The Role Of Information And Communication Technologies In Enhancing Agricultural Supply Chain Management: Evidence From Liberian Farmers Via Structural Equation Modeling

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Abstract

The purpose of this study is to examine the effects of Information and Communication Technology (ICT) tools—namely mobile phones, internet, radio, and televisions—on Supply Chain Management (SCM) among farmers in Liberia. This research examines the effects of ICT tools—mobile phones, internet, radio, and televisions—on supply chain performance among farmers in Liberia. Set against fragmented logistics, limited market linkages, and uneven ICT access in Liberia's agri-food sector, data were collected via electronic questionnaires from 147 respondents across five agricultural regions and analyzed using Structural Equation Modeling (SEM) in IBM SPSS AMOS. Results indicate that mobile phone-based information has significantly positive effects (p<0.05) on supply chain management. However, information derived from internet, television, and radio didn't show a statistically significant effect on overall supply chain management performance (p>0.05). The study supports the strategic role of ICTs in enhancing rural agribusiness by improving communication, operational efficiency, and market access. It contributes context-specific evidence from Liberia and proposes digital infrastructure improvements that can inform strategies in other emerging economies in sub-Saharan Africa. The study has some limitations as the five-county scope and cross-sectional design restrict external validity and causal inference. Future research should broaden and stratify samples, incorporate informal information channels (community centers, local markets, religious institutions, peer networks), and consider mixed-methods (quantitative + qualitative) or hybrid SEM+DCE approaches to strengthen mechanism tests and policy relevance. Policy recommendations include improving internet access and training through national institutions such as the Ministry of Agriculture, CARI, and NADP. Enhanced digital literacy and promotion of agricultural content through mobile platforms and targeted TV/radio programming could foster better ICT use among farmers.

Keywords: Information and Communication Technologies, Agricultural Supply Chain Management, Rural Development, Structural Equation Modeling, Liberia

1. INTRODUCTION

Agriculture is a part of the key economic basis of rural economies and a primary basis of global sustainability (Dumont et al., 2013). The new technologies such as the use of hybrid seeds, fertilizers, tractors, and agrochemicals have effectively increased productivity of substances as well as the area under cultivation (Aker, 2011). Such inventions also have a benefit on farmers in terms of agricultural input, yield and quality, yet they also affect food security for consumers and stakeholders and governmental institutions. Information and communication technologies (ICTs) are becoming a major element of agricultural diffusion in the developing world as these tools provide key facts on weather conditions and pest control, farm markets (Malhan & Rao, 2007; Makki & Somwaru, 2004). On the contrary, ICTs in the continent of Africa and Asia are slowly transforming agriculture, but the limited availability of infrastructure and digital literacy level remain to limit the potentials (Chhachhar et al., 2016; Gichamba & Lukandu, 2012). The mobile phones, television, radio, and internet (read devices and media channels) have become essential to spread agricultural information and in improving decision-making (Abbott & Coenen, 2008; Das et al., 2016; Knickel et al., 2009). Despite such difficulties, ICTs have allowed about 60% of the African farmers to gain access to relevant agricultural data (Mapiye et al., 2021; Deichmann et al., 2016), and mobile internet has become the most popular channel worldwide (Kiambi, 2018).

ICT adoption has enhanced food security and minimized the expenses in both advanced and emerged economies and increased the efficiency of operations (Xi et al., 2022; Ayim et al., 2022). ICTs also contribute to the development of the transparency and efficiency of the agri-food value chain through real-time communication and transaction costs, as well as increased farmer incomes (Serbulova et al., 2019; Jiang & Chen, 2020).While the initial investment in ICT infrastructure may be high, studies suggest that digital tools could increase agricultural output by as much as 65–85% (Sanyé-Mengual et al., 2015; Wielemaker et al., 2018).

