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Food hub as an efficient alternative to sustainably feed the cities

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Résumé

Cet article décrit la place des pôles logistiques alimentaire et leurs systèmes de distribution associés. Les déficiences des systèmes alimentaires qui ont conduit à l'émergence du concept des Food hubs et leur impact sur le développement urbain sont analysées. L'état de l'art sur le concept de Food Hub est présenté en premier lieu, puis une classification des différents types de Food hub est faite en se concentrant sur leur emplacement, zone d'influence et les acteurs impliqués. Enfin, il y a un cas d'étude sur le système d'approvisionnement de nourriture à Bogota, il y a une comparaison entre le modèle présenté et le concept du Food hub comme une alternative efficace pour nourrir la ville d'une manière durable.

Mots-clés : Food hub, logistique urbaine, chaînes alimentaires, chaînes d'approvisionnement durables, la sécurité alimentaire.

Abstract

This paper describes the place and opportunities of food hubs and related food distribution systems. Food systems deficiencies, the emergence of Food hubs concept, and its impact on urban development are analyzed. The state of the art of Food Hub concept is presented at first instance. Then a classification of different types of Food hub is done by focusing on their location, area of influence and stakeholders involved. The Bogota's Food distribution system is described as a study case. Finally, a comparison between the Colombian model and the Food hubs theory as an efficient alternative to feed the city in a sustainable way is performed.

Key-words: Food hub, urban logistics, food chains, sustainable supply chains, food security.

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This paper describes the place and opportunities of food hubs and related food distribution systems. Food systems deficiencies, the emergence of Food hubs concept and its impact on urban development are analyzed. The state of the art of Food Hub concept is presented at first instance. Then a classification of different types of Food hub is done by focusing on their location, area of influence and stakeholders involved. The Bogota's Food distribution system is described as a case study. Finally, a comparison between the Colombian model and the Food hubs theory as an efficient alternative to feed the city in a sustainable way is performed.

Introduction

The task of feeding the cities is a challenge that all governments face today. It involves coordinating multiple agricultural producers, assemblers and distributors, logistics operators and wholesalers, as well as traditional merchants of perishable foods.

With the increasing population in cities, more food and better freight transport system are required. This is evidenced by different studies as [1][2][3], where World Urbanization Prospects report is presented. In this report, on 2011 was predicted that by 2015 67% of the world's population live in urban areas and by 2050 in developed countries this figure will reach 86%.

The implications that bring food supply, such as sustainability, social equity and economic development are the central topic of discussion in various policy areas today. This is shown by the fact that today when the availability of food is assured, it is made with high economic, social and environmental costs [4].

In response to these discussions, the various control entities and supply chain stakeholders have promoted local food production and consumption [5] by reducing the distance that food travels to reach the consumer, compared to conventional channels [6]. This in turn facilitates access to freshest and better quality foods [1]. In the last 10 years, demand for locally grown food has dramatically increased in countries such as the United States [7].

An efficient delivery system is key to ensure the quality of food distributed in an efficient way both time and quality wise [6]. However, according to [8] one of the recurring challenges faced by producers is the lack of a distribution infrastructure that could allow them to better serve the increasing demand for local products in large markets. This added to the fact that the food distribution system seeks to capture the growing demand at lower prices but they do not always share the localization and distribution infrastructure strategies [9].

The idea of creating Food hubs is created as an alternative to solve dysfunctions of local food distribution [10]. According to [11], in recent years the Food hubs have been the focus of attention of many stakeholders in food security, agriculture, and rural development areas among others. This concept is perceived by these groups as a mean of cooperation between them, which has created positive changes in the communities, generating improvements in local food systems [12]. An example of this is the number of Food hubs in the United States that has increased by 65 % since 2009 [13]. However, it is not a concept that has been extensively studied in the literature [14]. There are few studies on food distribution in urban areas in a sustainable way, which take into account social, economic, and environmental impacts [15].

This article analyzes the urban food distribution system focusing on the Food hub concept. In the first part it is defined the Food hub concept, the actors involved and some elements to

consider as infrastructure and logistics organization. Then it is presented a Colombian case of study which describes an analysis about the current situation of the food system focusing on Bogota, the capital city. It is presented a description of the Corabastos Wholesale Market relating it to the Food Hub theory. Finally the implementation limits and future research developments are presented.

