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The Influence of Green Logistics and Food Distribution Strategy on Post-Harvest Loss Reduction

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Abstract

Post-harvest losses are a significant issue confronting farmers in Ghana, which requires the proper intervention to help deal with the situation and improve the social and economic life of the farmers. The farms in Ghana are primarily located in the hinterlands, making it very difficult to get the agri-food stuff transported to the marketplaces or points of a process, usually leading to substantial post-harvest losses due to the short life of most of the foodstuff. Therefore, it is imperative to devise the right food distribution strategy to reduce post-harvest loss. The study examined the influence of green logistics and food distribution strategy on post-harvest loss reduction. Structural equation modelling was used to analyse 238 useable data from the extension officers, freight forwarding/logistics companies, and local food distributing agencies in Ghana. We found support for all the two hypotheses. We then offer both theoretical and managerial implications.

Keywords: *Green Logistics, Food Distribution Strategy, Post-Harvest Loss Reduction***,** *Supply Chain Collaboration, Organizational Resources, Supply Chain Performance*

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1.0 INTRODUCTION

The global population is presumed to reach 9.70 billion and the demand for food is prognosticated to rise by 59.0 to 98.0 per cent by the year 2050 (Elferink and Schierhorn, 2016; Tsolakis et al., 2014). It may be noted that there is significant pressure on food supply chains to ensure the availability of food and fulfilling its demand. The food distribution companies are to ensure that foodstuff is picked promptly and delivered to areas needed at the right time in quantity and quality. Statistics on post-harvest losses in Ghana, Ghana lost about 318,514 tonnes of maize annually to post-harvest losses and this makes up to 18% of the total stock of maize produced in Ghana (Fahimnia, Sarkis and Davarni, 2015).

Globally, it is estimated that approximately one-third (i.e. around 1.3 billion tonnes per year) of the food produced annually for human consumption is lost or wasted globally (Gustavsson et al., 2017). Furthermore, more than 40 percent of the food losses occur at the post-harvest or processing level in many developing economies (Gustavsson

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et al., 2017). Consumer awareness about the impact of food production, processing, and distribution on health has increased and there is the need for integration of green logistics practices into the supply chain management of agri-food products (Fahimnia, Sarkis, and Davarni, 2015).

The concept of green logistics has attracted wide interest that every country is in the state of promoting it to reduce negative environmental impact. Rodrigue, Slack, and Comtois (2011) defined green logistics as the practices and strategies of the supply chain management which aim to reduce environmental effects and energy consumption caused by cargo handling, waste handling, packaging, and transportation. The government, industries, and non-governmental organizations (NGOs) are promoting eco-friendly products for protecting the environment. Also, the protection of the environment is ethical itself. The industries are planning their environmental programs by incorporating green logistics practices to play their role to avoid long-term damage to the planet and are interested in identifying and evaluating the drivers or performance indicators or critical success factors accountable for the green logistics management implementation. It may be noted that the organizational environmental commitment provides a competitive advantage and also ensures sustainable development. Green logistics practices also ensure waste reduction, energy consumption reduction, environmental degradation reduction and improves the overall supply chains performance (Choudhury et al., 2018; Gardas and Narkhede, 2013; Gardas et al., 2015).

The agri-food supply chain management involves a series of activities and processes during the flow of the food products from farm to fork (Dinu, 2016; Shukla and Jharkharia, 2013). The factors affecting new agri-food supply chains such as globalization, technological innovations, trade agreements, consumer awareness, and environmental concerns, raise serious economic, environmental, and social concerns (Shukla and Jharkharia, 2013). There have been several studies on green logistics. Khan, Yu, and Nathaniel (2020) analyzed the relationship between green logistics operations national economic and environmental indicators. The findings of their study indicated that green logistics has a positive and statistically significant relationship with foreign direct investment inflows, renewable energy consumption, and energy demand. On the other hand, there is a significant negative correlation between CO2 emissions and green logistics. Reyes et al. (2016) considered lean and green in the transport and logistics sector. The results indicate that deploying the green and lean paradigms is an effective approach to improve both operational efficiency and environmental performance of road transport operations.