Liberia, like many other sub-Saharan African countries, heavily relies on agriculture, especially forestry, for both employment and economic growth (Van Bockstael, 2014; Osabohienn et al., 2019). However, the country faces multiple constraints such as market instability, input costs, and infrastructure gaps (Bruinsma, 2003; Urama & Ozor, 2011). Over half of the farming population is illiterate, and nearly 43% lack access to internet or ICT devices (FAO & ITU, 2022), hindering the effective adoption of digital solutions. Yet ICTs offer a valuable opportunity to enhance supply chain management (SCM) through better coordination, timely information, and market connectivity (Wolfensohn & Lloyd, 2013; Lacour et al., 2018; Hobbs, 2020). In practice, Liberia's agricultural SCM faces persistent bottlenecks: smallholder-dominated production, long farm-to-market distances and seasonally unreliable rural roads, limited aggregation/warehousing and cold-chain capacity, weak coordination among value-chain actors, and significant post-harvest losses—especially in rice—while standards/traceability and digital payments remain unevenly adopted (World Bank, 2021; Ministry of Agriculture, 2021; Ministry of Agriculture, 2023; HELP Logistics, 2023; FAO, 2025). Recent programs (e.g., the World Bank's RETRAP) explicitly target these constraints via storage/marketing infrastructure, feeder-road upgrades, and platforms to strengthen value-chain coordination (World Bank, 2021).

Although SCM is essential for the agricultural sector—spanning production, transport, marketing, and customer service—its optimization in Liberia remains limited. Against this backdrop, this study aims to fill this gap by analyzing how different ICT tools affect supply chain performance among Liberian farmers. Focusing on mobile phones, internet, radio, and television, the study evaluates their effectiveness in improving agricultural SCM and offers insights for policymakers and development agencies to boost rural livelihoods and economic resilience.

ICTs are bringing a very fundamental change in supply chain management in the agricultural sector in Liberia. The current study aims to shed light on the impact of these technologies on the sector in Liberia with a discussion of the following questions:

i) What is the effect of information and communication technologies on SCM?
ii) What is the effect of internet-based agricultural information on SCM?
iii) What is the effect of mobile phone usage on SCM?
iv) What is the effect of agricultural content delivered through television on SCM?
v) What is the effect of radio-based agricultural information on SCM?

2. LITERATURE REVIEW

The integration of information and communication technologies in agriculture has become a central topic in development discourse, particularly due to its transformative potential in improving supply chain management. As noted by Aker (2011), ICT tools such as mobile phones and the internet have enabled farmers to access real-time information, make timely decisions, and reduce inefficiencies across different stages of agricultural production. In particular, these tools play a crucial role in mitigating the effects of information asymmetry—a persistent issue that often prevents farmers from accessing fair prices and up-to-date market information (Sanyé-Mengual et al., 2015).

Numerous studies emphasize how ICTs contribute to enhancing the transparency and coordination of agricultural supply chains. For example, Jiang and Chen (2020) argued that digital platforms can streamline interactions between producers, processors, and distributors by providing accurate forecasts, logistical updates, and transaction records. In the same vein, Serbulova et al. (2019) highlighted that ICTs could foster trust and reduce uncertainty by improving communication channels throughout the agri-food value chain. These efficiencies ultimately result in lower transaction costs and improved income for producers.

In sub-Saharan Africa, the practical application of ICTs in agriculture is growing, yet varies significantly across regions. According to Mapiye et al. (2021), countries which have invested in rural connectivity and farmer training programs report higher ICT utilization and better supply chain outcomes. However, Deichmann et al. (2016) cautioned those infrastructural limitations—such as unreliable electricity and

internet networks—remain critical barriers. These challenges are particularly pronounced in Liberia, where over half of the rural population lacks consistent access to digital communication tools (FAO & ITU, 2022).

Despite these limitations, the potential benefits of ICT adoption in agricultural SCM are evident. Ayim et al. (2022) demonstrated that mobile applications and radio broadcasts helped smallholder farmers in Ghana made more informed decisions about input purchases, harvest timing, and market selection. Similar results were observed in Kenya and Uganda, where interactive platforms allowed farmers to bypass traditional intermediaries and connect directly with buyers (Gichamba & Lukandu, 2012).

