Issues in supply chain planning of Fruits and Vegetables in Agri-food supply chain: A review of certain aspects

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Abstract

Fresh Fruits and Vegetable (FFV) are one of the most important component of a retail chain (supermarket) and act as a strategic product in attracting the customers. The demand for fresh fruits and vegetables is growing year-by-year, with greater potential for the future. Agri-food produces from the farmer's field reach the end consumer through a long chain of intermediaries such as farmers/growers, cooperatives, wholesalers, retailers, commission agents, etc. The dynamically changing fruits and vegetable market environment differentiate it from other agricultural products and complicates the efforts of local or regional suppliers to effectively match supply with demand. Thus, there is a need for the retail chains (supermarkets) to structure their agri-food procurement processes to respond to upstream-side demand and to absorb downstream-side risks with the objective to augment, retain, satisfy consumers and gain new revenue opportunities without the creation of excess inventory or capacity. The primary aim of this paper is to provide a brief literature review with the focus on identifying the issues with the procurement of fruits and vegetables in agri-food supply chains and recommending measures to solve these issues.

Keywords: Agri-supply chain management, fruits, vegetables, farmers, farmer cooperatives

1. Introduction

Globalization and economic growth have led to an increased importance of the agricultural sectors. There is a rapid structural change in the agricultural industry and food economy at the global level. An increase in per capita income, urban populations and maturing of the agribusiness markets has led to the transformation of food production and distribution pattern. The concept of agri-supply chain refers to the activities of procurement, order fulfillment, distribution, delivery and customer service executed by two or more separate organizations in the agribusiness industry. Agri-supply chain consists of small and medium enterprises, such as farmers and raw material producers, suppliers of agricultural inputs, processors of agricultural outputs, farmer-cooperatives, brokers, suppliers, distributors, wholesalers, retailers, that tend to operate independently or in co-operation with each other throughout the supply chain.

Demand and supply are no longer restricted to nations or regions but have become international processes. The market exerts a dual pressure on agri-food chains, forcing improved coordination among buyers and sellers and continuous innovation. Indian agricultural farms are more interested in export-oriented agri-food providers like supermarkets and wholesale procurement cultures for domestic consumption. This causes numerous coordination problems because of the cost associated with contracting farmers, a collection of large volumes of fresh farm products from small and marginal farmers, inadequate infrastructural facilities, and the geographical distance between farmers and supermarkets in cities (Mikkola, 2008) [24].

Problems faced by contract farmers include lack of their bargaining power, long payment delays, inaccessibility to high quality seeds and fertilizers, inadequate energy and water availability, logistics, transportation and lack of post-harvest processing infrastructure, incomplete information on fertilizer and pesticides use and associated risks (Kopanos *et al*., 2012; Ahumada *et al*., 2011; Tilman *et al*., 2002) [21, 2, 36]. The main reason for supply chain coordination is the search for quality agri-foods from the contract farmers (Rong *et al*., 2011) [29]. Private contracts and vertical and horizontal cooperation are needed to regulate and control the impact of wholesale agri-food markets and their distribution channels on supermarkets (Dries *et al*., 2009; Jia *et al*., 2011) [13, 18].

However, there lies a complexity in the after harvest processing, packaging, storing and distribution processes linked to the supply chain planning and coordination environment of low to medium level capital intensive capacity of the contract farmers and farmer cooperatives (Kopanos *et al*., 2012; Amorim *et al*., 2012; Lemeilleur *et al*., 2011; Schipmann *et al*., 2011; Kamath *et al*., 2007) [21, 3, 23, 33, 20]. Due to the fast moving customer demand supply chain have to face a time-constrained competition (Diop *et al*., 2005; Sagheer *et al*., 2009) [11, 31]. The major objective is accurate and real-time information sharing which is required for procurement of fresh and quality produces from farmer cooperatives and small or medium capacity farmers (Berdegue *et al*., 2005; Rao, 2007; Prajogo *et al*., 2012; Kaipia *et al*., 2007) [6, 28, 27, 19].

Supply chain collaboration has become the prerequisite for successful procurement and operational business practices for perishable products with the emerging trends of globalization and competitive marketplace. Supply chain planning in the agri-food industry integrates the complex network of farmers, demand, and supply to end consumers to enhance operational effectiveness. So, the supply chain planning system should integrate data from multiple sources to provide visibility and collaboration in an extended network of stakeholders. Privatization and restructuring of agri-food supply chains has created a lot of coordination problems, long payment delays, timely access to quality inputs and services, high searching costs, and problems in achieving the target improved crop

production standards and required food safety requirements (Berdegue *et al*., 2005; Dries *et al*., 2009) [6, 13].