Ramanathan et al. (2014) suggest the use of collaboration to reduce CO2e. There is significant evidence in the literature on attempts made in reducing the CO2e associated with the food supply chain in the developed countries but less attention is given to those in the developing countries specifically Africa (Oglethorpe and Heron, 2013; Ramanathan et al., 2014). There is the need to look at the influence of green logistics on post-harvest loss reduction and therefore this study sought to analyze the influence of green logistics on post-harvest loss reduction. Caixeta-Filho (2017) investigated losses in the transportation of fruits and vegetables and results indicate that implementation of new technological options for diminishing losses would first benefit the consumer at the wholesale market.

Parmar, Hensel, and Sturn (2017) considered post-harvest handling practices and associated food losses and limitations in the sweet potato value chain of Southern Ethiopia, and results show that harvest and handling at farm level and shelf-life issues at distribution were identified as vulnerable hot-spots of the sweet potato food losses. Wu (2016) empirically analyzed factors influencing rice harvest losses based in China.

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Gunasekera (2017) further investigated post-harvest loss reduction in Asia-Pacific developing economies and the results indicate that limited access to vital farm inputs and credit, poor infrastructure, and lack of technical and market information are some of the critical challenges confronting many small farmers in developing economies and suggested that further work is urgently required to collect more up-to-date on food losses along the food supply chain, including post-harvest losses in many economies across the world. Shai, Zhang, and Qu (2016) assessed optimizing distribution strategies for perishable foods.

Wang, Yang, and Hou (2019) investigated risk management in perishable food distribution operations. None of the studies considered the influence of food distribution strategy on post-harvest loss reduction. This necessitated this study to examine the influence of food distribution strategy on post-harvest loss reduction.
The rest of the paper is organized as follows. The literature review leads to the theoretical model and hypothesis development; this is followed by methodology, presentation of results, discussion, and conclusion.

2.0 THEORETICAL REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Green logistics and post-harvest loss reduction

Currently, there is a global and interconnected system in food industry that has various complex relationships for the logistics management of food products, because of consumers concerns related to food safety scandals and globalization of food production (Trienekens and Zuurbier, 2008). Also, food security is still a considerable problem due to the growing population which is projected to reach 9Billion by 2050 (Global Food Security, 2012) that necessitated emphasis on the reduction of food waste. In food supply chains, reaching the customer (higher revenue) at the right level of quantity, with the appropriate remaining shelf life and with the proper routing through the chain are crucial factors for solidifying and maintaining competitive advantage (Ahumada and Villalobos, 2011).

However, this claims need to be extended when sustainability concerns are involved in decision making. Thereby, the ultimate goal in a sustainable food supply chain is ensuring customer satisfaction with the most efficient/effective way possible while being aware of the impacts of operations on the environment and society. In view of this, the consideration is relation to cover the core issues in sustainable food logistics management in three groups: cost reduction and improved responsiveness, improved food quality and a reduction of food waste and improved sustainability and transparency.

Moreover, some scholars believe that the use of advanced Internet of Things (IoT) and quality vehicles can reduce food safety risks during the distribution process (Pal and Kant, 2018; Tsang et al., 2018). In addition, the optimization of the distribution path is also the focus of scholars. Risk management is receiving increasing attention, especially in fresh food supply chain operations. Food safety risks have also been quantified in many ways from different perspectives and scholars have expressed different opinions on how to control risks. The environmental concern is a critical issue to be considered in transporting or dealing with food supply chain therefore inculcating green logistics in transporting of agri-food is quite imperative to reduce the negative environmental impact. Based on the logical arguments, it is proposed that:

H1: Green logistics has a positive influence on post-harvest loss reduction

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2.2 Food Distribution Strategy and Post-Harvest Reduction

Food chain logistics comprises organizations that are responsible for the production and distribution of vegetable or animal-based products. These products can be fresh (such as vegetables, flowers and fruit) or processed (such as portioned meats, snacks, desserts and canned food products). In general, these chains may comprise growers, auctions, wholesalers, importers and exporters, retailers and specialty shops and their input and service suppliers. In fresh supply chains, the main processes are the handling, conditioned storing, packing, transportation and especially trading of goods.