In the Liberian context, literature remains scarce but suggestive. Van Bockstael (2014) pointed out that Liberia's agriculture sector, particularly forestry, supports a majority of the population, yet suffers from low productivity and fragmented markets. ICTs could play a critical role in addressing these gaps by promoting better data collection, logistics coordination, and stakeholder communication. The study by Oyelami et. al. (2022) supports this view, showing that even modest digital interventions can improve supply chain efficiency in regions with similar socio-economic conditions.

In recent years, several studies from Nigeria have examined the role of information and communication technologies and social networks in agricultural development. Olaniyi et al. (2024) employed a descriptive survey and multinomial logistic regression to analyze ICT use among cassava value-chain actors in Anambra State, revealing that adoption was limited by unreliable power supply, weak network coverage, high costs, inadequate training facilities, and low awareness. Moreover, Ameh et al. (2025) investigated rice farmers in Ebonyi State using a questionnaire-based survey and found that peer-to-peer interactions, radio agricultural programs, and Farmer Field Schools were the most effective channels for disseminating climate-smart agriculture knowledge, while mobile phones played a moderate role; larger, more diverse, and more interactive networks enhanced adoption, and digital communication varied notably across age groups.

Taken together, the existing literature underscores the transformative potential of ICTs in agriculture, especially in optimizing supply chains. However, a nuanced understanding is required to assess the effectiveness of specific tools—such as mobile phones, television, radio, and the internet—in a localized context like Liberia. This study aims to contribute to this gap by providing empirical insights into how these technologies shape supply chain practices in Liberia's agriculture.

3. Research Model and Hypotheses Development

Guided by the set objectives of the study and the existing literature, a parsimonious model was built to examine how significantly information and communication technologies (ICT) impact the performance of supply chains in Liberia's agriculture sector. In this model, the four information channels that are questioned as independent variables are namely the internet, mobile phones, television, and the radio. The resultant measure is supply-chain management performance. This was meant to clarify how both channels increase the access to the market, optimize logistic services and improve decision-making process. Based on the objectives of the study, the model of the study is specified below.
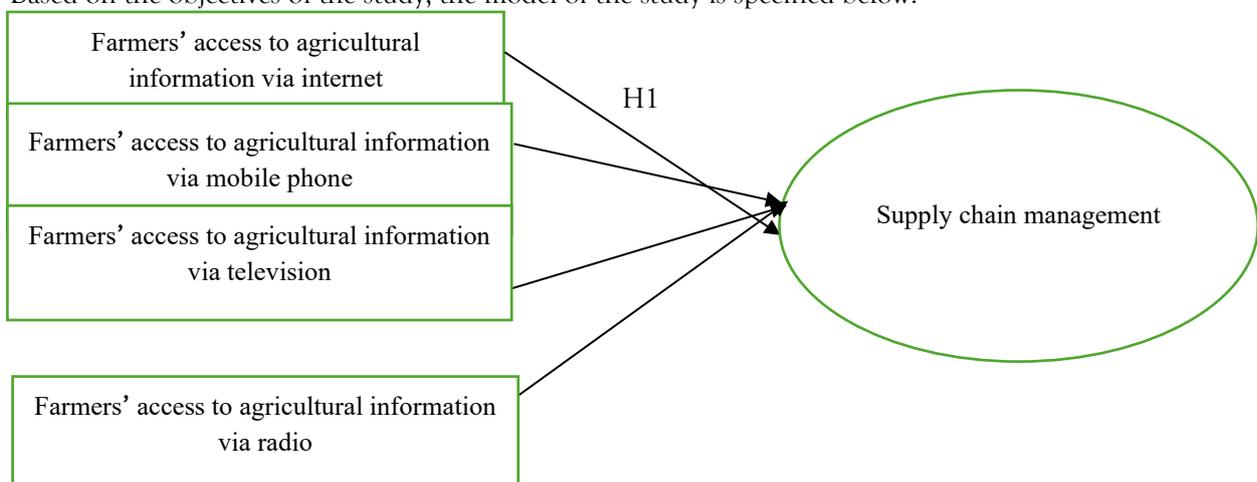

