The role of diverse distribution channels in reducing food loss and waste: the case of the Cali tomato supply chain in Colombia

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1. Introduction

Food loss and waste (FLW) has become a growing concern for the international community in recent years (HLPE, 2014). FLW reduction is commonly identified as a means to address issues regarding food security, natural resources and the economic performance of agrifood systems (FAO, 2013; HLPE, 2014; Lipinski et al., 2013; Lundqvist et al., 2008; Parry et al., 2015; Smith, 2013). There are many incentives and opportunities to reduce FLW in developing countries (Hodges et al., 2011), but the current state of knowledge on FLW in low and middle-income countries is still limited (Affognon et al., 2015; Hodges et al., 2011; Parfitt et al., 2010).

In many middle-income countries, particularly in Latin America, the development of supermarkets in the last two decades has attracted the attention of several scholars (Reardon et al., 2003; Reardon and Berdegué, 2002; Traill, 2006). Supermarket expansion raises multiple development issues (Timmer, 2009). Supermarkets generally change the conditions by which farmers market their produce. They "have different and more demanding product and transaction requirements" than other types of buyer (Hernández et al., 2007) (p. 281). They set up long-term reciprocity agreements (including contractual arrangements) with their suppliers to market large volumes of upgraded food products on a continuous basis (Brousseau and Codron, 1998). They adopt more integrated forms of coordination, e.g. purchasing managers draw up a set of commitments with farmers on a weekly basis. This does not apply to other types of buyer, such as collectors, middlemen, small brokers or non-specialized wholesalers. The latter tend to conduct more spot market-oriented transactions[1] with their suppliers. It is generally acknowledged that supermarkets trigger organizational,

[1] Most exchanges occur in the absence of a binding agreement between buyers and sellers. Commodities are physically exchanged at the time of sale (or purchase) and the supplier is paid immediately.

institutional and technological transformations along agrifood supply chains (Reardon, 2006; Reardon et al., 2004). According to the latter authors, organizational changes concern shifts that have occurred in terms of how supermarkets procure products, i.e. they tend to use specialized procurement agents, centralized distribution centers and specific 'preferred' supplier systems. The institutional transformations are due to the development of private standards that supermarkets impose on their suppliers to guarantee product quality and safety. The technological changes concern improved production practices that require investment, postharvest handling and equipment (e.g. trucks, sheds and cold chains) to be able to meet supermarket requirements. To date, the performances of supermarket and non-supermarket channels have been compared from multiple angles (i.e. economic performance, employment potential, stability and price level, etc.) (Cadilhon et al., 2006; Minten et al., 2009; Neven et al., 2009; Rao and Qaim, 2013, 2011; Wertheim-heck et al., 2015). FLW issues have not yet been addressed, although they might be an indicator of the economic efficiency of the food supply chains (FSC) involved.

The present study was designed to assess the volume of FLW (i.e. unsold food products) along an FSC and to analyze the roles that supermarket and non-supermarket channels play in terms of FLW. The study findings are based on primary data collected along a tomato supply chain in Cali, Colombia. Colombia is an interesting example of a middle-income country because the retail food market is shared by both supermarket and non-supermarket outlets (Guarín, 2009). From an economic perspective, in this study we assumed that unsold food products represent a commercial loss for stakeholders, so unsold products were classified as FLW, regardless of their final destination (e.g. home consumption, compost, etc.). The study had several original features. First, it was focused on FSC related to fresh products from the production to the retail stage. Second, it shed light on FLW in both supermarket and non-supermarket channels. Third, it involved a novel approach to FLW

whereby the coexistence of supermarket and non-supermarket channels (for the same commodity) was considered as a key factor determining FLW levels observed along the FSC. Finally, the study focused on gaining further insight into the implications of supermarket development by conducting a detailed analysis of farmers who marketed their produce using a combination of different types of buyer.

Hereafter the article is structured as follows. The next section presents a literature review and the conceptual framework used to analyze the role that supermarket channels play in terms of FLW in low- and middle-income countries. Section 3 introduces the case study, the existing marketing channels, the empirical database and the method. Section 4 presents the results, which are interpreted in section 5. Section 6 presents the discussion and our conclusions.

2. Literature review and conceptual framework

This section explains how supermarkets are presumed to be linked to FLW, according to the literature on supermarket expansion in low- and middle-income countries. More specifically, the links between supermarkets and FLW are analyzed through the lens of the organizational, institutional and technological changes that supermarkets induce along agrifood supply chains (Reardon, 2006; Reardon et al., 2004).

Supermarkets are considered to be associated with FLW through three closely related pathways. The first is linked to the organizational changes that supermarkets induce in developing countries. Supermarkets establish long-term binding agreements with 'preferred suppliers', thus leading to 'natural selection' among farmers (Boselie et al., 2003) (p. 1159). These outlets are encouraged to work with farmers who have sufficient assets to meet their demands, i.e. guarantee a continuous supply in terms of quantity and quality (Reardon and

Berdegué, 2002), and vice versa (i.e. farmers who are better off are more likely to supply supermarkets rather than other types of buyers). Previous studies have revealed structural differences (producer and farm characteristics) between farmers who sell to supermarkets and those who do not (Chege et al., 2015; Hernández et al., 2007; Neven et al., 2009; Rao and Qaim, 2013, 2011). Although these differences cannot be interpreted as being the net impact of supplying supermarkets, farmers that do supply supermarkets tend to be better endowed in terms of human capital (education or/and training) and material capital (e.g. greenhouses, irrigation systems and means of transport) than those who sell to other buyers. In turn, these assets should be negatively correlated with the amount of FLW recorded by farmers. For example, human capital influences access to as well as adoption and application of available technologies or innovations, which decreases the likelihood of FLW (Addo et al., 2015; Babalola et al., 2010; Basavaraja et al., 2007; Buyukbay et al., 2011; Kumar et al., 2006). Other studies revealed that post-primary education is closely related to lower FLW levels (Delgado et al., 2017; Kaminski and Christiaensen, 2014), which leads to the following assumption:

(A) The supermarket channel has lower FLW as the suppliers (i.e. farmers) are better off (e.g. human and material capital).