Basically, these supply chain steps leave the intrinsic characteristics of the product grown or produced in the countryside untouched. In processed food supply chains, agricultural products are used as raw materials for producing consumer products with higher added value. In most cases, conservation and conditioning processes extend the shelf life of the agricultural and consumer products. Bourlakis and Weightman (2004); van der Vorst, Tromp and van der Zee (2009) discuss a list of specific process and product chains that impact the (re) design process, including the following: Seasonality in production, requiring global sourcing; variable process yields in quantity and quality due to biological variations, seasonality and random factors connected with weather, pests and other biological hazards; keeping quality constraints for raw materials, intermediates and finished products and quality decay while products pass through the supply chain.

As a result, there is a chance of product shrinkage and stock-outs in retail outlets when products' best-before dates have passed and/or product quality level has declined too much; requirement for conditioned transportation and storage means (e.g. cooling) and necessity for lot traceability of work in process due to quality and environmental requirements and product responsibility. Due to these specific characteristics of food products, it is vital for industrial producers to contract suppliers to guarantee the supply of raw materials in terms of the right volume, quality, place and time. Actors in food chain logistics understand that products are subject to quality decay as they traverse the supply chain, while the degree and speed of decay may be influenced by environmental conditions.

Nest to this, companies operating in the food sector are confronted with (i) accelerating environmental and social impact assessment policies and standards (such as the risk inventory Hazard Analysis and Critical Control Points, the British Retail Consortium (BRC) Global Standards programme and the ISO 22000 standard on food safety management systems); (ii) the emerging concept of extended producer responsibility supporting the shift from 'seed to meat' ''cradle to cradle" the philosophy that all used materials after life can be useful again in another product and (iii) increasing preoccupation in society to live well without compromising future generation's rights to prosper. Consequently, it is important that actors in food chains obtain a licence to produce and deliver that is society has to accept the way they produce and deliver goods. The argument raised is establishing that:

H2: food distribution has a positive and significant influence on post-harvest loss reduction

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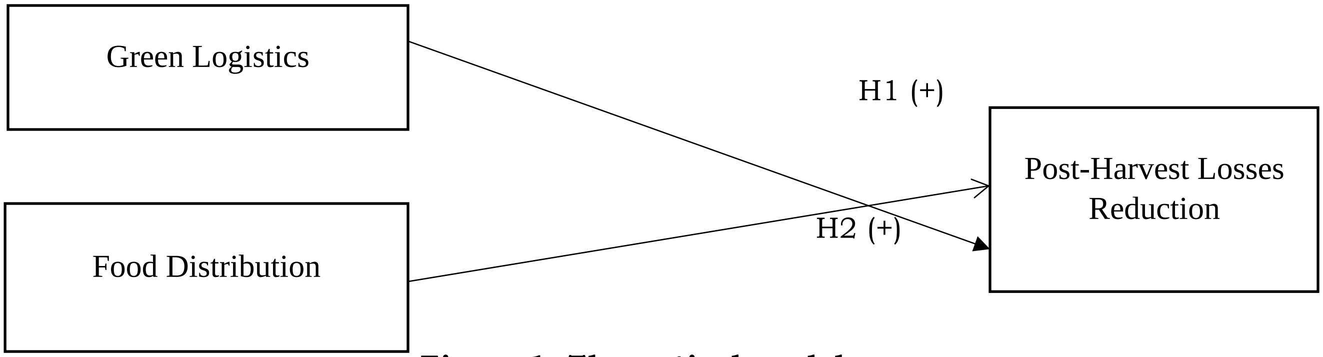

Figure 1: Theoretical model

3.0 METHODOLOGY

To test for the hypotheses, this study utilized data from extension officers and farmers in the agriculture industry of Ghana, the management in the freight forwarding companies and the local food distribution companies. A total of 300 questionnaires were administered to the extension officers and farmers, freight forwarding companies and local food distributors. The final analysis was based on 238 response rate representing 79%. A 8-item scale that was used to measure post-harvest loss reduction was adopted from (Gunasekera, Parsons and Smith, 2015). The packaging of post-harvest loss reduction comprised of 3 items, storage of post-harvest loss reduction comprised of 2 items and transportation of post-harvest loss reduction comprised of 3 items. 16 items used to measure green logistics was adopted from (Pazirandeh and Jafari, 2013).