Figure 1. The Research Model

The current hypotheses provide the outline of the way in which separate ICT channels are expected to influence supply chain management among Liberian farmers:

H1: Information accessed by farmers via the internet has a significant effect on supply chain management.
H2: Information accessed by farmers via mobile phones has a significant effect on supply chain management.
H3: Information accessed by farmers via television has a significant effect on supply chain management.
H4: Information accessed by farmers via radio has a significant effect on supply chain management.

4. METHODOLOGY
4.1 Research Design
In this study, a quantitative research method with a deductive research design was used to determine the effects of the ICT tools on supply chain management (SCM) in the agricultural sector in Liberia. By employing a quantitative approach, it became possible to turn the responses of the participants into quantitative data, which could be further analyzed with the help of statistical methods. The deductive design allowed conducting the testing in a clear manner, and the general design allowed ensuring consistency and transparency in the course of the research (Migiro & Magangi, 2011; Bleiker et al., 2019).

4.2 Study Area and Sampling
This study investigated the farmers in five of the largest agricultural counties of Liberia, Lofa, Nimba, Bong, Grand Bassa, and Grand Cape Mount. Since the total number of the farm population is indeterminable, the Cochran formula based on a large undefined population was used to compute the optimal sample size where 95% was the expected confidence interval, 5% the margin of error, and 10% the expected population proportion. The formula is expressed as follows:

$$n = \frac{(p\,(1-p)*Z^2)}{e^2} \tag{1}$$

Where:
n = required sample size
Z= 95% confidence level (1.96)
p = the population proportion (p = 0.1)
e = margin of error (e = 0.05)
Substituting the values:

$$n = \frac{(0.1\,(1-0.1)*1.96^2)}{(0.05)^2} \tag{2}$$

$$n = 138 \tag{3}$$

4.3 Data Collection
The data were collected with the help of a structured online questionnaire containing three parts, namely, demographic information, use of ICT, and SCM practices. Questions connected to ICT were modified based on Chhachhar et al. (2014), and those addressed to SCM were used based on Aramyan (2007). A five-point Likert scale with responses of 1-Strongly Disagree to 5-Strongly Agree was used to rate (Mwang'amba, 2017). The Questionnaire was developed in "Google Forms" where the form was shared through WhatsApp and email, which is easily accessible to many people (Munthali et al., 2021; Wang et al., 2019).

4.4 Data Analysis
In the data analysis process, AMOS software was used to interpret survey data. The key analytical method included path analysis and confirmatory factor analysis (CFA), as well as the reliability, validity, and normality tests. Loadings above 0.70 were considered to show acceptable estimates of loading values. Hypotheses were tested using the results of regressions; p-values equal to less than 0.05 were considered statistically significant (Niati et al., 2021).

5. RESULTS
Research results were summarized in Table 1 with the socio-demographic details of the 147 farmers surveyed in Liberia. Just over half of the respondents were male (53.7%), while 46.3% were female. A little more than half (55.1%) had received formal education, while 44.9% had not. In terms of age, the largest group (36.7%) was between 18 and 30 years, followed by 31–45 years (30.6%), 46–60 years (23.1%), and those over 61 (9.5%). When asked about their farming experience, most had been in the field for 1–4 years (44.9%) or 5–15 years (38.1%). A smaller number had more than 15 years of experience. Regarding their type of farming, 44.2% focused on crops, 14.3% raised animals, another 14.3% were involved in both, 7.5% worked as consultants, and 19.7% indicated other roles.
Table 1. Socio-demographic characteristics of the farmers

