

# Coordination on Agrifood Supply Chain

Martha Liliana Reina Usuga, Wilson Adarme Jaimes, and Oscar Eduardo Suarez

**Abstract**—Coordinated supply chain represents major challenges for the different actors involved in it, because each agent responds to individual interests. The paper presents a framework with the reviewed literature regarding the system's decision structure and nature of demand. Later, it characterizes an agri food supply chain in the Central Region of Colombia, it responds to a decentralized distribution system and a stochastic demand. Finally, the paper recommends coordinating the chain based on shared information, and mechanisms for each agent, as VMI (vendor-managed inventory) strategy for farmer-buyer relationship, information system for farmers and contracts for transportation service providers.

**Keywords**—Agri-food supply chain, Coordination mechanisms, Decentralized distribution system, Supply chain coordination.

## I. INTRODUCTION

THE supply chain management (SCM) for perishable products has become relevant during the last decade due to international policies, such as the Millennium Goals, and its inclusion in public health issues [1]; the term agri-food supply chain (ASC) has been adopted to refer to activities that take place from production to distribution, and that allow agricultural and horticultural products from farm to consumer [2].

Suppliers of food systems worldwide are rural dwellers, which correspond to 49% of the total population, and in Colombia this indicator amounts to 31.6% [3]. The rural Colombian peasantry occupies 51% of the total agricultural area [4], and 36.15% of the total value of agricultural production [5]. The peasant economy is predominantly Andean rural with greater relevance in the departments of Antioquia, Bolivar, Boyaca, Cundinamarca, Nariño, and Santander, in this region are also more established cities of the country to which the peasantry provides the service of provide food provisioning at good prices and galore [3], which represents 35% of the Colombian diet and 67% of the Bogotá [6].

The food supply system in Bogotá is composed of 26,000 farmers, 1,846 brokers / carriers, 4,800 wholesalers and 135,000 retailers, due to the existence of multiple agents in the supply chain, this is a deficient and has high supply costs and inequitable distribution earnings among the agents.

The paper analyzes one of the supply chains linked to the food system of Bogota and explore alternatives for implementing coordination mechanisms between the different

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agents.

## II. METHODOLOGY AND LITERATURE REVIEW

### A. Methodology

This paper will provides a review on coordination of supply chain systems; this is organized in a framework that is based on a supply chain decision structure and on the nature of demand. Section III discusses the case of agri-food supply chain in Colombia and Section IV provides some alternative mechanisms for the coordination of the supply chain. Finally, Section V concludes and gives direction for future research.

### B. Review Stage

#### Supply chain coordination

There are different perspectives on supply chain coordination (SCC) and there is not a unique definition. The terms like integration, collaboration, cooperation and coordination are complementary to each other and when used in the context of SC can easily be considered as a part of SCC [7]. [8] defined the SCC as strategy response to the challenges that arise from the dependencies SC members; [9] stated that coordination is a central lever of SCM. The most commonly accepted definition of coordination in the literature is “the act of managing dependencies between entities and the joint effort of entities working together towards mutually defined goals” [10].

The following types of conflicts may exist for coordination: conflicting goals and objectives (goal conflict), disagreements over domain of decisions and actions (domain conflict) and differences in perceptions of reality used in joint decision making (perceptual conflict) between SC members [7]. The consequences of lack of coordination are: inaccurate forecasts, low capacity utilization, excessive inventory, inadequate customer service, inventory turns, inventory costs, time to market, order fulfillment response, quality, customer focus and customer satisfaction [11]. The lack of coordination may result in poor performance of SC. [12] has cited a study of the US food industry, which estimated that poor coordination among SC partners was wasting \$30 billion annually. The mismatch between supply and demand results in rise in the costs of stock out, markdown, expediting, transshipment, advertising and sale preparation, excess inventory [13].obsolescence, and disposal [12]. There are multiple benefits accruing from effective SCC. Some of these include: elimination of excess inventory, reduction of lead times, increased sales, improved customer service, efficient product developments efforts, low manufacturing costs, increased flexibility to cope with high demand uncertainty, increased customer retention, and revenue enhancements [12] ,[13].

Coordination is perceived as a prerequisite to integrate operations of SC entities to achieve common goals.

[14] Defined two types of supply chain systems:

- Centralized supply chain systems: the system is viewed as one entity that aims to optimize system performance.
- Decentralized distribution system: it differs from a centralized system in that members act independently to optimize their individual performance.

