

# Key Performance Indicators of Cold Supply Chain Practices in the Agriculture Sector: An Empirical Study on Egyptian Export Companies

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**Abstract**—Tracking and monitoring agricultural products, cold chain activities, and transportation in real-time can effectively ensure both the quality and safety of agricultural products, as well as reduce overall logistics costs. Effective supply chain practices are one of the main requirements for enhancing agricultural business in Egypt. Cold chain is among the best practices for the storage and transportation of perishable goods and has potential within the agricultural sector in Egypt. This practice has the scope of reducing the wastage of food and increasing the profitability with a reduction in costs. Even though it has several implementation challenges for the farmers, traders, and people involved in the entire supply chain, it has highlighted better benefits for all and for the export of goods for the economic progression for Egypt. The aim of this paper is to explore cold supply chain practices for the agriculture sector in Egypt, to enhance the export performance of fresh goods. In this context, this study attempts to explore those aspects of the performance of cold supply chain practices that can enhance the functioning of the agriculture sector in Egypt from the perspective of export companies (traders) and farmers. Based on the empirical results obtained by data collection from the farmers and traders, the study argues that there is a significant association between cold supply chain practices and enhancement of the agriculture value chain. The paper thus highlights the contribution of the study with final conclusions and limitations with scope for future research.

**Keywords**—Agriculture sector, cold chain management, export companies, non-traded goods, supply chain management.

## I. INTRODUCTION

COLD Chain Management (CCM) is known as the network of facilities and distribution options that perform the usual functions of traditional and standard Supply Chain (SC) cycles but with temperature and humidity control throughout the whole SC stages and entities [1]. Cold SC has become more and more significant within the changing global market economy due to increasing demand for the products of temperature-controlled industries, especially fresh agricultural products, manufactured food, chemical, military services, and medical vaccines [2].

Cold chain infrastructure helps the agriculture sector to reduce their post-harvest losses and enables them with the

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proper handling and storage of perishable products through the development of systems and best practices for the safe, efficient and reliable movement of food [3].

Global food losses have been documented to be in the order of 25%-50% of production volumes, caloric content, and market values depending on the commodity [4]. The use of CCM helps in handling and storing perishable goods and prevents their losses. It also considered a highly cost-effective tool when compared to continually increasing production when it comes to meet dynamic demand for food products [5]. Roughly 30% of the food consumed in developing countries is perishable. Cold storage facilities are considered as crucial to minimize post-harvest losses; however, losses occur at every stage in the SC cycle, and therefore, CCM is the suitable solution to reduce food losses and integrate the whole SC system [6].

The main reason for food manufacturing losses in Egypt is poor SC practices and especially the wastage of perishable food due to ineffective measures and challenges in establishing cold chains. Moreover, agricultural export companies face some decline in the quality of exported products, no strong competitiveness, and the impact of non-traded goods. Therefore, Egypt has exerted efforts in adopting various export promotion programs for improving the accessibility of agricultural exports within foreign markets [7]. Accordingly, the aim of this study is to explore the main indicators and practices for the cold SC for the agriculture sector in Egypt in order to enhance the level of export performance for fresh foods.

## II. THEORETICAL FRAMEWORK AND HYPOTHESES

### A. Agricultural Sector and Exports in Egypt

Agriculture is considered as the main component of the Egyptian economy, as it contributes 14.5% of the whole country's Gross Domestic Product (GDP). The Egyptian agricultural sector accounts for 28% of all jobs and over 55% of employment in Upper Egypt in agriculture-related sectors [3]. The Egyptian economy has traditionally relied heavily on the agriculture sector as a source of growth and support for all non-agricultural sectors [8].

Despite the decline in the significance of agricultural production in recent decades, comparatively, it still has a vital contribution to the country's economy. This is due to the role of food requirements to the nation as a whole, the provision of raw materials to regional industrial sectors, and an increase in

the exports' income. Due to high dependency on food imports and contact with higher and unpredictable international food prices, the policymakers of Egypt are always concerned. Moreover, sensitive food security apprehensions echoed in the significance given by the Egyptian government to essential food supplies in 2017 as well as 2030's strategic development plan [9].

Any country which focuses on producing non-tradable goods tends to achieve more benefits through financial integration as it is not as much as expected for meeting the provisions for factor price equalization. The present configuration of Egypt's trade taxes increased various issues due to higher and isolated import duties. Consequently, constant policy changes and efforts for institutional improvements are vital in resolving feeble export performance and enhancing Egypt's economic reaction to standard economic price signals such as exchange rate [10]. It highlighted that the launch of the Economic Reform and Structural Adjustment Program in 1991, with the International Monetary Fund (IMF) as well as the World Bank created an effect over the Egyptian agricultural segment. Through change in the governmental policies from being locally-managed to a market-based economy, the program hastened the liberty of the market and promoted the private segment in playing a better part within agricultural trading [11].