The trends towards rapid agri-food production cycles, volatile nature of product demands, complex methods of agri-supply chain partnerships are reflected by the emergence of contract farming and farmer cooperatives and the perishable nature of the agri-food products (Christopher *et al*., 2006) [6]. Contracts with individual farmers are based on soil quality, land size, history, interest and attitude for a given period (Jia *et al*., 2011) [18]. Farmer cooperatives help supermarkets to hire the labor force of contract farmers, make capital investments and produce vegetables of good quality by using latest technology (Schipmann *et al*., 2011) [33]. Supermarkets help the contract farmers by providing quality seeds, inputs and extension services. Collaborative efforts in terms of investment, resource sharing, and crop production, knowledge and information sharing, marketing and R&D for optimal technology and strategy development are very much project-specific (for a specific fruit or vegetable) and short-term (Byrne *et al*., 2006; Halley *et al*., 2009; Lee *et al*., 2011) [9, 15, 22]. Thus, operational competencies are required to be possessed by members of the agri-supply chain network to sustain relationships (Halley *et al*., 2009) [15].

2. A Brief Literature Review

The objective of this paper is to present a brief literature review with the focus on identifying the issues in the supply chain planning of fruits and vegetables in agri-food supply chains and recommending measures to solve these issues. The research papers were collected for ten years (2006-2015) and papers dealing with agri-fresh produce (fruits and vegetables) were considered. Citations of papers related to the supply of fresh fruits and vegetables were referred to find more relevant papers addressing supply side issues. Thus a cross-referencing approach was adopted to find other relevant papers. We reviewed the works of some of the leading authors with details like the year of publication of their work, the objectives of the reviewed work, the methodology adopted, and the tools employed for the study. We also studied the results derived from the study and identified the gaps in the research.

Schepers *et al*. (2006) [32] described the purchase frequency of the consumer segments and under what conditions a ready-to-eat strategy created value for a retailer, trader, and grower in a fruit production chain and illustrated how factors other than price optimized total chain profit and profit per player. A system dynamics model was used as a discussion support tool. Sub-models were also created using formal mathematical equations and solved. The model showed the vertical cooperation between trade partners on the level of fruit ripeness and variation in the ripeness factor. It showed that at minimum levels of variability in quality, profits for all business partners are highest. The model also indicated that product loss due to over-ripeness in retail chains should be considered and optimized. Ripeness factor with more specific dynamics of fruit ripening to keep quality and reduce product loss can be addressed. All fruits differ in the variance in ripeness hence further research is required in the area of calibration and validation.

Ruben *et al*. (2007) [30] analyzed the factors motivating Asian supermarkets' sourcing alternatives as wholesale systems or preferred supplier systems. A detailed assessment of supply chain organization was done, and a field survey was conducted. Information on variable cost and fixed cost in the supply chain, searching cost, monitoring costs was collected. Insights from transaction cost theory were used to compare two case studies of two major supermarkets chains for their vegetable procurement practices. The findings suggested that the governance costs were more than the actual investment costs for supermarket chains and moving from wholesale system to the preferred supplier system would involve significant fixed cost which could only be met by reducing governance costs. The focus should be gradually moved from chain optimization towards strengthening buyer-supplier relationships. With the expansion of the supermarket's chains, the smallholder farmers will be gradually neglected and will be progressively excluded with only some out growers linked to the farmer organizations or large- scale suppliers. Hence supply chain strategies for strengthening the position of the smallholder farmers could be designed after further analysis and investigation.

Ahmad *et al*. (2008) [1] examined the current practices of quality assurance in the supply chain of fruits and vegetables in Hungary and proposed and re-designed quality oriented business processes required for an integrated supply chain system. A questionnaire technique was employed by using a pre-tested questionnaire and interviews were conducted. ADONIS tool was used. The quality gaps have been identified in the whole chain as some units of operations of quality assurance were not practiced in the SCM. The quality assurance system must be implemented from farm to fork to develop safe food management system. Mind mapping technique used was a new method of collecting information. The research work can be further extended by developing integrated models of the supply chain of fruits and vegetables with quality oriented business processes.