Environmental operations of green logistics comprised of 4 items, operation positive economic of green logistics comprised of 3 items, operational negative economic of green logistics comprised of 3 items, operational green of green logistics comprised of 2 items, collaboration customers/suppliers for green logistics of green logistics comprised of 2 items and green product design of green logistics comprised of 2 items. 5 items used to measure food distribution strategy was adopted from (Chandrasekaran and Ranganathan, 2017). Flexibility of food distribution strategy comprised of all the 5 items.

The study analyzed the data based on Structural Equation Modeling using Analysis of Moment Structures (AMOS-SEM). AMOS-SEM is distinct analytical software that makes it possible to analyze complex models with many constructs, indicator variables and structure paths. The AMOS-SEM comprises of two basic assessments: the measurement model and structural model. The study also checks the data validity and reliability tests.

4.0 DATA ANALYSIS

4.1 Results and Discussion

Table 1 Respondents Demographics

Profile	Characteristics	Frequency	Percentage
Gender	Male	129	54.2
	Female	109	45.8
	Total	238	100
Age			
	25-30 years	11	4.6
	31-35 years	55	23.1

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	36-40 years	92	38.7
	41-45 years	63	26.5
	51-55 years	17	7.1
	56 years and above	0	0
	Total	238	100
Marital status	Married	163	68.5
	Single	75	31.5
	Total	238	100
Educational background	Diploma	40	16.8
	Higher National Diploma	24	10.1
	Master's Degree	81	34.0
	First Degree	84	35.3
	Doctorate Degree	9	3.8
	Total	238	100.0
Years of experience	1-5 years	26	10.9
	6-10 years	78	32.8
	11-15 years	84	35.3
	16 years and above	50	21.0
	Total	238	100.0

Source: Field Data, 2021

4.1 Characteristics of Respondents

The table 4.1 presents the results on the respondents' backgrounds. 129 of the respondents were male representing 54.2% percent whereas 109 of the respondents were female representing 45.8%. The age of the respondents, 4.6% were between the ages of 25-30 years. 23.1% were between the age 31-35 years. 38.7% were between the ages of 36-40 years. 26.5% were between the age of 41-45 years. 7.1% of the respondents were between age of 51-55 years and none of the respondents was 56 years and above. In terms of marital respondents' status, 68.5% were married but 31.5% percent were not married. Concerning the educational background, 16.8% were diploma graduates, 10.1% were Higher National Diploma graduates, 34.0% were second degree graduates, 35.3% first degree graduates and 3.8% were doctorate degree graduates.
Their years of experience, 10.9% have acquired 1-5 five years working experience. 32.8% have 6-10 years' working experience. 35.3% have about 11-15 years working experience whereas 21.0% have about 16 years of working experience.

4.2 Measurement Model Results

Reliability is said to be particular important when latent variables are calculated from underlying item scales. Since these scales consist of a group of interrelated items designed to measure underlying constructs, it is important to establish whether the same set of items would extract the same responses if they were re-administered to the same sample group on more than one occasion. Variables derived from test instruments are only said to be reliable when it is clear that they elicit stable responses over multiple measurements of the instrument's surveys (Bhattacherjee, 2012). Cronbach's Alpha coefficient was used as a measure of internal consistency-reliability of the scale used in this study. Cronbach's Alpha is a measure of internal reliability for multi-item summated rating scales. Its values range 0 and 1, where the higher the score, the more reliable the scale. A coefficient reliability of 0.70 or higher indicated that the instrument used is reliable (Cronbach, 2004). For measure of sampling adequacy or whether data

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could factor well, Hair et al (2010); pallant (2007) suggested that if the Kaiser-Meyer-Olkin (KMO) is greater than 0.6 then factorability of the correlation matrix is assumed. The table 4.2 presents the results on the reliability and the validity of the constructs.