It is clear that any increase in the agricultural exports replicates the rise in total GDP contribution of the agriculture sector, and Egypt presents high dollar value in opposition to its national currency, which needs a rise in exports for providing string foreign reserves [12]. The context of Egypt and its agricultural intervention, the measurement of the shadow price of foreign exchange and the foreign exchange premium is possible when interferences agreed for the tradable goods. This should be done concerning entire economic welfare effects which were influenced through market alterations and the dealings about variations in demands as well as the supply of the tradable and non-tradable goods [13].

#### *B. Competencies of Cold SC in Agriculture*

The cold chain is a concept used for those goods which are perishable, and it follows continuous product management in a setting of lower temperature. After the postharvest stage, there are several stages in this value chain to reach end consumers, which are; harvesting, collecting, packaging, processing, storage, transportation, and selling. The cold chain is considered a popular approach followed for reducing food losses and wastages and is being encouraged by recognized industry-focused organizations [5].

The core difference between cold SC and traditional SC of non-perishable goods is the sensitivity of products/materials to get wasted in a specified time. Cold SC manages the supply of perishable food items, vaccines, and biological tissues. Cold products require a particular temperature and have a shorter life which puts an energetic impact on the distributions. Within the traditional SC set-up, various environment-linked elements are not so significant in comparison to cold SCs coolant leakages and wastage because of expiry [14].

Egypt's perishable goods such as fruits, vegetables, and dairy items are inadequate due to transportation and storage systems which lead to food loss and poor quality. The facts show that still 40% of the entire production of tremendously fresh processed foods spoiled or misplaced in transfer and management. The reasons identified for the loss and wastage are inappropriate packaging, lacking cold chain services, uneven transport, and diverse labor management [15].

In all developing nations, there is a lot of scope for expansion, and a lot of efforts are needed to exert for improving the training capacity for better technicians and improvement in applications. Furthermore, the Egyptian economy focuses on developing cold chain infrastructure [16].

While food needs are growing, Food Loss and Waste (FLW) in Egypt are high, especially for perishable products. Across the region, FLW for fruits and vegetables has reached 45%-55% of production annually [17]. There has been an issue in developing countries such as Egypt in adopting cold chains due to lack of equipment, and the basic configuration of cold chain restricted to the type of infrastructure as a community product and associated price [18].

#### *C. Imbalance in Food SC and Exports*

The latest market-oriented agriculture influenced the food consumption pattern in rural houses with urbanization as well as better income [19]. Low-income nations shifted from subsistence to commercial agriculture to upgrade their economic progression. It helps in closing the gaps between the structured procedure of crop production, commercialization, income, consumption, and nutrition. Moreover, it has created an imbalance in the main steps between food production, consumption, and commercialization with exports of food products [20].

Food traceability concentrated on food safety, its frauds, defense, and quality to its customers. Traceability has been a costly investment technique as it involves responding to probable threats emerging from food-guaranteeing that food is adequately protected [21]. Traceability is a vital key in protecting customers' health and is required to complete SC, from harvest to processors, suppliers, importers or exporters. This mode reduces the difference between the production of goods and its exports [22].

#### *D. Inefficiencies in Cold SC*

There are three main significant constituents of the cold chain; people who utilize and do maintenance of system devices, that equipment required for secured storage and transport of foods, and methods followed for managing the whole process, distribution, and user consumption. Even though it provides benefits, these advantages come at a price [2]:

- The use of non-environmental gas compounds leads to severe destruction to the environment when exposed to the atmosphere.
- Frosting occurs, and this layer is needed to be removed as it decreases the cooling effect.
- Safety measure is required to be followed for correct

installation and working.

- The right temperature is essential to be maintained while storing and transporting in the SC.

There are three core concerns related to cold chain performance, which are; (1) insufficient cold chain capacity, (2) lacking latest technology or precise equipment, and (3) insufficient temperature monitoring and maintenance systems [23].

Inadequate infrastructure with higher installation costs, and operational expenses along with no support of government policies, and regulations are core challenges for efficient cold chains. Moreover, no cooperation among significant contributors leads to higher food losses in the cold chain as well. No implementation standards in the industry, lack of technology for handling different foods, and lack of completely integrated planning are hindrances for the CCM during transit transportation and storage. Lack of top-level commitment, no uses of information systems, and poor cold storage infrastructure are also some issues for cold chains [24].