Ferrer *et al*. (2008) [14] optimally scheduled wine grape harvesting operations of harvest scheduling, labor allocation, and routing decisions on operational costs and grape quality. A mixed integer linear programming model which includes a TSP formulation that considers an objective of cost minimization along with an objective of quality maximization of harvested grapes was solved using standard optimization software. Travelling salesman problem using MTZ formulation was solved using heuristic approach and tested through a case study. AMPl was used for coding, and Cplex 7.1 on DEC Alpha machine was used for solving, GLPK solver has also been used. One of the main contributions of this model is the quality loss function included in the objective function. The optimal plan proposed by the model had shown a decrease in the operational and labor costs. The model provides a useful tool for large-scale resource allocation. The proposed model not only provides a solution to a relevant practical problem in industrial sector but is also a contribution to the use of Operations Research in other agricultural sectors. The model covers a fixed planning horizon which can be variable. The blocks of grape cultivation can only be assigned to a single winery which can

be extended to include alternative wineries. The model doesn't take into account the inventory of the harvested grapes as everything harvested has to be directed towards the production plant due to deterioration of the grapes. Hence the lower quality grapes are considered waste and are discarded.

et al. (2009) [8] examined and studied the optimal supply chain design strategies for a particular type of perishable product(fresh produce) melons and sweet corns and minimized lost value in the post-harvest supply chain of these perishable products. A model was developed using the product's marginal value of time using an exponential decay function. The model was then validated through a case study. One of the important findings of this work was that coordination across the supply chain was not a pre-requisite for supply chain optimization. The marginal cost of time for a product was used as a tool to analyze the optimal supply chain strategy. The model can be further extended with modifications towards other fresh produce that mature in the field and reach their peak value at the time of harvest. The model doesn't include an inventory carrying cost, and the location of the facilities was not taken into account which would affect the quality of the produce after it has been harvested and needs to be transferred to the cooling shed. These issues can be addressed in future research.

Arumugam *et al*. (2010) [5] identified the factors that motivated farmers to participate in the contract farming and practices for marketing their produce (fresh fruits and vegetables) in the Peninsular Malaysia. A survey method was used and a semi-structured questionnaire was designed to collect primary data through interviews. The Stratified sampling method was used. Descriptive analysis, factor analysis, and reliability analysis were used to analyze the data. The factors that motivated farmers to participate in contract farming were identified as market stability, access to inputs, marketing information, and technology, transfer of technology to improve farming practices, indirect benefits. The work can be further extended by identifying the factors which lead to the farmer selection by agri-food retail chains (supermarket) and selection of the optimum supplier (farmer/wholesaler/farmer cooperative).

dos Santos *et al*. (2010) [12] developed a linear mixed-integer model formulation for sustainable vegetable crop supply problem with variables indicating the plot size associated with a crop rotation schedule with the aim to meet the known demand of crops meeting ecologically-based production constraints. A linear mixed-integer programming model was developed with the exponential number of variables and each associated with a feasible crop rotation plan. A large number of variables were solved using column-generation algorithm. The model was solved with the help of CPLEX 11.0.A set of computational tests using the real world data verify the performance of the column-generation approach and the efficacy of the proposed model. The performance was tested for a different number of cropping areas. The model may be further extended to incorporate additional characteristics of field conditions.

Verdouw *et al*. (2010) [37] proposed a reference process model for demand-driven fruit supply chains and its application in fruit supply chains. A design-testing approach using deductive reasoning was used. Data was collected through in-depth structured interviews and structured questionnaires. SCOR-model was used for design with Product Flow Models, Thread Diagrams and Business Process Diagrams. A Case study was used for analysis. Business Process Modeling Notation (BPMN) was used. The process models help to provide a consistent set of process models which are understandable by the managers. The main contribution of the work was that it describes how building blocks can be used to compose specific configurations using pre-configured templates of the fruit supply chains which in turn help the users to configure their templates using these building blocks. The reference model can be further developed iteratively by pilot runs. The model can also be implemented in operational supply chain information systems and how they can be integrated. Tool support and video demonstrations could be developed for configuration of process models. Future research could help in the extension of the model to other processes. Institutionalizing the model for its maintenance and further development could be a significant future research issue.