The second pathway is associated with technological changes that supermarket development involves (Reardon et al., 2004). In most Latin American countries, it has been observed that supermarket development goes hand in hand with improvements in logistics and coordination systems (e.g. distribution centers and logistics platforms) (Reardon and Berdegué, 2002). Supermarkets and suppliers should adopt best practice logistics to be able to deliver high quality products on time to centralized distribution centers (Boselie et al., 2003; Reardon et al., 2003). In contrast to non-supermarket channels, investments in equipment

such as trucks, cooling sheds and cold chains are considered essential for meeting supermarket quality, volume and delivery time requirements (Reardon, 2006; Reardon and Berdegué, 2002). Boselie et al. (2003) found that providing chilled products or rapid delivery was a key to achieving a successful market trading relationship with supermarkets. In addition, supermarket channels usually benefit from new inventory management practices (e.g. computers for inventory control and ordering systems) (Boselie et al., 2003; Reardon et al., 2003). Product flows between supermarkets and suppliers have to be planned with a high degree of precision (Boselie et al., 2003). In theory, the nature of the trading relationship with supermarkets (i.e. a long-term binding agreement) encourages supermarket suppliers to invest in improved postharvest management practices (Reardon et al., 2003; Reardon and Berdegué, 2002). The next assumption therefore is:

(B) The supermarket channel has lower FLW given that improved logistical facilities and better postharvest management practices are used.

The third pathway is related to the institutional changes brought about by supermarkets. Supermarket participation may be positively correlated with farmers' FLW (i.e. higher FLW) through the implementation and monitoring of private standards. Supermarkets have stricter requirements in terms of quality standards, especially for perishable products (Neven et al., 2009; Rao and Qaim, 2011; Schipmann and Qaim, 2011). With some exceptions (Minten et al., 2010) and contrary to non-supermarket channels, previous evidence has shown that supermarkets buy and sell 'better quality' products (e.g. unblemished tomatoes, etc.) (Michelson et al., 2012; Minten and Reardon, 2008). Farmers have to carry out additional tasks, e.g. sorting, grading, cleaning and packaging, to meet supermarkets' specific quality criteria and ensure product homogeneity (Reardon and Berdegué, 2002). This implies that supermarket suppliers must remove substandard or so-called 'misfit' products at the farm gate

(Di Muro et al., 2016), which may generate higher rates of rejected or/and returned products. This argument supports the last assumption:

(C) The supermarket channel has higher FLW as all agricultural outputs that fail to comply with the stringent quality criteria are withdrawn or rejected.

The three previous and underlying assumptions can be summarized as follows:

Supermarket channels should record significantly lower FLW levels than non-supermarket channels if the following condition is fulfilled: the reduction in FLW due to two supplier assets (i.e. human and material capital) and the adoption of best practices and equipment along the marketing channel has to exceed the increased FLW due to the more stringent quality requirements.

3. Background and data collection method

This section describes the background of the case study. It presents a general overview of how the Cali tomato supply chain and associated marketing channels function. The data collection method is then described.

3.1. Case study

In the 1990s, Colombia launched national economic liberalization policies, including foreign investment deregulation, import liberalization, etc. (OCDE, 2015). These policies fostered rapid supermarket expansion, which in turn impacted FSC both upstream and downstream (Guarín, 2013). Supermarkets developed their own food procurement systems and established higher quality standards for products at the upstream stages. Contrary to

expectations, at the retail stage, supermarket growth has not been detrimental to the existing forms of retailing, such as corner stores (Guarín, 2013). Corner stores, or so-called *tiendas de barrio*, are still very common in the urban food landscape (Guarín, 2009).

The study focused on Cali, the third largest city in Colombia in terms of population. In Cali, as in many other Colombian cities, food products are still sold to consumers through supermarkets, small grocery stores (e.g. corner stores), street vendors and market places, so-called *galerias* and *plazas* (Guarín, 2013). We studied the fresh tomato market because tomatoes represent a major agrifood commodity in Colombia in terms of production, marketing and consumption (Combariza, 2013; Hernández et al., 2013). Fresh tomatoes are harder to handle and market than processed food and many other food products. Handling, transportation and marketing are problematic, especially in the tropics (Addo et al., 2015). How suppliers (e.g. producers) and buyers (e.g. supermarkets, traders, etc.) are organized and the way they market fresh products are important when it comes to avoiding resource misallocation, i.e. unsold food products or FLW (Brousseau and Codron, 1998). There is no link between fresh and processed tomato supply chains.

3.2. Marketing channels

The overall functioning of the Cali tomato chain with its different marketing channels is presented hereafter. All the information was obtained in interviews and surveys carried out at each stage along the Cali tomato supply chain (i.e. farmers, traders, supermarket purchasing managers and corner stores). The data collection procedures are detailed in section 3.3.

Most food delivered in the city of Cali is routed through the two wholesale markets, Cavasa and Santa Elena, and through the marketing channels of the supermarkets. Cali's two wholesale markets are the major fruit and vegetable suppliers for the city's corner stores. In

the wholesale markets, each product is managed by a relatively small number of traders. They have considerable bargaining power and simultaneously act as collectors and wholesalers. Traders collect food products from rural areas and sell them in the city throughout the year. Traders purchase unsorted and/or sorted tomatoes from farmers, but they generally sell sorted products. Most exchanges between farmers and traders are agreed without any binding arrangement. However, not all sales are strictly spot market transactions. Producers often have long-term relationships with traders, but they remain free to make their own marketing decisions (i.e. they are not committed to the buyers). In turn, the wholesale markets supply corner stores, market places, street vendors, as well as the catering sector and supermarket chains in the city.

Supermarkets usually have their own procurement channels, but they rely on wholesale markets to supplement their supply. The percentage of food that supermarkets procure from farmers and traders varies depending on the brand and market conditions (e.g. product shortage) at the time of purchase. Supermarkets establish oral binding agreements and long-term relationships with farmers. Depending on the supermarket brands, farmers are monitored through a rating system based on their ability to negotiate (e.g. competitive price and quality) and fulfil their commitments (e.g. delivery, quality, continuity, etc.). Purchasing managers regularly establish prior agreements with farmers concerning the volume, quality, price, mode of payment, conditions for returning produce, day and time of delivery. Supermarkets provide farmers with a detailed technical sheet on product quality requirements (e.g. size, color, etc.) to ensure consistency with regard to grading criteria. In addition, depending on the supermarket brands, the mode of production (e.g. good agricultural practices) and postharvest management practices (e.g. cleaning operations, tomato baskets, etc.) may also be specified.

Some producers simultaneously rely on different types of buyer. They sell tomatoes to both supermarkets and non-supermarket outlets and deal with both traders and supermarkets. They also combine direct selling and supermarket sales. Similarly, they combine direct selling or sales to traders with sales to supermarkets through cooperatives. These farmers (who rely on different buyers) were considered separately in the present study. They were differentiated from those who solely rely on a single type of buyer associated with a single form of coordination and marketing channel (i.e. supermarkets with binding agreements or traders with more market-oriented relationships).