#### E. Hypothetical Framework

The framework (Fig. 1) is created based on the literature review with the development of the hypothesis. The framework represents the hypothetical association among the study variables. The hypotheses that will be tested in this research work as follows:

- H1: Competencies of cold SC have a positive significant impact on the agriculture sector in Egypt.
- H2: There is a significant relationship between imbalance in food SC and exports in Egypt.
- H3: There is a positive significant relationship between cold SC practices and export of goods in Egypt.
- H4: There is a negative relationship between inefficiency of cold SC practices and export businesses.
- H5: There is a positive relationship between cold SC in agriculture sector and non-traded goods.

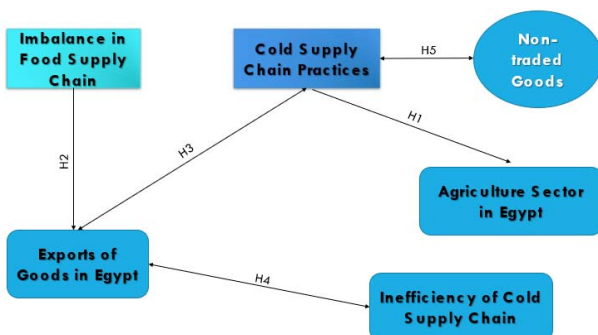


Fig. 1 Hypothetical Framework

The following section will present the research methodology by which the aim of the study will be achieved.

### III. RESEARCH METHODOLOGY

As illustrated in the previous section, a narrative review is

conducted to highlight Egyptian agricultural export companies and common SC practices that followed. Upon which, the hypothetical framework was developed. The study was performed with farmers and traders for relevant data and further analysis.

#### A. Research Approach

The affirmation of the research approach is supported by the aim of the research identified earlier in this study. This study follows a qualitative research approach for understanding the close association between the different variables under study, and to structure the analysis. For data collection, a mixed approach, which includes the primary data collection as well as secondary data collection, was followed.

The techniques applied for primary data collection comprise interview methods and surveys by a structured open-ended questionnaire. The secondary data gathered from different research papers and journals are relevant to the topic under study. The reasoning approach followed for this study is the deductive approach, as the research involves the development of assumptions based on previous studies and testing the hypotheses.

#### B. Research Design

The research design shows the obvious procedure pursued examining the determinants of the variables cited in the research problem. This study followed an experimental research design to investigate the effect of the variables identified on the agricultural exports in Egypt. It also assisted in identifying the challenges and inefficiencies in the SC with an impact on the exports.

#### C. Data Analysis

Based on the data collected through interviews and structured questionnaires with farmers and traders as the sample population, thematic data analysis was performed to infer data results for further interpretation and deducing outcomes of the study. The results of the data analysis and consequent discussion are presented in the following section.

## IV. RESULTS

The results obtained from the interviews and structured questionnaires performed with the farmers and the traders are analyzed. The discussion on the results is also done for generating outcomes.

#### A. Interviews with Framers

The interview with farmers on various aspects of cold SCM in the agricultural segment revealed that most of the respondents agree that through the initiation of cold SC management, there will be able to access more new market opportunities. The responses revealed the importance of introducing cold SC management opportunities and the advantages of the system for providing easy access to the corresponding marketing information as well as penetration.

Most of the farmers stated that cold SC will increase their total costs due to additional refrigerated storage, and refrigerated transportation; while some of them agreed that

refrigerated systems will help them to reduce damaged goods or food.

All of the respondents agreed that due to the cold SC the risk of the perishability of produced goods will be reduced. Moreover, they all acknowledged that cold SCM enhances the profitability of the agricultural sector as a whole by mitigating the risk factors. Most of the farmers stated that the benefits that cold chains provide are in the form of reduction in the damage of the produced goods with savings in the costs. Very few agree that entrance to new markets is among the benefits of this SC practice.

On being asked about the challenges this system has for implementation, most of them agreed that the cost of infrastructure, as well as the transportation and trained labor, are among the key barriers. Most of the farmers agree that through alliances with different refrigeration establishments, the effectiveness and efficiency of the cold SC in the agricultural sector can be improved. Few agreed for coordination with export companies as well for enhancement in the system. Lastly, most of the farmers were unsure of the impact competencies of the cold chain has on the agriculture sector of Egypt with few agreeing positively.

#### *B. Interviews with Traders*

The interview with traders on various aspects of cold SCM in the agricultural segment revealed that different traders highlighted different factors for the development of an efficient cold chain system with common being the set-up of optimal temperature. As per them, the distribution centers, transportation, skilled labor, the role of the country itself in terms of policies, regulations, technological advancements, endowment factors, and the role of management in terms of managing supply, cost, risk innovation, and strategies have a vital role.