Ahumada *et al*. (2011) [2] proposed an operational model for short-term planning decisions in fresh produce industry which would assist in making production and distribution decisions during harvest season with the objective of maximization of revenue. A mixed-integer programming (MIP) model was developed. A case-study based on bell peppers and tomatoes was used to show the validity of the proposed model. The main contribution of the proposed model was the integration of the biological functions with mixed-integer programming for determination of best harvest and distribution practices for short periods. The proposed model could be applied to improve current labor-management policies. The proposed model could be useful to growers for maximizing revenues under varying climatic and marketing conditions and potential customers for determining profitability and analyzing new markets. As the proposed MIP model can be solved with commercially available solvers, it can be extended to explore more parameters for perishable produce in short term planning.

Jang *et al*. (2011) [17] studied and developed models for supply chain for small agricultural enterprises. Mathematical and experimental modeling techniques were used. The proposed models would help in developing strategic planning and decision–making tools to keep the small agricultural enterprises in market competition, and this scientific approach will help them to reduce costs and improve their service. The pricing strategy for multiple products could be investigated in future work with more focus towards other parameters of quality and customer service rather than size of the enterprise.

Jia *et al*. (2011) [18] investigated the contractual agreements between Farmer Professional Cooperatives (FPC's) and buyers in China. A conceptual framework was developed, and a research hypothesis was drawn using transaction cost approach. Data was collected through a questionnaire-based survey. The descriptive analysis was used, and estimation was done using Ordinary Least Square Estimator (OLS).The main findings of the proposed framework were that vertical coordination at the farm gate level through farmer

cooperatives and associations in the agri-food sector is emerging in China. These cooperatives followed both oral and written contracts. Vertical coordination through contracts is market-specific and contracts were not dependent on transactional attributes. The vertical coordination among the FPC's was achieved through branding. The proposed work could be further extended in the direction of developing strategies for branding and certification. The inclusion of parameters of dedicated suppliers, individual farmer's decisions, characteristics of buyers could be a possible extension of the proposed framework.

Rong *et al*. (2011) [29] modelled food quality degradation in decision making and integrated it with a mixed-integer linear programming model used for production and distribution planning. A model using linear mixed-integer programming was developed. The model was applied in an illustrative case study of a supply chain of bell peppers and was implemented in ILOG's OPL Studio in combination with CPLEX 10.2 optimization software. The product quality was included in the food supply chain modeling thus integrating the aspects of managing product quality and controlling temperature in decision making in supply chain management. The model could also help in evaluating performance regarding cost and quality. The model can be further extended to analyze a detailed impact of temperature fluctuations by the inclusion of quality decay models. Future research could include multiple products instead of single product. Further research may help in developing more industry-specific models for a broad range of agricultural commodities and food industries.

Perdana (2012) [26] developed Fresh Fruits and Vegetables (FFV) supply chain management system by application of Triple Helix Model on improving the small farmer's access to export market through interaction between different supply chain partners. A case study method was used to discuss the role of Triple Helix Model in the development of FFV supply chain to meet global market demands. Causal Loop Diagram (CLD) as a part of system thinking approach (a part of system dynamics) was used as an analysis tool. The triple helix model shared knowledge and experience between different chain actors and thus this multi-stakeholder interaction involved the small farmers in the FFV export supply chain and created a set of relationship rules at production, supply, and agricultural level which in turn helps in reducing risks which occur in its development. An information system can be developed to measure the performance of the multi-stakeholder interaction between different chain partners, policy simulator can also be developed, and the replication of this model can be applied to other areas after further research.

Sutopo *et al*. (2012) [35] proposed an agri-food supply chain model with emphasis on the corporate social responsibility(CSR) activities thereby helping farmers to solve their internal problems. The Agri-food supply chain model was developed using the mixed-integer linear programming (MILP) with multi-objective optimization. Branch and bound algorithm was used to solve the MILP formulation using ILOG CPLEX Academic Version solver. The proposed model incorporated the effect of product deterioration on the revenue of the farmer and the retailer. The findings helped to determine which producers required training skills, amount and timing of supply, total cost allocation for CSR activities and how improving quality would lengthen the deterioration time of vegetables. The proposed work can be extended further by considering the effects of variable factors such as price, demand, and supply. Farmers capabilities to access the capital and market and incorporate new farming technologies can be another possible extension of the proposed work.