1 : What is a Food Hub ?

Multiple definitions of the Food hubs have emerged in the US and in the rest of the world [16]. This type of structures represent a model of organization for food supply providing adequate volumes and services, and promoting it as a sustainable food system [17]. Another definition of Food hubs is an innovative approach that emerges from the aggregation and distribution of locally grown foods [18]. The food hub concept has also become a logistical environment that facilitates the operations of a local food supply chain [17] [12].

According to [19], in recent years , the concept of "Food hubs " has been defined to identify and better understand the specialized logistics platforms for food products. Another work [20] define Food hubs as agreements based on coordinating the distribution of food products from the same origin to conventional or hybrid markets.

The United States Department of Agriculture (USDA) defines the Food Hub concept strictly as " *An organization that actively manages the aggregation, distribution, and marketing of source-identified food products primarily from local and regional* " [8], in order to strengthen local capacities to meet demand for wholesale customers, retailers and end users [21]. As we can see from this non-exhaustive overview, there are different definitions of what can be a Food hub but they have the common point on being collaborative structures that add value to the supply, distribution or sales of fresh food products.

To move the food from the farm to the consumer more directly, an efficient and effective distribution system is needed to gather food from farms to Food hub and Food hub to the consumer, while maintaining an adequate quality of food [22]. To bring food to the Food hub, this new concept proposes three options to farmers: they can bring the product by themselves, they can pay someone who transport from the farm to the Food hub and if they prefer the Food hub offers the products collection process directly from farms [23].

In conclusion, we will define the Food hub as a collaborative system between producer, distributor and trader eliminating middlemen in order to shorten the food supply chain; its main function is to strengthen the supply of agro-industrial products; the characteristics of a Food hub can be of commercial or logistical nature which aims to add value to the final product.

1.1 : Food hubs stakeholders

According to [17], the stakeholders involved in the food supply system in cities are economic agents (producers, wholesalers, retailers [21]); public institutions (municipal and local mayors, Ministry of Agriculture, Ministry of Transport) and private associations (wholesalers, logistics service providers, and consumers) .

According to the roles these stakeholders play in the functioning of the Food hub, [15] classifies them into three categories :

- Wholesalers: They produce and store food wholesale products, they are considered commercial and logistic nodes in the food supply chain. Generally they are producers, importers, wholesalers, processors and storage logistics services supplier.

- Urban Agents: They carry out the last mile transportation and delivery service in the urban area by connecting the wholesaler with the retailer. They are generally suppliers, manufacturers, carriers, logistics service supplier (3PLs).
- Retailers and food services. They are the receptors of foodstuffs. Usually they are traditional outlets and distribution, alternative markets and flea markets, restaurants, hotels, cafeterias, institutional kitchens and companies, among others.

Today, these stakeholders could vary by integrating supply chain led by electronic commerce [24] where the intermediaries are eliminated and replaced by the electronic platform.

For us, the stakeholders of a Food hub from a logistical point of view can be classified as Load Generator (G), Load Beneficiary (B), and Logistics Services Supplier (LSS). The first is the one that generates the load and the second is the beneficiary of the load. Some of the actors can take both roles as appropriate. Meanwhile, there are public institutions that regulate the roles played by each actor/stakeholder. This classification is detailed in Figure 1.

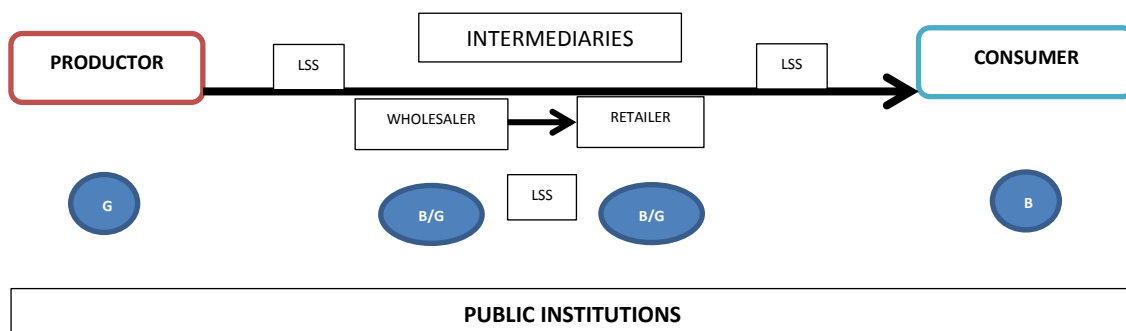


Figure 1 . Food hub stakeholders

1.2 : Food hubs elements

From the overview presented above, and synthesizing the existing literature of Food Hubs, we can identify the main elements that constitute this type of structures. We propose to synthesise them in Table 1.