[7] Presented a literature review on supply chain coordination focused on coordination across functions of supply chain, coordination at interfaces of supply chain and Coordination at interfaces of supply chain. [14] Defined a supply chain coordination mechanism is an operational plan to coordinate the operations of individual supply chain members and improve system profit. When supply chain members are separate and independent economic entities, this action plan has to include an incentive model to allocate the benefits from coordination among them so as to entice their cooperation. Several coordination strategies and mechanism have been developed to align SC processes and activities to ensure better SC performance, for each type of system and according to the nature of the demand. The fig 1 illustrates these relationships.

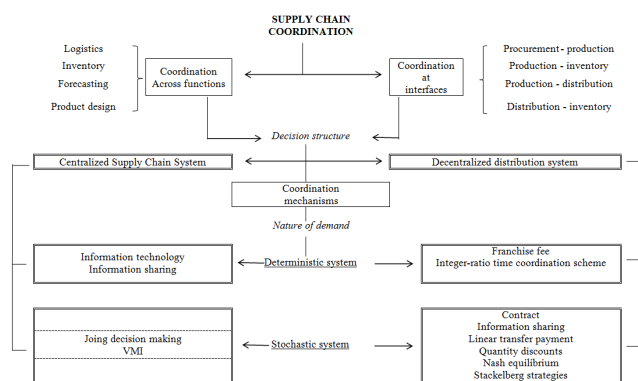


Fig. 1 Supply Chain Coordination  
 [7] and [13] modify by authors

### Agri-food Supply Chain

The Agri-food Supply Chain (ASC) typically starts on farms and involves many different types of facilities, including processors, packers, distributors, transporters, and retail stores, before finally reaching the consumer. Agri-food supply chain is a special kind of supply chain because the commodities transferred in this chain have their special characteristics, for instance, the perishable characteristics play a great role in this kind of supply chain management. There are three Categories Food: Fresh and perishable vegetables and fruits, animal and water products and processed food products [15].

The literature reports little progress in the coordination mechanisms, the researchers have focused primarily on vertical coordination of the chain and the use of information systems. [16] studied the vertical coordination in the dairy chain, its relationship with policy reforms, its effects and the implications for small farms. Their results suggested that in several countries small dairy farms have benefited from

vertical coordination processes by providing them access to inputs and higher value markets. [17] dealt with the link between innovation and market structure using the empirical example of the Danish agri-food industry. They found vertical integration may resolve hold-up problems and here they tested the importance of vertical integration and networks on innovation. The vertical integration as well as the contractual arrangements is significant determinants innovative of companies behavior. On the other hand, [18] developed a reference model for a bridging the gap between supply chain design and information systems engineering by providing a consistent set of processing models that are on the one hand, understandable for business managers and on the other hand, serve as a basis for information systems implementation. [19] described an Internet-based coffee information system (CINFO), which provides farmers information on where and how to produce coffee with particular features, whilst providing traders with information on the availability of products with particular traits.

The literature reports important research on SCC but few focused on ASC, it is clear that there are few studies on the mechanisms of coordination of supply chain applied to real cases of perishable products. The aim of the present paper is to describe two logistics systems of distribution of perishables products, vegetables and fruits, and propose some mechanisms for their coordination.

### III. AGRIFOOD SUPPLY CHAIN IN COLOMBIA

The Mercados Campesinos program is an alternative form of marketing which involved small farmers in the Central Region of Colombia; this initiative is linked to the Food Master Plan of Bogota and it involved 80 townships. The aim is to remove the chains of intermediaries between farmers and final consumers, based on the premise of the defense of the peasant economy and the pursuit of security and sovereignty food [20]. The program has two marketing channels, one in which the peasants go twice a month to 10 parks in Bogotá and sell their products directly to final consumers, and another in which farmers sell to retailers and wholesalers. Farmers have the support of a marketing committee and a regional promoter for the management of marketing channels, but each farmer is responsible for the logistics to distribute their products. The Fig. 2 shows the information, products and money flow on the Mercados Campesinos program.