Table 2 Reliability and Validity Results

Variable	Loadings	KMO	Cronbach's Alpha
Green Logistics		.685	.785
ENOP01	.603		
ENOP02	.824		
ENOP03	.719		
ENOP04	.684		
OPEC01	.832		
OPEC02	.780		
OPEC03	.433		
ONEC01	.726		
ONEC02	.585		
ONEC03	.717		
OPG01	.647		
OPG02	.778		
CCGL01	.603		
CCGL02	.558		
GDP01	.746		
GDP02	.781		
Post-Harvest Losses		.709	.827
PCK01	.727		
PCK02	.719		
PCK03	.686		
ST01	.816		
ST02	.775		
TRSP01	.740		
TRSP02	.678		
TRSP03	.707		
Food Distribution		.851	.880
FD01	.768		
FD02	.820		
FD03	.860		
FD04	.910		
FD05	.764		

The Cronbach's Alpha is the basic measure of the reliability which indicates relative reliability of each factor as a scale. The sufficient value of Cronbach's Alpha is 0.6 (Nunnally, 1967). In order to improve the reliability, items with values less than 0.6 were eliminated (Rahman, 2001). All of the reliability coefficient values in this study are above 0.7 which show that each factor is sufficiently reliable measure. The suitability of the sample was tested by applying KMO measure. The KMO values are also generally acceptable because they are above 0.6 proposed by Hair et al. (2010). The confirmatory factor analysis is the determination of factor loading of each item and factors that develop scale. Initially, the researchers provided three factor that involve 30 items, but

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based on the threshold of 0.7, 23 valid items were selected to perform the convergent and discriminant validity. Thus during the validation process, items with factor loading less 0.7 were subsequently removed.

4.3 Construct Validity

According to Furr & Bacharach (2003) construct validity refers to an extent to which the measurement score reflects latent construct to be measured. Meanwhile, Hair et al. (2019) define construct validity as an approach to make sure that a set of variables represents the theoretical latent construct which is being measured. Fornell & Larcker (1998); Agarwal (2013) noted that construct validity of confirmatory factor analysis includes two main tests, namely convergent validity test and discriminant validity test.

Campbell & Fiske (1959) describe that convergent and discriminant validity are essential requirements on every instrument development to obtain accountable data psychometrically. Accordingly, this research reported both convergent and discriminant validity.

Table 3 Convergent and Discriminant validity

Variables	**AVE**	**Discriminant Validity**
Green Logistics	0.59	0.77
Post-Harvest Loss Reduction	0.54	0.73
Food Distribution Strategy	0.68	0.83

Igbaria et al. (1997) demonstrated that a variable is of good fit if the latent variable shows the factor loading of > 0.50. Haire et al. (2019) recommended that an Average Variance Extracted (AVE) as convergent validity measure since AVE could explain the degree to which items are shared between the construct in Structural Equation Modeling (SEM) where AVE 0.5 or more are acceptable as convergent validity. The scale development in this study involved three construct namely Green Logistics, Post-Harvest Loss Reduction and Food Distribution Strategy.

The results shown that the AVE values for the three constructs respectively were 0.59; 0.54 and 0.68. As all the constructs were within and above the threshold of > 0.50, it is concluded that they could measure the latent variables. Hence, they fulfilled the convergent validity criteria. Haire et al. (2019) stated that discriminant validity could be established by correlating one construct to another. If the correlation value of both constructs is lower than 0.85, it means that the discriminant validity exists. Besides, Furnell and Larker (1981) argue that discriminant validity exists if latent variable shows more variance on related indicator variable rather than share with other construct in the same model.