Food hub elements	Description	
Actor / Stakeholder	<ul style="list-style-type: none"> • Focused on the retailer [25]; Farm -to -business / institution model [8]; Led by retailer through a signed commitment to the producers [20] • Focused on the producer [25]; Led by producer entrepreneur [20] • Focused on the consumers [25]; Farm -to -consumer model [8] • Hybrid model [8]: The food hub sold to buyers in the wholesale market and end consumers. • Led by the wholesale and food services [20]: Originated by traditional wholesale markets and distribution, handling processed food products rather than commodities. 	
Structure	<ul style="list-style-type: none"> • Non-profit organizations [8][25]: Those are developed from community-based initiatives. • Food Hubs in private hands [8]: Those are often structured as a limited liability company or other corporate structure. • Cooperatives owned either by producers and / or consumers [8]. Led by producer cooperatives where they make decisions in a decentralized manner and they share the risks [20]. • Led by the public sector [20]; Food hubs listed on the stock market [8]. It is funded and led by the public sector, which takes into account political, environmental, social, and economic considerations. 	
Functions	Commercial Functions	Logistical Functions
	<ul style="list-style-type: none"> • Markets of local producers who provide sales services [19]. • Retail or diversified (wholesalers and retailers) [26]: They engage in various activities such as wholesalers, retailers, and training, among others. • Processing of convenience [26] : They are engaged in activities that add value to the product, such as washing, peeling, and cutting food, among others. • Physical Services: physical aggregation, classification, packaging, sale and delivery of products. Infrastructure area: 5,000-10,000 square feet [27]. • Intangible Services: They are specialists in coordinating, payment, marketing and product promotion. Infrastructure area: 1,000-4,000 square feet [27]. 	<ul style="list-style-type: none"> • Producer cooperatives offer logistics services in order to increase processed volumes and reduce logistics costs [19]. • Urban logistics areas: Set of companies specialized on food distribution located in the same place [19]. • First mile Consolidation [26]: Works directly with producers to collect and store different products from various communities to centralized locations. • Last mile Distribution [26]: They distribute products to end customers . • Processing conservation: According to [26], the foods are processed with relatively complex storage conditions for product preservation including canning, pickling, and preserving in cold rooms, among others.

Table 1. Food hubs elements to consider

1.3 Sustainability elements

The Food Hubs need to be included into a sustainable development logic [28], as is already done in several non-perishable supply chains [29]. The Food Hub allows not only to meet the local food demand [30] by increasing the local food products supply on a larger scale, but also it brings economic, social and environmental impacts to communities [8] which are listed below in Table 3 .

Economic Impacts	Social Impacts	Environmental Impacts
<ul style="list-style-type: none"> • The conservation and development of local enterprises. Sometimes it is increasing acreage and production capacity [8]. • Improvement of rural economy through job creation and increase local production [12][31]. • It increases farmer income, profitability and viability for producers [32]. • Small farmers can access buyers that previously were inaccessible, it means advantages of large scale economies [31]. • It promotes diverse product differentiation strategies to get better prices [31]. • It provides a wide range of different farmers, which makes them more attractive to buyers on a large scale [23]. • It reduces marketing costs for farmers [31]. • It promotes a good communication and information traceability [33], allowing them to understand the operational costs of products production, processing, transportation, and marketing [8]. • Strengthen agricultural communities, strengthening the food system on a sustainable way over time [8] [26] 	<ul style="list-style-type: none"> • Improvement of the quality of life through generation of employment [31] [34]. • Training and professional development for farmers [33]. It is, creating the next generation of farmers [8]. • Promotes the availability of fresh and healthy food products [8] [18]. • It provides access to local food markets [12] [30] [35] in order to reduce health care costs [35]. • It works closely to the producers [36], who are really valued in this model [31]. 	<ul style="list-style-type: none"> • Reduction of environmental costs for food transportation over long distances through complex distribution networks [23]. • Contribution to reduce wear of local roads [23]. • It encourages farmers to improve their productive capacities in order to develop more reliable supplies of local and regional products grown in a sustainable way [8] • Reduction of energy use and waste generation in the distribution process [8]