All the traders agreed that the cold SC system affects the export of goods as they have to follow restrictions, require refrigerated warehouses, need temperature sensors, make improvements in packaging, have proper distribution channels with the process, and need to assure storage transport. They revealed that sticking to laws as well as regulations, providing quality products with processing, logistics system, procurement, transport, storage, and end customers are among the core processes of the cold SC.

As per the traders, efficiency improvement, production issues, timing with climate, packaging, monitoring the storage, pertinent transportation, distribution channel, contingency planning, non-skilled labor, and managing processing are the main challenges of this practice. Traders agreed that through the distribution of material required for pre-production, better primary production, the following packing and transporting operations, better distribution with marketing, complying with CCM, temperature mapping in storage areas, information transparency, and simple logistics lead an effective agricultural SC performance.

All the traders agreed that inefficiency in the cold chain affects the export of goods and this happens due to the lack of proper harvesting as well as post-harvest techniques, complex

distribution channels, inappropriate packaging with lacking communication, and inefficiency of SC in terms location, inventory, transportation, production and needs improvement. They all agreed that traded and non-traded goods are considered in one SC only and are dependent on each other.

Traders agreed that if an efficient cold chain is executed then it does increase profitability by optimization and reduces cost by producing products of good quality and reduction in losses. It increased the overall performance. They also agreed that due to the cold chain, the risk of perishability in produced goods has reduced due to food safety and quality standards, fewer health problems, reduced wastes, product tracing, and better control.

Most of the traders agreed that there is an imbalance in the food SC and exports in Egypt. They suggested efficiency, flexibility, product and process quality, carrier selection, auditing methods, certified cold-storage facilities, and SC information are among the factors that can improve the performance of the cold chain.

Based on the study results, the testing of the hypothesis reveals that the competencies of the cold SC do not have a significant impact on the agriculture sector of Egypt but the imbalance in the food chain does have an association with Egypt's exports. There is a positive significance between cold SC practices and the export of goods in Egypt and inefficiencies in the cold chain also affect the export of goods. Lastly, there is a positive significance between the cold SC in the agriculture sector and non-traded goods.

#### V. DISCUSSION

Comparison with prior studies and the interviews' results emphasized that the cold SC has the potential to provide new market opportunities and easy access in connecting with people in the market that can provide sustainability. With better efficiency, this practice makes it easier to penetrate the market with access to market information that can better help decision support and corrective actions.

The cold chain system increases the costs due to system complexity with compliance, but with less wastage and lower risk to perishable foods it can increase profitability and reduce expenses. Due to enhancement in product quality with cold chain, profitability in the agriculture segment can be achieved with risk mitigation. Assistance from government, technological advancement, understanding product attributes, and managerial decisions can lead to an efficient cold SC. Challenges that require attention specifically are production challenges, packing challenges, distribution route and contingency plans, and monitoring storage areas.

Following the CCM and its compliance regularly can bring success in the agricultural sector. Inefficiencies in handling different SC stages have greatly affected export business practices. It was discovered that all traded and non-traded goods are affected through the proper practice of the cold SC. However, implementing a cold chain can enhance predictability, reduce the risk for agricultural produce, and maintain balance in the food safety SC.

## VI. CONCLUSION

This study will contribute to creating awareness that the cold SC can be a significant element of the agriculture segment of Egypt. The study presents the perceptions of the farmers and traders with details on the benefits of the cold chain, actual processes carried out currently, and scope of improvement with an emphasis on the challenges in the implementation of the cold chain. The outcomes can help in exerting efforts to make the entire chain efficient and identify the crucial factors at each stage for establishing the cold chain practices in the agricultural sector of Egypt.

The usage of the cold chain cannot be the cure for the entire SC proposition but can significantly affect the SC of perishable goods in agricultural production. Presently, the cold chain execution is normally avoided by farmers, middlemen, and marketers as well because of its perceived high cost. However, when a huge amount of food is wasted after production, the actual cost of production appears to be much higher than expected.

Better knowledge over the expense of using the cold chain and related benefits through higher volumes of food for selling, higher market value, and enhanced nutritional value needs to be compiled and should be provided to potential consumers and involved people. The cold chain implementation is generally avoided because of its perceived complex processes and logistics-related barriers. There is a requirement of encouraging awareness and capacity building at all levels with proper training in using the cold chain.

## VII. LIMITATION

The current study has the following limitations:

- The present study is more focused on understanding the performance-related features of the cold chain for implementation by acknowledging the barriers in the Egyptian agriculture sector; however, the mechanisms to manage the barriers are not covered.
- The impact of the cold chain system on exports of goods in Egypt was realized through data analysis however, a detailed analysis is not included in the study.

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