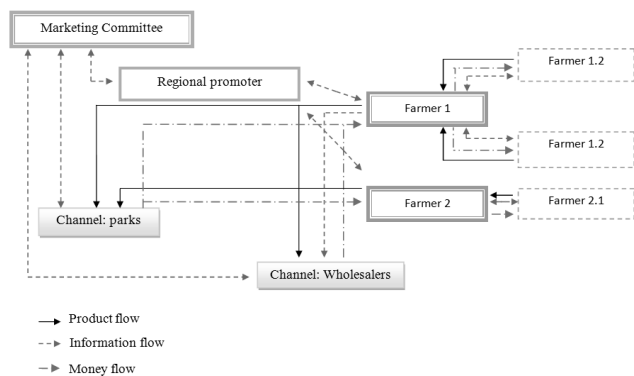


Fig. 2 Information, products and money flow [21]

Fuente de Oro (Meta) is a small town located 203 kilometers from Bogota; it participates in the two marketing channels of the program, with products such as plantains, cassavas, avocados and lemons. There is a farmer who brings 60% of the products from this municipality; he sells products from his own production and from other farmers who cannot go to Bogotá. The farmer is taken part in the activities of harvesting, postharvesting, transportation and selling of their products along the supply chain; there is only a transfer of ownership, from farmer to consumer he only hires transportation services. The Fig. 3 shows the scope of farmer on supply chain.

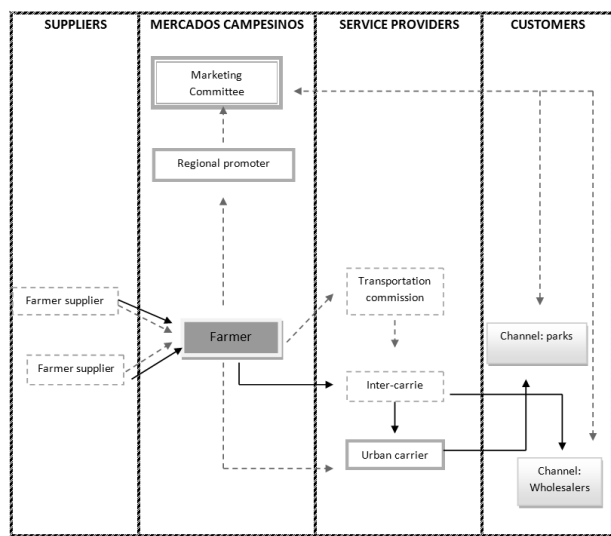


Fig. 3 Scope of farmer on supply chain [21]

The selection of the mode of transportation depends on the climate factor in the rainy season, the road is flooded, the farmer must take his products by boat and later by truck. This aspect increases logistics costs. During the summer season, the question is to determine the means of transportation; the farmer depends on the supply transportation services, yielding THE power of negotiation the offerer has on this regards.

The explicit costs for supply chain are between 10 and 13% and total logistic cost is 28% of incomes.

The program responds to a stochastic demand, because although historical data are available for planning in supply, demand tends to fluctuate because buyers do not always buy from farmers in the program. This adds complexity to the program, complexifying negotiation with buyers and service providers, increases costs logistics and may cause apathy of farmers to participate in the program.

The supply chain of Mercados Campesinos Program resembles a coordinated supply chain; in the practice there is incoordination between farmer, marketing committee and marketing channel, as well as between farmers and service providers. The fact that the farmer is present in each of the links in the chain does not mean that there is coordination along the chain, because the characterization of the chain shows that the farmer has no bargaining power against the carrier or the buyer, especially in the retail channel.

As there is no coordination among chain actors, neither farmers nor consumers perceive the benefits of the program; transportation plays an important role in the chain and has become a bottleneck for the optimal development.

The configuration of the above supply chain indicates that exploring decentralized coordination mechanisms could significantly improve the benefits of this chain.

#### IV. COORDINATION MECHANISMS FOR AGRI-FOOD SUPPLY CHAIN

The supply chain of Mercados Campesinos Program functions as a decentralized logistics system because there is no agent to make decisions for the whole chain, but achieving coordination among sellers (farmers) and buyers (retailers) is a challenge that can result in valuable benefits for both agents.

Since its inception, the program has had the marketing committee as a facilitator in the relationships between farmers and buyers, this is an important factor because it has drawn the interest of farmers to act together to unify the food market in Bogotá. Then, to achieve coordination, the marketing committee should assume a new role, as it must be the coordinator and executor of strategies and plans; the agents that must be coordinated are: farmers, transporters and retailers, the mechanisms for coordination of the chain will depend on each agent linked.

The Fig. 4 illustrates the coordination of the supply chain.