3.3. Data collection method

Exploratory interviews with experts and a panel of supply chain stakeholders were conducted from November to December 2014. Then surveys were conducted from May to September 2015 on a sample that was as representative as possible of the Cali tomato supply chain (from retailers to farmers). Three semi-structured questionnaires adapted to each FSC stakeholder were used for data collection. Ninety-nine farmers[2], 18 traders and 200 corner stores were surveyed. In addition, data were collected from three major supermarket chains in Cali. According to a purchasing manager interviewed, one of the companies surveyed represented approximately 40% of the supermarket retail market in Cali. Corner stores were selected by using a stratified and weighted random sampling. It was applied in relation to the number of inhabitants living within neighborhoods with different socio-economic strata (Alcaldia de Santiago de Cali, 2013; Camacol, 2014). Almost all the traders managing

[2] Amongst the respondents, two farmers were excluded from the analysis because of harvest failures. Their entire tomato crops had been lost due to pest and disease attacks prior to harvest. Eleven farmers selling tomatoes exclusively to cooperatives or directly to consumers were also excluded from the analysis. Their specific functioning was beyond the scope of the study.

tomatoes in the two wholesale markets of Cali (i.e. Cavasa and Santa Elena) were surveyed. For the farmers, three sources of information were used to select the municipalities to investigate: 1) the list of tomato suppliers provided by traders, 2) the register of the Cavasa wholesale market (i.e. the volume and geographical origin of each type of food entering the market are recorded), and lastly 3) the Colombian Ministry of Agriculture production database to identify the main tomato producing areas. The eight municipalities surveyed represented more than half of the tomato production in the whole department of Cali over the 2010-2013 period. In May 2015, 56% of the tomatoes in the Cavasa wholesale market came from these eight municipalities selected for the survey. Some producers were randomly chosen, while others were surveyed because their names had been mentioned in the interviews (i.e. each stakeholder was asked to report the name of their tomato supplier(s)).

Information was collected on: management practices for unsold food products; the stakeholders' socio-demographic and professional characteristics; agroclimatic conditions (farmers only); storage, transport and handling practices; marketing relationships (e.g. quantity, price, quality, etc.); farmers' perception of market opportunities for selling tomatoes; and their marketing strategies. Purchasing managers provided information on their tomato suppliers, procurement policies, estimates of unsold food products and product return policies, etc. The volume of unsold tomatoes was reported at each stage along the FSC, in addition to purchase and sale prices in relation to product quality. FLW were therefore assessed on the basis of the FSC stakeholder declarations.

Corner stores and traders were asked to report the amounts of FLW of the week before the interview in order to increase the reported data accuracy. Farmers were asked to report data for the last complete tomato crop cycle. Although the self-reported amounts of FLW may not have exactly corresponded to the actual situation, we assumed that they were relatively

accurate. FSC stakeholders manage food products on a daily basis as part of their business and they are highly knowledgeable with regard to the quantities harvested (for farmers) or purchased (for traders and retailers), sold or unsold. FLW estimates should therefore be a good indicator of what happens in the field (Sheahan and Barrett, 2016).

4. Results: FLW along the tomato supply chain according to the marketing channels

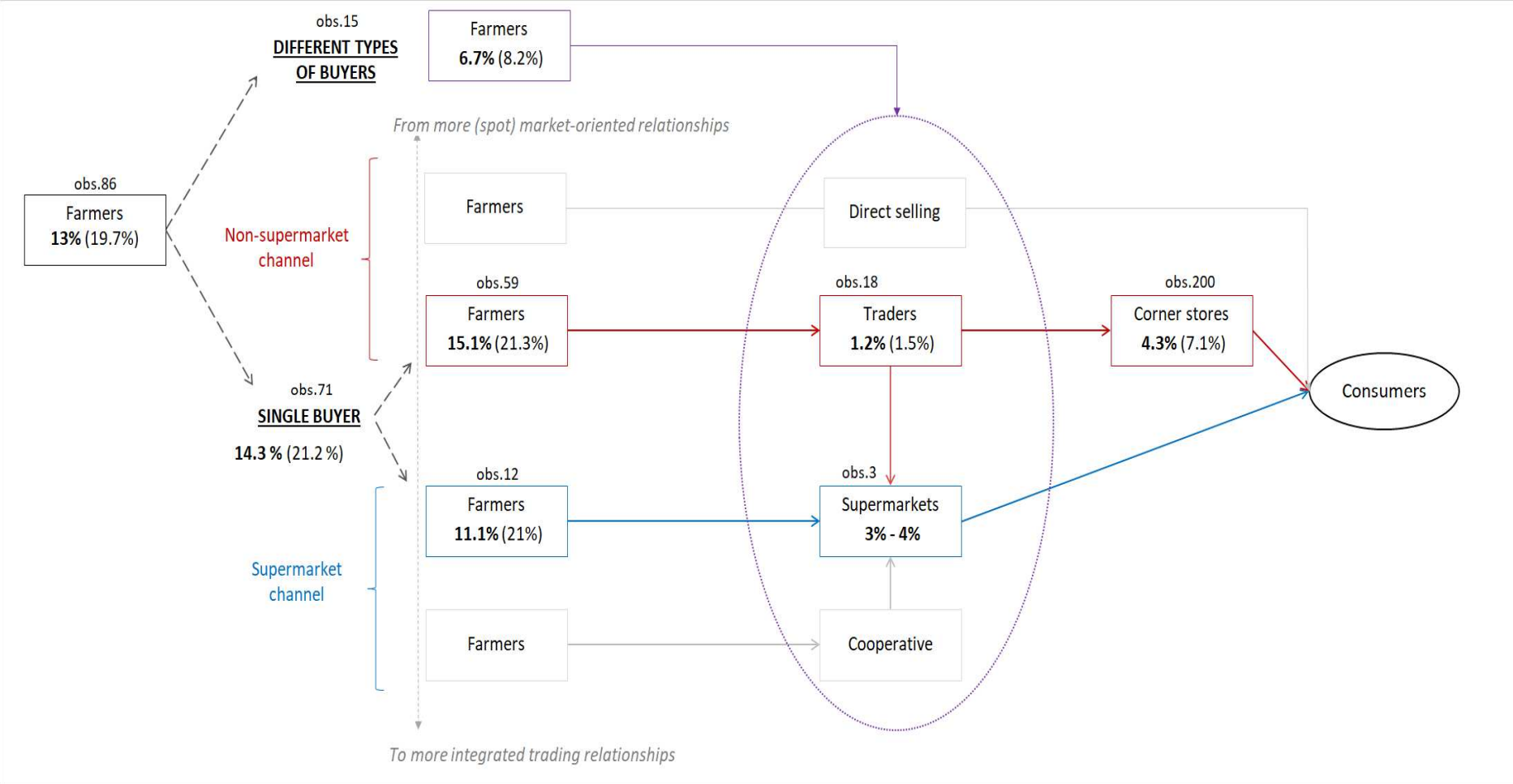
Figure 1 presents the FLW (i.e. unsold tomatoes) observed along the tomato supply chain according to the different marketing channels. The three key findings are summarized below:

1) FLW levels were lower than the 30-50% FLW range previously reported for fresh produce at production and postharvest stages in low and middle-income countries (Gustavsson et al., 2011; Kader, 2005; Parfitt et al., 2010). The average percentage FLW along the whole food chain was 13% at the farm stage, just over 1% for traders and 3-4% at the retailing stages. The approximate average cumulative percentage FLW across the whole FSC was 15-20%.