Table 2 . Impacts through a Food hub implementation

2: Case Study : Bogotá

Bogota is the capital city of Colombia; it has more than 9.2 million people and it receives on average 200,000 tons of goods per year. According to the IDB (Inter-American Development Bank), Bogota performs logistics activities twenty-four hours a day, seven days a week which

represents about 2,000 daily routes associated with goods transportation. The city has eight accessible ways through which products enter and the city is supplied [37].

Given the particular Bogotá city design, it is hard for transit of large cargo vehicles. For this reason, transporters and distributors are forced to change the vehicles type to smaller vehicles for last mile deliveries. This is reflected by a considerable increase in vehicles that transit in the city and it generates high negative impacts on mobility and environmental issues.

1. Colombian Food System stakeholders

The traditional Colombian food supply consists of a large number of stakeholders, business models, and interests. These stakeholders are not articulated according to [38], and they could hardly articulate nowadays. According to [38][39], the Colombian food system is constituted by various stakeholders. In its commercial chain a product must pass through more than seven stakeholders to reach the consumer, which are: (1) the farmer (producer and seller of fresh food products), (2) first buyer in small farm, who performs the food collection and selection process in a rural market town, (3) second buyer in rural municipality, who owns often transportation and is responsible for the transfer process to the city; however, he can also outsource the transportation process, which includes another intermediary in the supply chain; (4) third buyer, i.e the wholesaler; (5) fourth buyer, i.e. retailers and final marketplaces; (6) fifth buyer, who could be the supermarkets, proximity commerce, and small shops distributor; (7) final consumer. These are grouped according to their logistic function (transporter or distributor) and whether it is urban or rural, as presented at Figure 2.



Figure 2. Supply Chain Fruits and Vegetables Stakeholders

Source: [38]

Meanwhile, [40] explains in detail what are the existing marketing channels in the country, they are: the farm, small town markets, and wholesale markets.

II. Bogota food system function

Consumers who make up the food system in Bogota are divided mainly into three groups according to [40]:

- Lower class: It is the less economically favored population who cannot always buy food products with the necessary nutritional requirements. It represents about 24.8 % of Bogota's population. The main marketing channels are the marketplaces and neighborhood stores.
- Middle class: It corresponds to the population who often sacrifice quality for quantity when they buy food. It represents about 67.8 % of Bogota's population. The marketing channels are neighborhood stores and hypermarkets.
- Upper class: It corresponds to the population who can acquire the volumes they want and with the best quality offered by the market. It represents about 7.4% of Bogota's population. They have access to specialized marketing channels who offer high quality products. .

To analyze the supply system in Bogota, one must take into account the activities from primary production (mostly coming from outside of the city), to processing and distribution.

Road infrastructure

According to [41], food supply monitoring system collects data once a month of the eight major entry ways to Bogota, on the north there are Autopista Norte (North-Central Trunk) and Carrera Septima roads, on the east there are Via la Calera and Choachí roads, on the south there are Villavicencio and Girardot roads and on the west there are the 13th and 80th roads.

Storage capacity

The city has twenty one warehouses in urban areas and three more in the periphery [42]. In Bogotá there are thirty three marketplaces, where Corabastos concentrates much of the wholesale market and it is estimated that it trades 10% of the city food demand [43]. The other wholesale markets such as Uniabastos, Maxiabastos, Paloquemao and Codabas function as retailers [44].

Supplying areas

Bogota has three food supply rings which are detailed in the [42] study and summarized below in Table 2.