		N	%
Gender	Male	79	53.7
	Female	68	46.3
Educational	No formal education	66	44.9
	Formal education	81	55.1
Age Group	18 -30 years	54	36.7
	31-45 years	45	30.6
	46-60 years	34	23.1
	61 years above	14	9.5
How long have you been in the farming business?	1-4 years	66	44.9
	5-15 years	56	38.1
	16-20 years	20	13.6
	More than 21 years	5	3.4
Which types of agriculture do you do?	Animals rearing	21	14.3
	Crops	65	44.2
	Consultant	11	7.5
	Both animal and crops	21	14.3
	Other	29	19.7

The normality tests conducted to check if the data followed a normal distribution which is a key requirement for using parametric methods like correlation and regression (Grech & Calleja, 2018). Skewness and kurtosis values were used to assess normality. While there is some debate over the acceptable range, literature suggests that for samples larger than 50, values between ±3.96 are generally considered acceptable (Jayaraman et al., 2018; Mishra et al., 2019). For smaller samples, a stricter range of ±1.96 is recommended (Matore & Khairani, 2020). The skewness values for the SCM items ranged from 1.661 to –0.727, and kurtosis from –0.071 to 3.599. In case of the radio items, the skewness was between -0.413 and 0.046, where kurtosis was between -1.323 – 1.029. TV items showed skewness between 0.033 and 0.319, and kurtosis from –1.357 to –1.123. In relation to the mobile phone items, the skewness values were within the range of 1.130 to 0.581, whereas the kurtosis values were within 0.607 to 0.479. Finally, internet items displayed skewness values between –0.174 and 0.179, and kurtosis ranging from –1.373 to –1.264. The skewness and kurtosis statistics obtained by the datasets are all within the range of +/- 3.96, and this makes them normally distributed. Thus, datasets can be considered to be appropriate for future analysis and exploration.

Table 2 shows the outcome of the convergent validity analysis and reliability. All factor loadings were above the value of 0.50 due to recommended George and Kumar (2014) and Ibrahim and Aljarah (2018) to guarantee appropriate item-level convergence, with the smallest being 0.644. Convergent validity has also been established because all constructs had an AVE value more than the AVE value cut-off recommended by Kwon et al. (2015), Safdari et al. (2020), and Centobelli et al. (2019). The internet construct, as an example, had a perfect AVE score of 0.632, and mobile phone usage, on the other hand, had 0.540. Furthermore, the values of Composite Reliability as well as Cronbach's Alpha exceeded 0.70 and were of high internal consistency for all constructs, as suggested by Sivaram et al. (2019) and Fitria and Linda (2019). The results obtained prove the reliability and the validity of the measures used in this study.

In addition, discriminant validity was assessed using the Fornell-Larcker criterion (Fornell & Larcker, 1981; Hair et al., 2021). As shown in Table 3, the square root of the AVE values (diagonal elements) for each construct was greater than the inter-construct correlations (off-diagonal elements), indicating adequate discriminant validity. For instance, the square root of AVE for the Internet construct was 0.810, which is higher than its correlations with mobile phone (0.742), television (0.499), and radio (0.572). These results support that the latent constructs are conceptually and statistically distinct.

Table 3 presents the goodness-of-fit statistics for the structural model. All indices meet or exceed recommended thresholds, confirming that the model fits the data well. Specifically, the χ^2/df value is within the acceptable range, and other key indicators such as GFI (0.934), CFI (0.961), TLI (0.921), RMSEA (0.031), and SRMR (0.042) all fall within ideal limits, indicating strong model adequacy (Bagozzi & Yi, 1988; Hu & Bentler, 1999).

Table 4 outlines the results of the hypothesis testing based on the structural model. Among the four hypothesized relationships, only the link between mobile phone use and supply chain management (H2) is statistically supported ($\beta = 0.564$, $p < 0.05$). The paths from Internet, television, and radio to supply chain management (H1, H3, and H4) are not statistically significant, indicating that these ICT tools did not show a meaningful direct effect on supply chain outcomes in this context (Figure 2).