2) The assumption that significantly lower FLW levels would be recorded in the supermarket channel was partially invalidated. The approximate average cumulative percentage FLW of the supermarket channels (14.2%) was slightly lower than that of the non-supermarket channels (19.7%). However, this difference was not clearcut for two reasons. First, at the retailing stages, FLW levels were similar for supermarkets and corner stores. Second, at the farm stage, the findings of a Wilcoxon-Mann-Whitney test did not reveal any significant differences (at the 10% level) in FLW

when comparing farmers who only sold to traders and those who only sold to supermarkets.

Figure 1. FLW (i.e. unsold products) percentages along the tomato supply chain for the different marketing channels



Source: the authors (numbers are rounded up to 10^{-1})

n.b. average percentages are shown and standard deviations are provided in brackets.

3) We also found that farmers selling to different types of buyer recorded the lowest average ratio of unsold food products (6.7%) in comparison to farmers who only sold to traders (15.1%) or supermarkets (11.1%)

Note that the average cumulative FLW percentages along the different marketing channels (e.g. supermarket and non-supermarket) should be interpreted cautiously for two reasons. First, this indicator of FLW differentiated on a marketing channel basis did not strictly reflect the real situation. The marketing channels overlapped at many stages. As mentioned previously, some farmers in the sample simultaneously relied on supermarket and non-supermarket channels. This observation also applied at the trader and supermarket levels. Traders simultaneously sold tomatoes to corner stores and supermarkets. Similarly, supermarkets purchased tomatoes directly from farmers and traders. Furthermore, stakeholders declared their overall volume of unsold food products, regardless of the type of buyer. For example, traders' FLW generated by their trading relationships with supermarkets could not be differentiated from FLW resulting from their trading relationships with corner stores. Stakeholders managed a volume of food products that had to be sold, irrespective of the buyer's identity. Second, these percentages should not hide the crucial importance of interactions between the marketing channels and how the overlap between them helped reduce FLW across all FSC.

5. Explanations on the results

The following section explains the three key results.

5.1 FLW in middle-income countries

The analysis sheds light on local food consumption habits and on the socioeconomic, institutional and infrastructural setting in which products are marketed. They explain: 1) the diversity in terms of the quality of the tomatoes sold, 2) the relatively high market acceptability of substandard produce, 3) the existence of two types of marketing outlets (i.e. supermarkets and non-supermarkets) associated with different quality requirements, and 4) the relatively favorable agroclimatic and infrastructural conditions that characterized the case study. All of these factors help explain why high FLW levels were not observed in this case study.

5.1.1 Food consumption habits

In Colombia, consumer preferences are diverse when it comes to the quality of purchased tomatoes. The quality of tomatoes sought by consumers depends on how they are to be consumed. Tomatoes are a staple food in the Colombian diet. They are used daily in many local dishes. Tomatoes are eaten raw (i.e. fresh) or cooked and processed at home. Fresh tomatoes are sliced in salads or served as a side dish. When consumed fresh, tomatoes are ideally firm, less mature and visually attractive. On the contrary, when used for home cooking and processing for sauces and stews, very ripe tomatoes are preferred and their visual appearance is less important. For example, ripe tomatoes are used for cooking *hogao*, a tomato sauce used as a base for many dishes. *Hogao* is one of the most common sauces used for seasoning many staple foods, such as beans, rice, potatoes and cassava (e.g. *yuca sudada*). It also goes well with chicken, pork or beef, e.g. *carne desmechada*, *estofado de Res* (classic beef dishes) and *sobrebarriga* (with flank steak). A typical Colombian breakfast consists of tomatoes that are chopped and cooked rapidly with scrambled eggs (*huevos pericos* or *huevos*

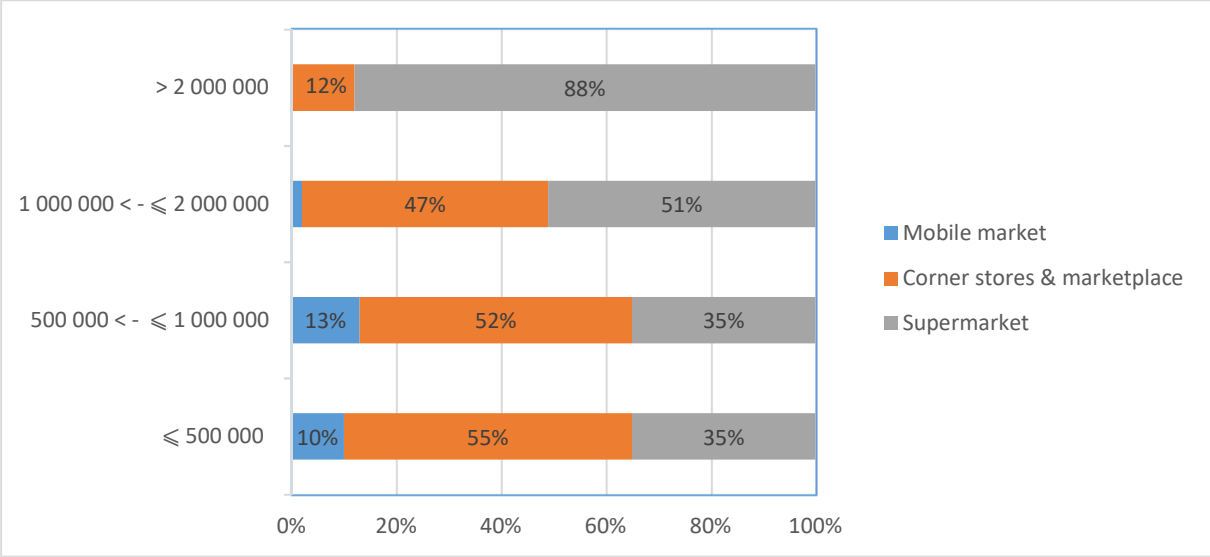
revueltos con tomate y cebolla). The demand for different quality tomatoes is partly related to the diversity of local consumption patterns.