Table 4 correlation among the constructs

Constructs	FDS	PHLR	GL
FDS	1	.713**	.373**
PHLR	.713**	1	.416**
GL	.373**	.416**	1

FD= Food Distribution Strategy, PHLR= Post-Harvest Loss Reduction, GL= Green Logistics.

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The results presented in the table 4.4 indicate that the correlation value of both constructs is lower than 0.85, it means that the discriminant validity exists according to Haire et al. (2019). Also, the correlation value of Food Distribution Strategy and Post-Harvest Loss Reduction Discriminant Validity (DV) of: 0.713, Food Distribution Strategy and Green Logistics Discriminant Validity (DV) of 0.373, Green Logistics and Post-Harvest loss reduction Discriminant Validity (DV) of 0.416 were greater than the inter-construct correlation therefore the three constructs had fulfilled the criteria of discriminant validity.

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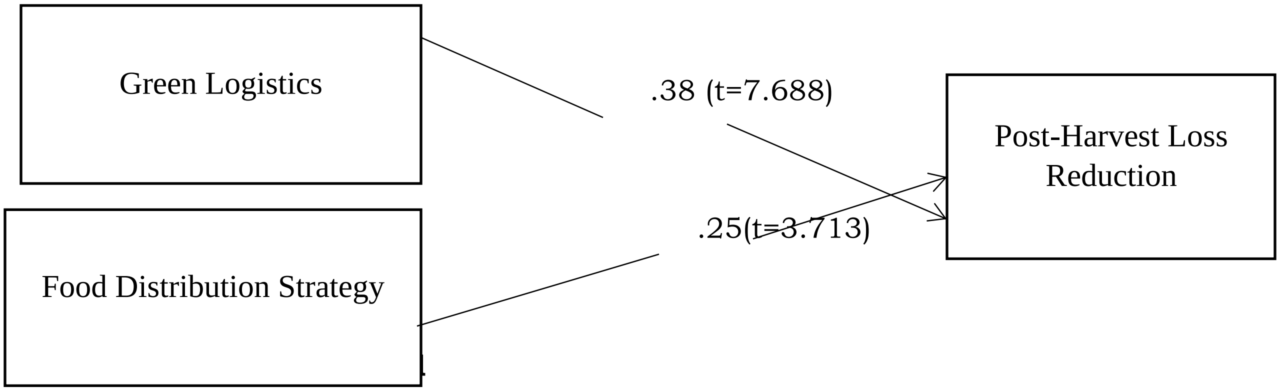

The study first considered the influence of green logistics on post-harvest loss reduction and the R^2 indicate that green logistics can overall influence post-harvest loss reduction of about 38%. This explains that an increase in green logistics activities is extremely important for organizations to achieve positive results on post-harvest loss reduction. Therefore, organizations or nations seeking to improve on post-harvest loss reduction must think of green logistics. The next hypothesis tested was the influence of food distribution strategy on post-harvest loss reduction and the statistical R^2 results show that food distribution strategy can overall influence post-harvest loss reduction of about 25%. This also explains that effective and efficient food distribution can help to reduce post-harvest loss reduction of about 25%.

Table 5 Summary of results

Hypothesis	Relationship	T value	Beta value	P value	Test results
H1	GL ---> PHLR	7.688	.376	0.000	Supported
H2	FDS--- >PHLR	3.713	.249	0.000	Supported

GL= Green Logistics, PHLR= Post-Harvest Loss Reduction, FDS= Food Distribution Strategy.

From table 5, all the hypothesized paths were supported. The results of the analysis revealed green logistics had a positive and significant influence on post-harvest loss reduction (β=.376; t=7.688; $p < .000$). This indicates that green logistics effective implementation is a key to reducing or combating post-harvest loss reduction. This explains the appropriate packaging, transporting, and vehicles with the right temperature for the agri-food stuff to remain and maintain their freshness. Green logistics is truly a good predictor of achieving post-harvest loss reduction because green logistics aims to reduce waste handling, packaging, and transportation which are also major factors in reducing post-harvest loss reduction.