Table 2. Reliability and convergent validity

Latent constructs	Items	Standardized factor loadings	CR	Cronbach AVE Alpha	Discriminant validity[a]		
					Internet Radio	Mobile phone	Television
Internet		0.910***		0.938	**0.810**		
	Internet5		0.889	0.632			
		0.796***					
	Internet4						
Mobile phone	Internet3	0.927***					
	Internet2	0.928***					
	Internet1	0.776***					
	Mobile5	0.679***	0.874	0.871	0.742	**0.795**	
	Mobile4	0.770***		0.540			
	Mobile3	0.754***					
	Mobile2	0.826***					
Television	Mobile1	0.787***	0.909	0.947	0.499	0.562	**0.735**
	Tv5	0.906***		0.656			
	Tv4	0.838***					
	Tv3	0.903***					
	Tv2	0.891***					
	Tv1	0.889***					
Radio	Radio5	0.807***	0.907	0.944	0.572	0.299	0.442
	Radio4	0.884***		0.649	**0.806**		
	Radio3	0.927***					
	Radio2	0.873***					
	Radio1	0.905***					
Supply chain management (SCM)	SCM16	0.772***	0.926	0.957			
	SCM15	0.763***		0.579			
	SCM14	0.704***					
	SCM13	0.767***					
	SCM12	0.852***					
	SCM11	0.786***					
	SCM10	0.707***					
	SCM9	0.839***					

SCM8	0.776***			
SCM7	0.644***			
SCM6	0.713***			
SCM5	0.770***			
SCM4	0.775***			
SCM3	0.817***			
SCM2	0.764***			
SCM1	0.759***			

Note: AVE (average variance explained), CR (composite reliability); * < 0.05, ** < 0.01, *** < 0.001

Table 3. Model fitness results

Fit indices	Recommended values	Obtained values
x^2/df	>1 and <5	4.715
GFI	≥0.90	0.934
RMSEA	≤0.80	0.031
CFI	≥0.90	0.961
TLI	≥0.90	0.921
SRMR	≤0.80	0.042

Source: Bagozzi and Yi (1988); Hu and Bentler (1999).

Table 4. Results of the hypothesized model

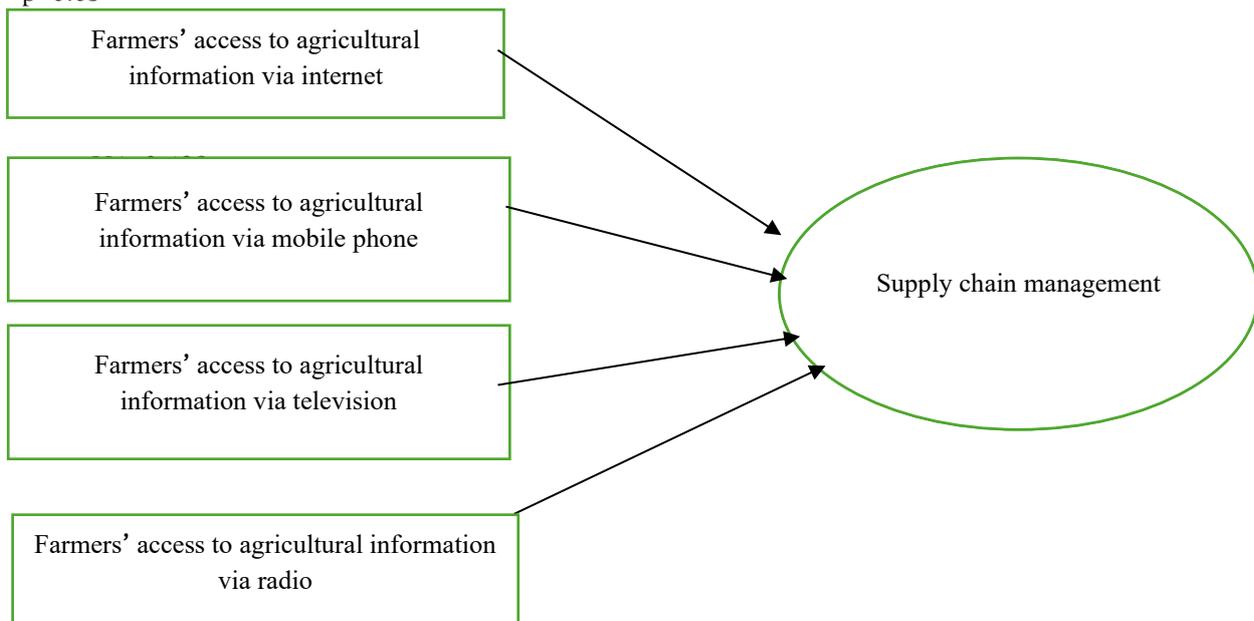| Hypothesis	Path	Standardized Coefficient (β)	p	Result
H1	Internet → SCM	0.087	0.429	Not Supported ✗
H2	Mobile phone → SCM	0.564	0.000*	Supported ✓
H3	Television → SCM	0.108	0.357	Not Supported ✗
H4	Radio → SCM	0.147	0.084	Not Supported ✗