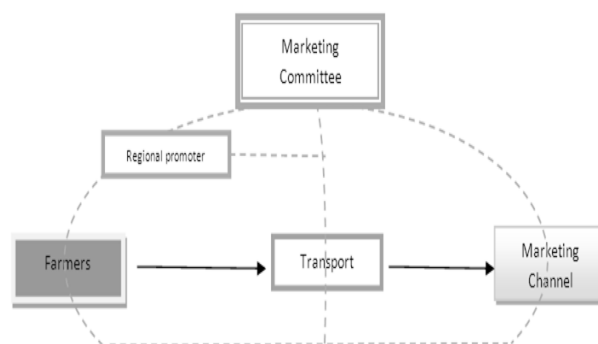


Fig. 4 Coordination supply chain Mercados Campesinos Program

A coordinated supply chain has three main actors, a coordinating agent and a platform for coordination based on information sharing mechanisms are proposed as the implementation of an information system for the supply, VMI strategy, and contracts for service providers; the marketing committee will be responsible of supporting each of the agents with the implementation of different mechanisms. Fig. 5 shows mechanisms for coordination of the supply chain.

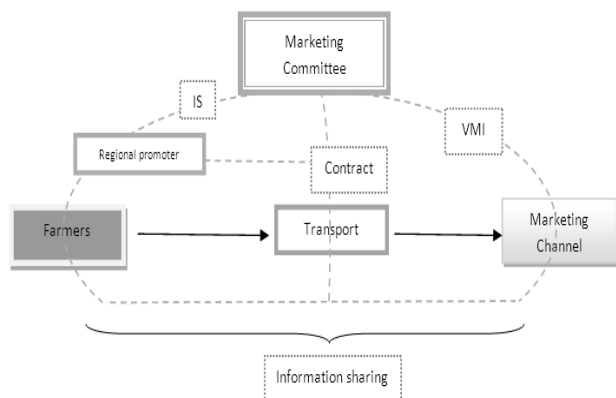


Fig. 5 Mechanisms for coordination supply chain Mercados Campesinos Program

The information sharing should be the support for coordination; it results in inventory reductions and cost savings [22]. The supplier may take advantage of the retailers' inventory information to allocate the stock to retailers in an optimal manner [23].

The organization of information among producers regarding quantities and quality products, storage and distribution costs is key to satisfy demand; therefore implementing the system information will serve to gather this information.

On the other hand, regarding coordination with retailers the VMI strategy can be very helpful. VMI is a collaborative business where suppliers are licensed to handle the inventory of the buyer, under this system the supplier decides the level of inventory for each product, designed delivery schedules and manages the order volume. The benefits that can be obtained with this system are the reduction of inventory costs for suppliers and buyers, the improvement of customer service, while reducing the time for the order cycle [24]. This strategy helps the system because it lets one us know the specific demand, in which "upstream" results into better production planning and gives tools to both farmers and the marketing committee to engage in better negotiating terms.

Finally, the mechanism to coordinate the farmer with along the carrier is the contract, because once the marketing committee knows the technical characteristics of the demand, the farmers can plan their production and supply, and the committee can create schedules for deliveries of products. The contracts increase customer service quality and promote quality of deliveries, while reducing the risk of errors in the distribution.

Mechanisms and strategies for chain coordination require effort of the marketing committee to plan and execute a

project between the different agents simultaneously, so it is required that the agents, farmers, transporters and retailers, have the desire to implement a strategy for collaboration and coordination.

Coordinated supply chain must start with the organization of supply, it must clearly know the products, quantities, qualities that can provide farmers, and this should be the basis designee an information system. Later, and based on the above the buyers, whose demand is articulated to the offer, and who are willing to be part of a coordinate chain. Once, the agreements exist transportation links these two ends of the chain.

This coordination has been proposed for a marketing channel, but taking into account that the parks sales channel could be more complex; given its many retail buyers. The latter, requires coordination mechanisms at each level, the consumers must manage their own mechanisms for coordination and joint development of orders and others who can help with this.

It is important to consider that the processes to become a coordinated chain are complex and may take time, as it is to build trust relationships in a dynamic system such as human relations.

## V. CONCLUSION

The agri food supply chain management has become very important due to public policies on food security. Food systems in large cities require coordination between different actors in the chain, to achieve benefits as well as the decrease in costs, prices and increased food quality.

The Mercados Campesinos program is an important initiative to shorten the chain of intermediaries in the food system; its supply chain is supported on a marketing committee, which acts as a facilitator between farmers and buyers. The supply chain responds to a decentralized distribution system, for which we propose the implementation of mechanisms for coordination as information sharing, information systems, VMI and Contracts, the coordination mechanism depends on the type of relationship between the agents.

The coordinated supply chain will give the program a better chance of sustainability over time because it allows articulating the rural economy with end consumers and building long term relationships for the benefit of all stakeholders.

Future research should delve into the type of information shared, designing an information system for the whole chain, and research on benefit-sharing strategies among different agents, which are obtained through the coordination of the supply chain.

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