Ring Description	Original department (Region)	Supply volume	%	Products
First Ring : Distance ratio of 64 km from Bogota	<ul style="list-style-type: none"> • Cundinamarca (19 localities) 	924.931 Tons	33%	Salt, potatoes, vegetables, milk and other milk based products
Second Ring: Distance ratio of 160 km and 300 km from Bogota	<ul style="list-style-type: none"> • Cundinamarca (97 localities) • Tolima • Meta • Boyacá 	1.236.575 Tons	44%	59.7% Primary consumption products. Meat, fruits, vegetables, cereal, chicken and eggs.
Third Ring	Rest of the country	639.171 Tons	23%	NA

Table 2. Rings for Bogotá food supply
Source: Adapted information from [42]

According to [45], small farmers in Colombia supply about 70% of the food consumed in the city, and they are responsible for most (over 50 %) of the food supplied to Corabastos. This

means that farmers' production is the main responsible of Bogota's food supply. Also, this study describes that for food supply in a sustainable way, the articulation of Bogota to the country's rural areas remains critical.

The Corabastos Wholesale Market

At the beginning of the seventies in Bogota, there were about three million people, at that time there were already problems in the food supply, such as lack of infrastructure and arbitrary prices management [46]. Face to these difficulties, the city's government created the Central de Abastos of Bogota, called Corabastos, and it was inaugurated in July 1972.

[47] defines a central supply as "*An entity whose objective is to facilitate the marketing of agricultural food products by leasing suitable local warehouses and thus food city security is controlled in terms of quality and quantity prices. This commercial equipment must be located in urban land with regional connectivity to the main areas of agricultural production.*"

Corabastos, was created according to [48], in order to solve the excessive demand for agricultural products in the city. However, according to [47] although initially the center was conceived as a project in the urban periphery, it is currently inside the Bogotá area. This urban location, based on [47] has allowed greater coverage in the food marketing within the city, facilitated by factors such as connectivity with neighboring municipalities that are supplied by the city, the development of urban land on the west of the city and the coverage of food security to neighborhoods.

This central supplier is considered from its origin as a pioneer in the country's agricultural trade area [49], supplying other places of the city, supermarkets, convenience stores, fruver

and superetes. Currently it is ranked in the second place in Latin America and in the first place in Colombia [49].

Among the products sold in Corabastos are : tubers, roots, bananas, vegetables and fresh fruits, processed grains, cereals, dairy and eggs, meat, and fish) [46]. It exports products to Peru, Ecuador and Venezuela. It imports products from countries like US, Spain, Chile, Canada, Mexico and Peru. It also plays a decisive role in the economy by fixing the prices of major food products [49]. The shareholding structure is private and public. The official sector represents 48% and private sector represents 52% [49].

Corabastos Infrastructure

Corabastos is one of the major stakeholders in the food supply system at national level, especially for potatoes and leafy vegetables, which are then shipped to other wholesale centers [46]. Corabastos is located in the south of the city; the address is Carrera 80 No. 2-51. To supply Corabastos, food items come from various parts of the country [49]. Those are shown on Figure 3.

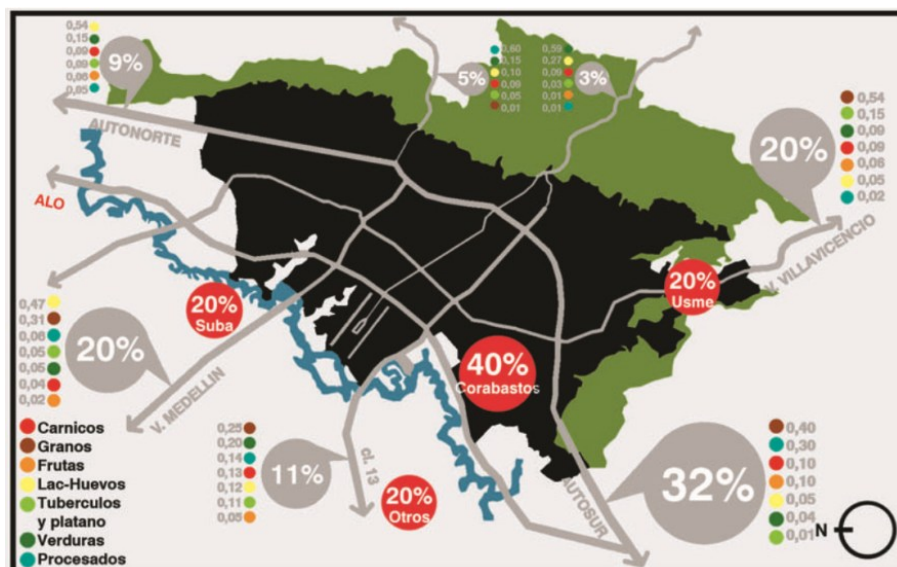


Figure 3. Principal access ways to Bogota food supply system.