5.1.2 Socioeconomic context

The socioeconomic context in Colombia and Cali also partly explains the differences in consumer choices, in terms of the product purchased and the preferred retail outlet. In Cali, there is huge disparity in income (i.e. the Gini coefficient was 0.479 in 2015) and high sociospatial segregation (Departamento Administrativo Nacional de Estadística, 2016; Vivas Pacheco, 2013). In 2015, 21.5% of the people living in the Cali region were experiencing financial poverty and 5.2% were in extreme poverty, without sufficient resources to satisfy their basic food needs (Departamento Administrativo Nacional de Estadística, 2016). The relatively low price of downgraded and substandard products means that poor consumers (whose priority is essentially affordability) have access to food. The acceptability of downgraded products is therefore relatively high and food purchasing habits are often contrasted as a function of the household income. Low-income households purchase food primarily at corner stores and market places, while high-income households tend to shop in supermarkets (Figure *2*) (Castellanos Peñaloza and Figueroa Ortiz, 2009). Corner stores are still more adapted to low-income households than supermarkets due to their geographical proximity and flexibility (price and supply). Corner stores are mostly located in low- and middle-income neighborhoods, while supermarkets are largely located in wealthy districts. Low- and middle-income households save time and transport costs by purchasing food from corner stores. In addition, households can purchase very small quantities of food in corner stores, which corresponds to the nature and level of their income, i.e. they are likely to be paid on a daily basis or, in the best-case scenario, every 2 weeks. Finally, Guarín (2013) indicated that the average retail prices in supermarkets are significantly higher than in any other outlet

(i.e. street vendors, corner stores, etc.) for four staple products (i.e. tomatoes, potatoes, plantain and beef), excluding the quality criteria. Product quality might explain part of this price difference.

Figure 2. Retail outlet for purchasing food in Cali as a function of household income (COP)



Source: Adapted from Castellanos Peñaloza and Figueroa Ortiz (2009)

5.1.3 Institutional context

The institutional context in which the marketing conditions are governed facilitates the sale of tomatoes of different quality, including substandard products. Although formal market regulations are institutionally designed to promote food product standardization, several indicators suggest that enforcement and monitoring are still flexible. For example, stakeholders identified a large number of quality categories and provided diverse definitions for them during the interviews and surveys. Table 1, which was provided by a farmer during an interview, presents an example of the multiple categories of the tomatoes marketed. It also indicates which tomato categories were prioritized according to the type of retail outlet.

Table 1. Example of the multiple classification of tomatoes

Priority destination	Classification	Weight		Maturation	Size	Appearance
Supermarkets	"Primera"	>100gr	<200gr	Optimal	Medium	Absence of pest damage
	"Segunda"	>50gr	<100gr	Optimal	Small	Absence of pest damage
	"Semi"	>50gr	<110gr	Optimal	Small	Absence of pest damage
Market places (plaza)	"Gallo"	-	-	-	-	*With pest damage*
	"Grueso"	>50gr	<200gr	Overripe	-	Absence of pest damage
	"Parejo"	>50gr	<100gr	Ripe	Small	Absence of pest damage
	"Pichurria"	<50gr	-	Ripe	Small	Absence of pest damage
	"Riñon"	>200gr	-	Optimal	Large irregular shape	Absence of pest damage
	"Malo"	-	-	Overripe	-	*Hit - squashed*

Source: Adapted from a personal classification table provided by a farmer during an interview

Among the stakeholders surveyed (i.e. farmers, traders and corner stores), 85% claimed that there was a market for all tomato qualities, while 15% disagreed. Most farmers perceived this positively (89% of the respondents) as it represented an opportunity for marketing all of their harvested produce.

5.1.4 Specific features of the production area surveyed

The Cali tomato supply chain benefits from relatively favorable conditions in terms of the agroclimatic features of the target production area and infrastructure (i.e. road network). This helps explain the low FLW levels we noted along the tomato supply chain. The area

surveyed (i.e. Valle del Cauca) is under tropical savanna climate conditions. Tomatoes can be grown throughout the year, with two production cycles a year. The conditions for marketing tomatoes are also favorable in terms of access (i.e. road conditions) and proximity (from farm to market). The infrastructure (e.g. primary road network) in the Valle del Cauca region in southwestern Colombia is quite well developed compared to other regions of the country (Semana, 2015). This explains why most of the surveyed farmers (88% of them) did not consider market access (e.g. road conditions) to be an issue in terms of FLW. During the period covered by the survey, most tomatoes marketed in Cali came from the Cali department (i.e. Valle del Cauca). The geographical proximity is beneficial for the tomato supply chain due to the short farm-to-market transport time, thus decreasing the likelihood of FLW.

5.2. Supermarket and non-supermarket channels

Now that the tomato marketing setting has been explained, this sub-section examines the harvest and handling methods along the food chain with the aim of pinpointing differences between the supermarket and non-supermarket channels that would likely play a role in terms of FLW. This helped clarify why the case study findings partially invalidated the assumption that the supermarket channel had significantly lower FLW levels than the non-supermarket channel.

5.2.1 Structural differences that characterized the marketing channels

In the area surveyed and in line with assumption (A), the characteristics of producers and farms varied according to the produce outlets (Table 2). The survey results confirmed that supermarket suppliers tended to be better off in terms of production factors, thus likely reducing their FLW levels. Farmers who sold exclusively to supermarkets had greater human capital (i.e. education) and they were more involved in farm groups than farmers who only

sold to traders. Education would decrease the likelihood of FLW (Delgado et al., 2017; Kaminski and Christiaensen, 2014). Moreover, farmers belonging to a farm group receive support for their agricultural activities (e.g. access to appropriate facilities, advice, training, product marketing support), which could also reduce FLW (Aidoo et al., 2014; Buyukbay et al., 2011). Farmers who only sold their tomatoes to supermarkets tended to be better off in terms of technical and technological factors (i.e. mode of production, farming practices) than those who sold their produce exclusively to traders. Among farmers who exclusively supplied supermarkets, 83%

Table 2. Characteristics of tomato farmers according to the marketing channel

Variables	**Full sample (N = 86)**	**Different buyers [a] (N = 15)**	**Trader [b] (N = 59)**	**Supermarket [c] (N = 12)**
Socioeconomic characteristics				
Gender (i.e. men) (%)	95	100	97	83
Age (years)	42.8 (11.3)	42 (11.7)	43.1 (11.4)	42.25 (11.2)
Education (years)	7.6 (4.1)	8.1 (3.5)	7 (4) **	10.1 (4.7)
Farm characteristics				
Agricultural area (ha)	4.7 (7.9)	9.5 (16.5)	3.9 (4.5)	2.6 (2.7)
Farming experience (years)	17.6 (12.4)	21.1 (10)	17.5 (12.7)	13.6 (13.1) *
Member of a farm group (% of yes)	13	20	7 **	33
Open field cultivation (%)	60	67	68 ***	17 ***
Farm with no specific techniques and technology (%)	56	53	63 **	25
Involvement of family members (% of yes)	20	13	24	8