*p<0.05

Figure 2. Results of the path analysis

6. DISCUSSION

This study explored the influence of various ICT tools—internet, mobile phones, television, and radio—on supply chain management (SCM) among farmers in Liberia. Of these tools, mobile phone use showed a statistically significant effect, highlighting its central role in agricultural communication.

Starting with internet use, although the results pointed to a positive relationship (β = 0.087), the effect was not statistically significant (p = 0.429). This suggests that while farmers may be accessing information online, its impact on practical aspects of SCM remains limited. A possible explanation lies in connectivity issues, digital skills, or the relevance of online content for rural farmers. Still, these findings echo previous work by Luthra et al. (2018), who noted a positive, though sometimes uneven, influence of digital tools in agriculture. Evidence from Anambra State points to persistent ICT constraints—unreliable power, weak coverage, high device and data costs, and limited training—which may explain the limited SCM impact of internet and broadcast channels in similar settings (Olaniyi et al., 2024).

By contrast, mobile phone use stood out as the strongest predictor of improved supply chain management (β = 0.564, p=0.000). This confirms that mobile communication plays a crucial role in helping farmers plan, access markets, and manage logistics. This aligns with the findings of Mittal et al. (2010), who observed that mobile phones helped reduce inefficiencies in the agricultural supply chain. In addition, Partey et al. (2020) reported how rural women in Ghana relied on mobile phones to access weather data and crop advice—often making up for a lack of physical extension services. The Liberian context may reflect similar patterns, especially given infrastructure challenges in rural areas. Complementary evidence from Ebonyi State indicates that mobiles are only moderately effective for CSA diffusion, while peer-to-peer networks and radio programmes often perform better—underscoring the value of integrating interpersonal channels (Ameh et al., 2025).

The role of television appeared more modest. Although the relationship was again positive (β = 0.108), it was not significant (p = 0.357). While earlier research like that of Rao (2007) emphasized the potential of TV for delivering agricultural advice, practical issues such as access to electricity or timing of programs might reduce its impact. Before the widespread adoption of the internet, television served as a key medium for agricultural extension in various developing countries (van den Ban & Hawkins, 1996; Leeuwis, 2004). Farmers may also prefer more interactive or immediate communication channels.