Bezat-Jarzębowska *et al*. (2013) [7] studied the concept of efficiency-focused economic modeling of the competitiveness in agri-food sector on the producer's end. The efficiency-focused modeling was done using SFA method (Stochastic Frontier Approach) for assessment of farm's productivity. Data collection was carried out within the framework of FADN (Farm Accountancy Data Network), and Cobb-Douglas and trans-logarithmic functions were applied for analysis. The SFA method considered the impact of weather, market shocks or statistical noise and also potential inefficiency which were not taken into consideration in a deterministic model. The study proved that the economic growth in agricultural sector depends on competitiveness based on efficiency improvement. The model can be further extended to be used for policy implications and management practices in the agricultural sector and other areas by considering other factors like production quality indicators in input and output, ownership form, and managerial characteristics.

Sudarshan *et al*. (2013) [34] estimated the post-harvest losses in pomegranate fruit at different stages of supply chain and developed appropriate strategies to reduce these losses. The multi-purpose random sampling technique was used and data was collected using pre-tested questionnaire and interview. Hypothesis-testing was done. Pre-harvest management practices can help in reducing the post-harvest losses. A regional Integrated Post-Harvest Management Center (IPHMC) had also been proposed. Post-harvest technologies could be employed to avoid the losses throughout the process by providing proper training and guidance to rural, urban horticultural growers. The indigenous fruits and vegetables waste utilization with emphasis on the design of effective strategies for this purpose can be a possible extension of the current research work. The post-harvest information management and traceability throughout the supply chain can also be explored as future work.

Iakovou *et al*. (2014) [16] developed a methodological framework which aimed to minimize the environmental burden and to maximize supply chain sustainability for the agri-food sector through the implementation of a green supply chain. A conceptual framework was developed which holistically tackles all aspects of green supply chain in the agri-food sector. Six different thematic areas were identified, their interdependencies and their impact on proposed supply chain management framework were studied. The optimization of the farming practices aimed towards increasing the farmer's income with the reduction in operational cost. Biofuel production could have a positive impact on rural development and generate agricultural employment. It also introduced an intelligent logistics network to reduce harvest and transportation energy input. The future research can focus

on the development of the operations of the green supply chains that could reduce an organization's carbon footprint, reduce costs, and design such supply chains and their operations replacing less sustainable practices and improving the reputation with customers, investors, and stakeholders with increased profitability.

Anastasiadis *et al*. (2015) [4] analyzed the interactions of market players at each stage in the agri-food sector throughout the whole chain from production to consumption regarding upgrading the emergent traditional supply chain into new efficient supply chains. Qualitative methods using a whole chain approach were employed. Research questions were drawn. Data was collected through Judgemental sampling, snowball sampling approach, and semi-structured interviews. A case study approach was used as an investigating tool. There was an obstruction in the information sharing by certain stakeholders of the emergent supply chains. The findings also suggested a lack of commitment, collaboration issues, and coordination problem among the supply chain members leading to mistrust among them. The nature of the new opportunities was poorly understood which obstructs further development of the emergent supply chains. The mechanism of collective emergence has been revealed in this study which would provide insights to overcome the obstacles. Further investigation using a similar approach with minor modifications can be applied in a wider context to other economies where emergent traditional supply chains are in their infancy. The extension of this work can be in the direction of designing appropriate supply chain strategies towards increasing inter-firm collaboration, co-ordination and commitment among the supply chain members towards building an efficient supply chain.

Negi *et al*. (2015) [25] identified the problems affecting the supply chain of fruits and vegetable sector in India and suggested appropriate supply chain strategies to overcome the problems and challenges. Descriptive research was used in the study with a review of existing literature dealing with the issues in the supply chain of fruits and vegetables and other agricultural products. Descriptive research was done with a thorough review of the existing literature studied under various factors from the perspectives of fruits and vegetable supply chain. The inefficient supply chains with inadequate cold chain facilities, lack of coordination between the supply chain partners resulting in the post-harvest losses and wastage during transit, and the poor quality of produce reaching the consumers were the major issues identified in the study. To strengthen supply chains of fruits and vegetable sector in India, appropriate models aimed at increasing the shelf-life of the fresh produce thus decreasing the post-harvest losses and wastage are required to be developed. The study can be further extended with empirical tests and validated through case studies on fresh produce supply chains and on other related sectors like milk, beverages, etc.