n.b. Mean values and average percentages are shown. For continuous variables, standard deviations are provided in brackets.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.
[a] Significance levels in this column refer to the difference between farmers selling to different buyers and those selling only to traders
[b] Significance levels in this column refer to the difference between farmers selling only to traders and those selling only to supermarkets
[c] Significance levels in this column refer to the difference between farmers selling to different buyers and those selling only to supermarkets

used greenhouses and semi-closed greenhouses, but this percentage dropped to 32% for farmers who only sold to traders (while 68% grew field tomatoes outside). Tomatoes cultivated outdoor are more exposed to diseases, pests and harsh climatic conditions than those grown in fully- or semi-closed greenhouses. Similarly, 63% of farmers who sold to traders stated that they cultivated tomatoes without using any specific techniques or technology (e.g. lack of proper irrigation systems, no advanced production techniques, etc.). This percentage was around 25% for supermarket-oriented farmers. Another difference worth mentioning (although not statistically significant) is that farmers who sold to different types of buyer cultivated a larger area of land (9.5 ha on average) than those who only sold to a single buyer. This may have been due to the fact that the agricultural output volume must be sufficiently high to prompt farmers to diversify their outlets.

5.2.2 Logistics and postharvest management practices for the different marketing channels

The survey results contradicted assumption (B). The facilities in terms of logistics and the handling and postharvest management practices (e.g. delivery time, storage time, packaging facility used for transport, harvest frequency, etc.) did not significantly differ between the supermarket and non-supermarket channels (Table 3). Regardless of the marketing channel, tomatoes were transported by truck (unrefrigerated) and always kept at ambient temperature from the production to the retail site. However, short-term storage and short farm-to-consumer time characterized the Cali tomato supply chain. Delivery was fast, with an average transport time 1.5-2 h. Similarly, the harvest-to-sale time was reduced, which decreases the likelihood of FLW (Aidoo et al., 2014; Babalola et al., 2010; Kaminski and Christiaensen, 2014). In the sample, most farmers were notified by their buyers the day before the physical sale at least. All farmers who supplied supermarkets and two-thirds of farmers who sold to traders received orders in advance. This helped farmers organize their harvests

before the sale. Information sharing and especially advance ordering help reduce FLW (Cadilhon et al., 2003; Moustier, 2010; Taylor and Fearne, 2009). Farmers sold their tomatoes on the harvest day (58%) or the day after (37.5%). The harvest days were usually planned on the actual day or the day before the wholesale market, or according to the supermarket delivery schedule. Tomatoes were transported from the farm to the traders' premises and/or to supermarkets. At the wholesale stage, tomatoes were delivered to traders and then sold the same night (1/3 of traders) or at the next market (two days of storage). The same applied at the retail stage. Corner stores kept tomatoes for no more than 2.5 days after purchase on average. In the supermarket channel, depending on the brand, perishable food products could be delivered directly to the stores or to distribution centers before being sent to the retail outlets.

Table 3. Handling and management practices at the farm stage according to the marketing channel

Variables	**Full sample (N = 86)**	**Different buyers [a] (N = 15)**	**Trader [b] (N = 59)**	**Supermarket [c] (N = 12)**
Harvest practices				
Harvest frequency (>2 per week) (%)	23	27	25	8
Harvest duration (days)	97.8 (31.9)	108.7 (30.7)	95.5 (33.2)	95.5 (25.3)
Harvest timing (% that harvest in the morning only)	44	20 *	46	67 **
Additional handling				
Sorting and washing	45	60 *	34 ***	83
Sorting (% of yes)	86	93	81	100
Washing treatment (% of yes)	53	67	44 **	83
Storage practices and handling				
Do not store (e.g. sell the same day) (%)	58	67	57	50
Packaging facility used for sale (plastic baskets) (%)	99	100	98	100
Transport practices and handling				
On-farm sale (%)	30	27	37 **	0 *
Mode of transport (truck) (%)	87	100	84	80
Duration of transport (min)	92 (48)	94 (35)	94 (49)	79 (60)

n.b.: Mean values and average percentages are shown. For continuous variables, standard deviations are provided in brackets.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.
[a] Significance levels in this column refer to the difference between farmers selling to different buyers and those selling only to traders
[b] Significance levels in this column refer to the difference between farmers selling only to traders and those selling only to supermarkets
[c] Significance levels in this column refer to the difference between farmers selling to different buyers and those selling only to supermarkets

Tomatoes were generally not harvested more than twice a week (75% of the responses) or three times a week (25%). Regardless of the marketing channel, tomatoes were harvested at different maturity stages. The farmers claimed that they harvested their tomatoes when they were starting to ripen, were half ripe or were at an advanced state of ripeness. Irrespective of the marketing channel, no particular problems were identified at the farm gate regarding the adequacy of the workforce (i.e. the involvement of family members, workers' experience) (Babalola et al., 2010; Kumar et al., 2006) and labor availability (Basavaraja et al., 2007; Kaminski and Christiaensen, 2014; Kumar et al., 2006). Tomatoes are mainly harvested using plastic boxes (e.g. buckets) (94%). Other facilities, such as wooden baskets or bags made from fiber, are still used but are less common (6%). Tomatoes were placed in plastic boxes, then poured onto wooden racks for sorting. Otherwise they were placed directly in the plastic baskets in which they were sold. Both supermarkets and traders purchased tomatoes in plastic baskets. The tomatoes remained in these plastic baskets at the wholesale stage after purchase while awaiting sale to a supermarket. Otherwise, tomatoes were transferred into wooden baskets and protected with layers of paper because this was cheaper. More than half of the corner stores thus claimed that they bought tomatoes in wooden baskets (52.5%), compared to plastic baskets (16.5%), while the remaining corner stores purchased tomatoes by weight (31%) using plastic bags or 'home packaging'.