Radio followed a similar trend. It showed a small, positive effect on SCM (β = 0.147), but this was not statistically significant (p = 0.084). Despite this, radio remains widely used and often trusted among rural populations. Studies by Ndlovu et al. (2021) and Adolwa et al. (2018) suggest that radio content can influence farm decisions, especially in contexts where other technologies are less available. Historically, radio has played a critical role in agricultural information dissemination, particularly in regions with limited infrastructure and literacy (Chapman et al., 2003; Farm Radio International, 2011). Other research (Drafor, 2016; Somashekhar et al., 2016) further shows how radio broadcasts can support market access and decision-making, though the effect may not always be directly measurable. In line with this, evidence from Ebonyi State shows radio agricultural programmes and Farmer Field Schools ranking among the most effective channels, with peer networks at the top, implying that broadcast media may shape intermediate behaviours without always producing direct, contemporaneous effects on SCM indices (Ameh et al., 2025).

Taken together, the results suggest that while all four ICT tools have some relevance, mobile phones are currently the most effective in improving agricultural supply chains in Liberia. The findings point to a need for strengthening mobile-based services while also investing in content quality and accessibility for other platforms like radio and television.

7. CONCLUSIONS

This study supports the emerging role of Information and Communication Technologies (ICTs) in the modernization of Liberia's agriculture. Before the use of ICT, farmers were more or less dependent on seasonal farming, manual weeding and occasional use of fertilizers or pesticides. As a result of ICT tools, farmers in Liberia now have access to the relevant and up-to-date agricultural information, a factor that is likely to have a great implication in supply chain management (SCM). To measure these implications, the present study examined the role of four ICT channels, namely the internet, radio, television, and mobile phones, on the performance of supply chains in Liberian farmers. Because the total number of farmers

was unknown, Cochran's formula was used to determine a minimum sample of 138. Ultimately, 147 valid responses were collected using an electronic questionnaire distributed via a snowball sampling technique. Convergent and discriminant validity tests confirmed the robustness of the constructs, and path analysis in AMOS software was used to evaluate the relationships between variables. The results revealed that, while correlation analysis showed generally positive relationships between all ICT tools and SCM, only mobile phone usage had a statistically significant positive effect in the path analysis. This suggests that mobile phones are currently the most effective ICT channel in supporting agricultural SCM in Liberia. Mobile communication proved especially relevant across various agricultural activities including crop production, animal rearing, and consultancy.

7.1 Recommendations and Policy Implications

The study established that the effect of the information that the farmers were getting as a result of the use of the internet was ineffective in the supply chain management. The Liberian government ought to make the farmers utilize the internet to access information on their agricultural activities. Agencies or departments (like the Ministry of Agriculture, CARI, NADP) which educate farmers on how to utilize the internet to acquire information on agricultural practices should be established by the government. The government must further have the telecommunications services in the country offer the farmers with high-speed internet. Slow connection to the internet by farmers puts them off using the internet as a source of information access. The extension officers in the agricultural sector can also enlighten the farmers about the necessity in acquiring information on the internet about the agricultural activities as the internet is factual and reliable source of information. Liberia agricultural sector must initiate various types of information technology through stakeholders and investors (Borah et al., 2020).

The national and other television stations in Liberia should have more TV shows on best farming practices through panel discussions or by inviting agricultural specialists to educate the farmers on the best practices. Anytime there is a panel discussion on agricultural practices or a show on agricultural practices, the farmers should be well informed before the program, or the program should be promoted using local information centers in the country.

In addition to traditional TV or radio programs, investing in mobile phones and social media may offer a more effective way to reach farmers. These platforms are widely used and allow faster interactive information sharing. Governments should promote reliable agricultural content through these channels and support their use in rural areas.

7.2 Limitations and Future Research

This study uses a non-probability, online sample from five counties, which limits external validity and may entail selection bias; all measures are self-reported and cross-sectional, constraining causal inference, while objective SCM indicators and subgroup (measurement invariance) checks were not included. Future work should broaden and stratify samples across additional counties and farmer groups and consider incorporating informal information channels (community centers, local markets, religious institutions, peer networks), as well as mixed-methods (qualitative + quantitative) and hybrid frameworks (e.g., Structural Equation Modeling + Discrete Choice Experiment) to strengthen evidence.

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