Zhong *et al*. (2015) [38] studied the information needs and sharing strategies among farmers and vendors in Chengdu, China. Data collection through convenience sampling and survey was conducted through interviews. Chi-square tests, Independent-sample t-tests were employed to answer research questions. Structured Equation Modeling (SEM) was performed to explore factors motivating farmers and vendors to join information centers. The study helped in bridging the information gap between farmers and vendors and local or private farmer-based organizations. These organizations could promote information sharing on specific crops and marketing systems. The ease of availability of information to farmers is the core predictor of farmer's willingness to join an information center. The findings also indicated that there existed some significant differences between farmers and vendors regarding access of information. The participants might not fully understand the purpose of the proposed information center and its benefits so future studies may incorporate a detailed video demonstration of the proposed information center to the participants before their survey through interviews. Future work may also address the variability of the information needs and share based on seasons areas, family size, educational background, etc. as these would have an impact on user's perception of the information system.

3. Findings

Through the review, it is found that supply chain planning of fruits and vegetables in agri-food supply chain is characterized by poor collaboration among the supply chain partners, huge post-harvest losses due to lack of proper infrastructure and cold chain facilities, a large number of market intermediaries leading to a fragmented supply chain, lack of information sharing among farmers and retailers, improper monitoring leading to poor quality of the produce reaching the consumer owing to the perishable nature of the fruits and vegetables and short shelf life, poor knowledge of farmers and lack of new farming practices and technology, lack of motivation on the farmer’s side for getting into contractual agreements with the retail chains(supermarkets) thus leading to poor pre-harvest practices and generating less income on the farmer’s side are the major problems identified in this review.

4. Conclusion

The fruits and vegetable sector in agri-food supply chain constitutes a significant part of the world economy and is a source of raw material for many industries. Among the other agricultural produce, fruits and vegetable sector have been explored the least. Agri-food Supply chain management involves all the activities in managing the relationships between the businesses and the chain partners involved in the efficient production and supply of products from the farm to the consumers with the objective to meet consumers' requirements reliably regarding quantity, quality, and price. The chain partners may include farmers, producers, growers, retailers, farmer cooperatives, wholesalers, distributors and other intermediaries involved in supplying the agri-fresh produce from farm to fork.

From the review of literature, we have identified the following issues and we recommend the following measures for improving the effectiveness of supply chain planning of fruits and vegetables in the agri-food supply chain.

1. Vertical coordination among the farmers/growers through farmer cooperatives or associations, intermediaries and retail chains by contract farming facilitating pre-harvest practices resulting in quality produce, timely transportation of fresh produce from the farm to distribution centers and finally the retailers thus reducing the post-harvest losses and wastage. Through contract farming, farmer's may have access to quality inputs, information, and new technology for farming thus resulting in an increased income of the farmers.
2. Demand forecasting is an important measure for improving the effectiveness of the agri-supply chains resulting in a match between the supply and demand as sometimes the vegetables are not harvested due to lack of demand and sometimes due to weather or other conditions vegetables are not available, in both the cases either there is a post-harvest loss or the prices go up. The collaborative forecasting and replenishment (CFAR) system enable the retail chains (supermarkets) to forecast demand and determine crop production schedule.
3. Developing appropriate infrastructure and cold chain facilities and customized logistics reduces cost, maintains the quality of the produce and ensures timely delivery of the produce.
4. An effective inventory management must incorporate segmentation of the fresh agri-produce, customers, supply and distribution channels, optimized postponement of deliveries and stock levels to maintain the stability of price while keeping the quality consistent.
5. The information systems must be incorporated as a collaborative tool for supply chain planning in agri-food supply chain to integrate farmers, cooperatives, retail chains (supermarkets) and target customers by facilitating information flow and exchange among them.
6. The agri-supply chain planning requires a holistic and integrated view of all the supply chain partners and systematic interactions between them recognizing their interdependencies thus promoting adoption and implementation of new technologies, increased revenues, better quality of produce and finally increased customer satisfaction.

In the given literature review we have considered only the fruits and vegetable sector but other perishable products like milk, cereals, etc. could also be included in the further research. Also, there is a lack of empirical research on the significance of vegetables and fruits sector in agri-food supply chain. The present work can be extended further towards developing a framework for depicting appropriate policy for agri-food supply chain considering the interrelated perspectives of supply chain planning, supply and demand management, transportation and logistics management, inventory management, order fulfillment management, performance management and information sharing.

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