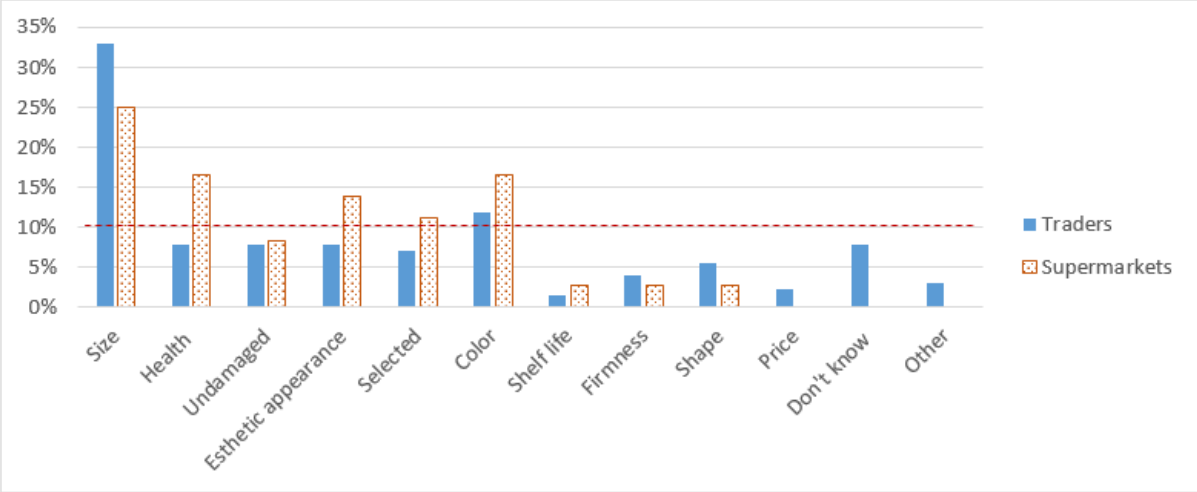
After harvest, farmers sold unsorted tomatoes directly (18%) or sorted them prior to sale (82% of the responses). It is recommended that food products be selected at the farm gate to avoid the spread of pathogens downstream in the FSC (Arah et al., 2016; Buyukbay et al., 2011; Cámara de comercio, 2015). In addition to sorting, farmers sometimes cleaned their tomatoes before sale to make them more attractive to customers. On-farm sorting and cleaning helps prevent FLW further downstream in the tomato supply chain (e.g. retail stage). Nevertheless, the volume of unsold tomatoes at the farm stage would likely be higher when tomatoes are sorted due to the withdrawal of products failing to meet market standards. Farmers who sold to supermarkets were obliged to sort and clean their tomatoes. This did not necessary apply to other farmers who could sell unsorted tomatoes to traders. However, the percentage of farmers who sorted tomatoes before selling to traders was surprisingly high (81%) and not significantly different from the percentage of those who sold to supermarket outlets. The stringency of the tomato quality criteria imposed on farmers was another crucial factor which may have boosted the FLW.

5.2.3 Quality requirements according to the marketing channel

The data revealed that supermarket and non-supermarket channels were complementary with regard to the differential in tomato quality criteria. At first glance, this also corresponded to assumption (C). In terms of product attributes and categories of tomatoes sold, the supermarket channel requirements were stricter than those of the non-supermarket channels. For example, there were more supermarket specifications at the farm stage compared to traders' requirements (Figure 3). Farmers who sold to supermarkets prioritized five attributes, i.e. tomato size (25%), health (17%), color (17%), physical appearance (14%), while underlining the importance of selection and presentation (11%). These criteria were consistent with a technical sheet provided by a supermarket purchasing manager during an interview

(Table 4). Only two attributes appeared to be important for farmers who sold to traders, i.e. size (33%) and color (12%). The criteria used by farmers who sold to traders were more diversified and heterogeneous than those who sold to supermarkets. In addition, 8% of farmers who sold to traders were unaware of the traders' quality criteria.

Figure 3. Quality attributes declared by farmers depending on the type of buyer



Source: the authors

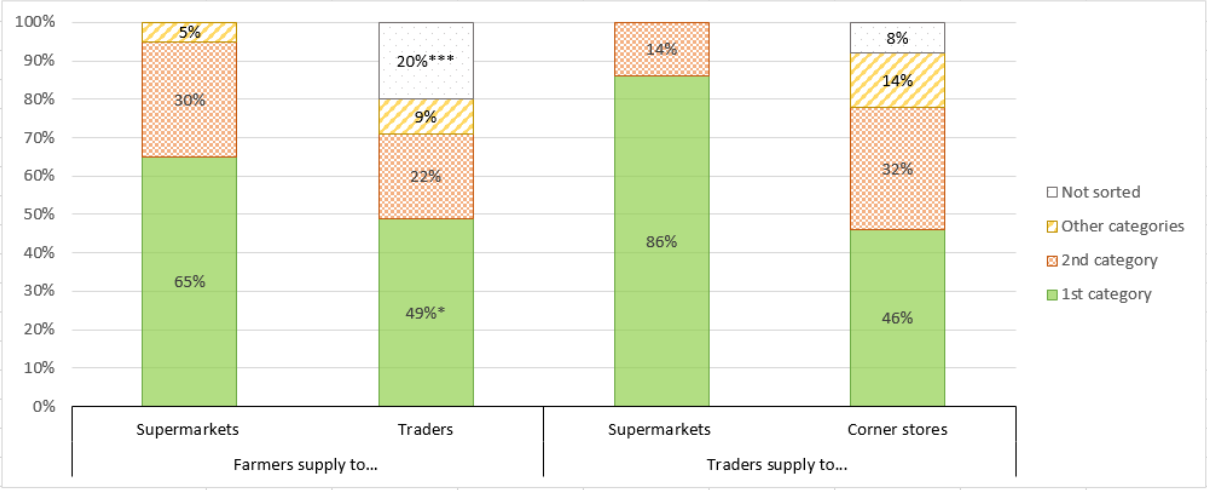
Table 4. Overview of the technical requirements of a supermarket chain

Conditions of acceptance:	**Conditions for rejection:**
- Whole ovoid-shaped tomatoes - Fresh appearance - Firm texture - Weight ⩾ 100 gr - Size: 5.5 cm 	- Signs of bruising and burst - Wrinkled skin and texture - The presence of fungi or insects - Abnormal external moisture - Extreme maturity - Visual traces of fumigation 

Source: Adapted from a technical sheet provided by a supermarket purchasing manager during an interview

Similarly, in accordance with the supermarket criteria, farmers supplied a far higher volume of category I tomatoes to supermarkets (65%) than to traders (49%) (Figure 4), and the same applied at the wholesale stage. Traders sold higher volumes of category I tomatoes to supermarkets (86%) than to corner stores (46%). Moreover, traders purchased unsorted products from farmers and resold them to corner stores, but this never happened in the supermarket channel.

Figure 4. The quality of tomatoes requested by the different FSC stakeholders



Source: the authors

n.b.: At the farm stage, some differences in tomato quality between farmers who sold to traders and those who sold to supermarkets were significant at the 10% level (*) and at the 1% level (***).

These results confirmed that the supermarket channel had more stringent quality requirements. However, as we will see next, further analysis failed to clarify the extent to which higher quality criteria generated higher FLW in the supermarket channel, or whether the lower quality criteria in the non-supermarket channel led to lower FLW.

