantis Press International BV, 317-324. https://doi.org/10.2991/978-94-6463-144-9_31

[7] Kabunga, A. and Jesse, M.J. (2016) A Study on Emotional Intelligence among Psychotherapists in Northern Uganda. https://doi.org/10.46886/IJARP/v5-i1/2484

[8] Shinyekwa, I.M., Bulime, E.W., Luwedde, J., Birabwa Aliro, E., Kajumba, M.M. and Nattabi, A.K. (2023) Identifying Commodity-Specific Priority Investments in Selected Districts of Uganda. Food & Agriculture Org. https://openknowledge.fao.org/server/api/core/bitstreams/f007aac5-62cc-412c-b65b-f7ba780fc99a/content

[9] Macfadyen, S., Kalyebi, A., Mubiru, D.N. and Hulthen, A. (2024) FR2024-007. https://www.aciar.gov.au/sites/default/files/2024-04/crop-2022-186-final-report.pdf

[10] Kabunga, A., Kigongo, E., Udho, S., Auma, A.G., Okalo, P., Apili, B., *et al.* (2023) Chronic Stress and Coping Mechanisms among Nurses in Lango Sub-Region, Northern Uganda. *Nursing Open*, **10**, 6101-6107. https://doi.org/10.1002/nop2.1831

[11] Nicolétis, É., *et al.* (2019) Agroecological and Other Innovative Approaches for Sustainable Agriculture and Food Systems That Enhance Food Security and Nutrition. A Report by the High Level Panel of Experts on Food Security and Nutrition of the

Committee on World Food Security. https://openknowledge.fao.org/server/api/core/bitstreams/ff385e60-0693-40fe-9a6b-79bbef05202c/content

[12] Zimmerer, K.S. and de Haan, S. (2020) Informal Food Chains and Agrobiodiversity Need Strengthening—Not Weakening—to Address Food Security amidst the COVID-19 Crisis in South America. *Food Security*, **12**, 891-894. https://doi.org/10.1007/s12571-020-01088-x

[13] Mbow, C., *et al.* (2020) Food Security (No. GSFC-E-DAA-TN78913). IPCC. https://www.ipcc.ch/site/assets/uploads/sites/4/2020/06/IPCCJ7230-Land_SM5_200226.pdf

[14] Deaton, B.J. and Deaton, B.J. (2020) Food Security and Canada's Agricultural System Challenged by Covid-19. *Canadian Journal of Agricultural Economics*, **68**, 143-149. https://doi.org/10.1111/cjag.12227

[15] Smith, R., Kelly, B., Yeatman, H. and Boyland, E. (2019) Food Marketing Influences Children's Attitudes, Preferences and Consumption: A Systematic Critical Review. *Nutrients*, **11**, Article No. 875. https://doi.org/10.3390/nu11040875

[16] Rejeb, A., Rejeb, K. and Zailani, S. (2021) Big Data for Sustainable Agri-Food Supply Chains: A Review and Future Research Perspectives. *Journal of Data, Information and Management*, **3**, 167-182. https://doi.org/10.1007/s42488-021-00045-3

[17] Wakaabu, D. (2023) The Sensitivity of Food Security to Agricultural Input Subsidies in Uganda. *International Journal of Agricultural Science and Food Technology*, **9**, 10-15. https://doi.org/10.17352/2455-815x.000184

[18] Mutegi, J., Adolwa, I., Kiwia, A., Njoroge, S., Gitonga, A., Muthamia, J., *et al.* (2024) Agricultural Production and Food Security Implications of Covid-19 Disruption on Small-Scale Farmer Households: Lessons from Kenya. *World Development*, **173**, Article ID: 106405. https://doi.org/10.1016/j.worlddev.2023.106405

[19] Ricome, A. and Louhichi, K. (2023) Subsidizing Agricultural Inputs in Senegal: Comparative Analysis of Three Modes of Intervention Using a Farm Household Model.

[20] Khan, S.A.R., Razzaq, A., Yu, Z., Shah, A., Sharif, A. and Janjua, L. (2022) Disruption in Food Supply Chain and Undernourishment Challenges: An Empirical Study in the Context of Asian Countries. *Socio-Economic Planning Sciences*, **82**, Article ID: 101033. https://doi.org/10.1016/j.seps.2021.101033

[21] Martínez-Martínez, O.A., Gil-Vasquez, K. and Romero-González, M.B. (2023) Food Insecurity and Levels of Marginalization: Food Accessibility, Consumption and Concern in Mexico. *International Journal for Equity in Health*, **22**, Article No. 178. https://doi.org/10.1186/s12939-023-01977-5