Source: [47]

According to data provided by the National Statistical Department, Corabastos on average receives 250,000 people and moves 12,500 vehicles per day. It has approximately 6,500 wholesalers and retailers [46] [47]. According to [50], every day are traded more than 500 products (perishable, grains, and processed foods) which represents 12,400 tons a day of food [49].

Corabastos has a total area of 42 hectares [46]. The warehouses are distributed according to the products and are classified according to their size and storage characteristics, as shown in Table 3. It has 32 warehouses, 29 spaces for trading services, intermediate warehouses, retail areas, hardware stores, packaging area, agrochemicals, cold chain, as well as a super warehouse that brings together nearly 1600 retailers called Bodega Popular [50].

Warehouse type	Number of warehouses	Area (m2)	Storage capacity
1	6	400	51 -100 tons
2	26	225	Until 50 tons

Table 3. Corabastos warehouses classification.

Source: Adapted from [46]

Supply Organization

For supply and marketing, according to [45], schedules are organized based on type of goods and negotiation agreements (This happens when the product is negotiated directly in the producing farms) [46]. Between 5 AM and 2 PM fruits, vegetables, bananas, grains and processed products are commercialized; between 2 PM and 10 PM only vegetables are sold.

According to [49], products relevance is classified in terms of sales and volume, as explained in Table 4 .

Product relevance	Rate of daily sales	Tons sold daily	Products
1	33%	2158	Vegetables: Welsh onion, onion bulb, peas, corn and carrots.
2	26%	1700	Potatoes
3	25 %	1635	Fruit
4	6%	327	Bananas
5	8%	523	Grains and processed
6	2%	131	Eggs , meat and dairy

Table 4. Classification of products in Corabastos based on sales volume
Source: [49]

According to statistics published on Corabastos' website, the regions (departments) that provide greater volumes of food goods are in order: Cundinamarca, Boyaca, and Meta, followed by the rest of the country. As for consumers' coverage, Corabastos supplies 10 million people in Bogota, nearby cities and other wholesalers in the country. This is reflected in 24 billion pesos of sales per day [49].

Limits

Corabastos model presents upstream and downstream high intermediation. This intermediation sometimes affects the quality of products. Also the Corabastos supply management has generated some organization and integration problems between sellers and consumers.

Comparison

Food hubs elements	Corabastos
Actor / Stakeholder	Focused on the retailer [25] Focused on the consumers [25] Hybrid model [8] Led by the wholesale and food services [20]
Structure	Food Hubs in private hands [8] Led by the public sector [20]
Functions	All the commercial functions are performed by Corabastos.

	<p>Logistic functions:</p> <ul style="list-style-type: none"> • Last mile Distribution [27] • Processing conservation [27]
Economic Impacts	<ul style="list-style-type: none"> • It promotes diverse product differentiation strategies [30]. • The conservation and development of local enterprises [8]. • It provides a wide range of different farmers [23]
Social Impacts	<ul style="list-style-type: none"> • Improvement of the life quality through employment generation [30] [33] • Promotion the availability of fresh and healthy food products [8] [18]. • It provides access to local food markets [12] [29] [34]
Environmental Impacts	<ul style="list-style-type: none"> • Corabastos generates 100 tons per year of organic wastes

Table 5. Comparison between Corabastos and SAAB model regarding the Food hub elements

Conclusion

In recent years, several initiatives have been created to improve the current food supply system. Some examples are : "Bogotá without hunger " [45], " Capital District and Region Food Supply Master Plan called PMAAB ", and Bogota Farmers Markets [51], among others.

We corroborated different implementation issues in the solution analyzed. Some of those are: geographical constraints (small farmers are in mountainous regions far from major outlets as well as its raw material suppliers); cultural and political challenges affecting the producers' organization; deficiency and poor relationship between supply chain stakeholders; high levels of intermediation in the handling, distribution and marketing process; among others.

When comparing the Corabastos model with the Food hubs theory, we observe that the model accomplishes several minimum requirements. However, there still exist deficiencies in the system and the programs proposed do not guarantee success over time. Finally, the Colombian model evaluates the expected sustainability impacts according the Food hub theory, especially regarding potential environmental impacts.

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