This then establishes that the ability to reduce waste handling by the logistics companies will go a long way to reduce post-harvest loss. Again, packaging plays a pivotal role in achieving post-harvest loss reduction therefore a good effort of ensuring the right packaging is a good step to reduce post-harvest loss. The right packaging of agri-food stuff is then the right approach to reduce post-harvest loss because suitable packaging helps to avoid damage to fruits and vegetables and also helps to maintain the freshness of the agri-food stuff. Freight forwarders/logistics companies thinking about green logistics are extremely important because it is the major factor in achieving post-harvest loss reduction.

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Moreover, ensuring cold storage or right temperature during transportation as applicable to particular agri-food stuff and relevant to the distance from collection/sorting centers to markets or distribution centers or consumers is extremely important to reduce post-harvest loss. The transporters' knowledge of handling the food products in question is highly important to help reduce post-harvest loss. The agri-food stuff in transit is to be monitored to help maintain the right moisture content to keep the freshness hence green logistics have a positive and significant influence on post-harvest loss reduction.

The findings also indicate that food distribution strategy had a positive and significant influence on post-harvest loss reduction (β= .249; t= 3.713; $p < .000$). The ability of the actors to identify the needed market of the agri-food stuff is extremely important to achieving post-harvest loss reduction. Also, the right distribution strategy is an important key because of the different shelf life of the agri-food. Food distribution is one of the factors contributing to the post-harvest loss. This means that adopting the right distribution strategy is vital in dealing with post-harvest loss, therefore, an effective and efficient distribution strategy is a good direction to achieve post-harvest loss reduction. The farms in Ghana are largely located in the hinterlands and therefore the speed to distribute the agri-food along the chain is quite crucial. A delay to convey the agri-food right after harvesting from the villages to market places and the processing factories will lead to post-harvest loss. The right time of conveying the agri-food to their point of consumption and processing is highly important to achieve post-harvest loss reduction.

Sometimes, there is the need for the logistics companies to be able to send the quantity of food produced from the farmers to agents, auctioneers, whole-sellers, retail stores, and customers. The agri-food is produced at one point and needs to be transported to areas that are needed by maintaining the quality nature of the foodstuff. The appropriate distribution strategy is one of the ways to help send the agri-food to the consumers in the right quality or form. Especially, the fruit and vegetable shelf life demands an agile distribution approach to help the actors along the chain to reduce post-harvest loss. Naturally, in Ghana, some crops are well grown in the northern part but the same crops cannot be cultivated in the southern part of Ghana and vice versa. There is a need to have a distribution strategy in place to help spot markets with high demand and respond to the demand by delivering the right quantity to help achieve post-harvest loss reduction.

5.0 CONCLUSION

Green logistics has been discovered as a good predictor of achieving post-harvest loss reduction. This study confirmed that green logistics is a good predictor of achieving post-harvest loss reduction because post-harvest loss is drastically reduced if the right packaging, storage, and distribution are ensured. Actors' ability to apply the right packaging tools, appropriate storage temperature, and timely distribution to places needed are quite critical for reducing post-harvest loss. Consumers' awareness of food hygiene and safety is advocating for safe handling of agri-food products and this is pushing transporters to adhere to green logistics ethics.

The transporters are now conscious of dangerous products usage and comply with customers' and all stakeholders' directives to deliver and promote eco-friendly products. The study also confirmed that food distribution strategy is a strong predictor of achieving post-harvest loss reduction.

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Thus, the fair knowledge of the actors knowing when to pick up the agri-food products from the farmers and send them to where they are needed is important. Hence, the actors' ability to send the agri-food products to areas that are in dire need of the agri-food products is to be considered. Most foodstuffs perished during transportation because the transporters cover a long distance before getting to the final destination.

Most fresh products rot before they are also being picked up by the transporters. It is therefore very imperative to have the right distribution strategy in place to help reduce post-harvest loss reduction. This explains why the right distribution strategy is a good predictor of achieving post-harvest loss reduction.

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