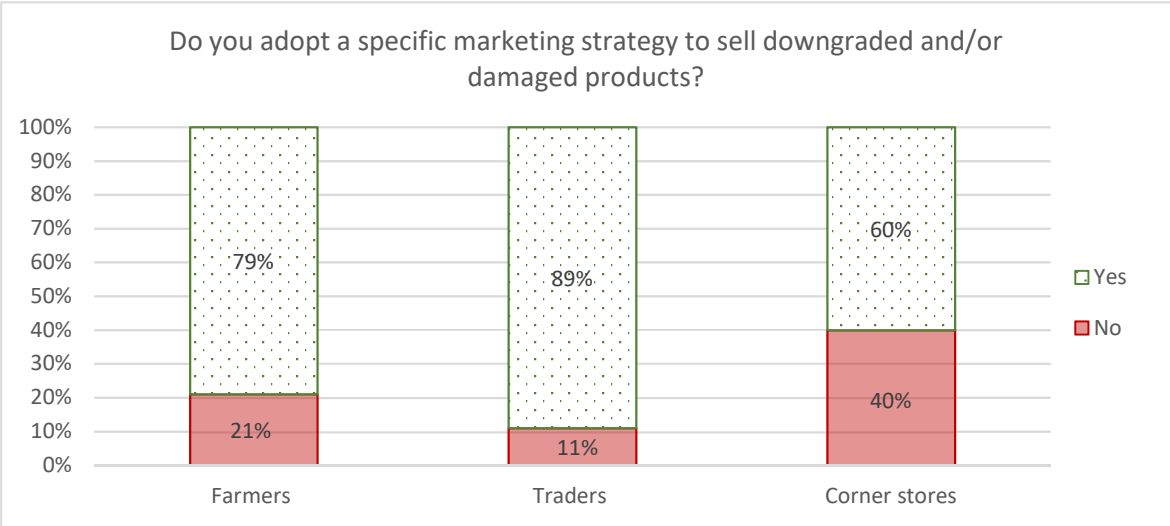
5.3 Marketing strategies and multiple forms of governance

Before discussing why the positive link between the quality criteria and the FLW level was unclear (assumption C), especially at the farm level, the following sub-section introduces the stakeholder marketing strategies implemented to overcome the risk of being left with unsold food products. The stakeholder strategies used to target and combine the two marketing channels are then discussed with regard to their role in reducing FLW levels.

5.3.1 Specific marketing strategies

The survey results showed that most stakeholders claimed to use a specific marketing strategy to avoid being left with unsold tomatoes and promote the sale of lower grade produce (Figure 5). Farmers who were reluctant to adopt specific measures to sell downgraded and/or damaged products argued that they wanted to avoid any adverse effects on their other sales. The preferred marketing strategy for selling poor quality tomatoes was to lower the price, which was the most effective way to conclude a sale. Stakeholders also sometimes lowered the price

Figure 5. Marketing strategies implemented to sell damaged/downgraded tomatoes



Source: the authors

for other reasons, such as oversupply. However, according to the traders' responses, oversupply (22%) was only the third reason for offering a price reduction, after damaged tomatoes (39%) and reduced quality (33%). Another selling strategy emerged at the farm stage. Farmers strived to find alternative outlets to sell damaged and downgraded products. They sold their produce to different buyers, at market places and supplied neighboring cities where the quality requirements were lower, etc. Stakeholders simultaneously sold their tomatoes to different buyers, who were generally associated with both supermarket and non-supermarket outlets.

5.3.2 Trade relations according to the marketing channel

In compliance with the quality criteria differential observed between the two types of outlet, farmers who sold exclusively to traders (61%) claimed to sell downgraded and/or damaged produce significantly more easily than farmers who only sold to supermarkets (33%). However, contrary to assumption (C), the fact that the product requirements imposed by traders were lower did not mean that farmers sold their whole harvest to traders more easily in comparison to those who only sold to supermarkets.

More than half of the farmers (56%) claimed that they had experienced situations where their produce was not up to par and they had struggled to meet the traders' requirements, even though they were lower than those of supermarkets (Table 5). Once the crops were harvested, farmers had nothing to lose by selling their entire harvest to traders (as the production costs had already been covered) unless they were obliged to pay transport costs (i.e. in this case, farmers only transported their products when the sale price offset the transaction costs). However, traders had a limited absorption capacity with regard to buying low-grade products

for two reasons (apart from production shortage situations). First, the lower grade tomato absorption capacity was limited in financial terms given that the sale price had to offset the transaction costs (i.e. transport cost, labor, etc.), while taking the reduced profit margin with lower grades into account. For example, between the 1st and the 3rd category or other categories, the survey results showed that the traders' average gross margin decreased by approximately 40%. Second, traders would take a risk when transporting lower grade tomatoes because they would perish more quickly, thus increasing the likelihood of accumulating unsold tomatoes. Furthermore, the traders' position was underpinned by the market structure, i.e. few traders purchased tomatoes from a large number of farmers, thus increasing the traders' choice in terms of the product (i.e., price, quality, etc.). This was confirmed by the farmers in the survey, who claimed that uncertainty was quite high with regard to the traders' quality assessments (64%) and monitoring (36%). However, despite traders' relatively high acceptability for downgraded and/or damaged products, it was insufficient to absorb all the agricultural produce offered by farmers. Similarly, although farmers who sold to supermarkets were better able to meet supermarket requirements (e.g. human and technical assets), they were still sometimes unable to meet the product specifications (58% of these farmers). Regardless of the quality criteria, farmers who sold only to traders or those who sold only to supermarkets declared that they often experience difficulties in meeting buyers' expectations, but this was seldom the case for farmers who sold their produce to different buyers.

Table 5. Characteristics of the trading relationships according to the marketing channel

Variables	**Full sample (N = 86)**	**Different buyers [a] (N = 15)**	**Trader [b] (N = 59)**	**Supermarket [c] (N = 12)**
Fails to meet requirements[1] (%)	48	7 ***	56	58 ***
Uncertainty on quality assessment[2] (%)	55	20 ***	64	58 **

Level of quality monitoring[3] (%)	34	27	36	33

n.b.: Average percentages are shown.
[1] Farmers who stated that they failed to satisfy the buyer's requirements.
[2] Farmers who claimed that the buyer did not always grade tomatoes as expected.
[3] Farmers who claimed that the buyer was very strict about monitoring quality at purchase
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.
[a] Significance levels in this column refer to the difference between farmers selling to different buyers and those selling only to traders
[b] Significance levels in this column refer to the difference between farmers selling only to traders and those selling only to supermarkets
[c] Significance levels in this column refer to the difference between farmers selling to different buyers and those selling only to supermarkets

Farmers who sold to different buyers were far less exposed to situations where their products did not meet the buyers' requirements (7%) compared to other farmers. Similarly, farmers who sold to different buyers tended to report a lower level of uncertainty with regard the quality assessment (20%) compared to other farmers (64% for traders and 58% for supermarkets). By selling tomatoes to different partners with different requirements, stakeholders were able to ensure a market outlet for both high and low quality products and minimize the unsold produce volume. This point was put forward by farmers and traders in response to open-ended questions. One of the two reasons given by producers (47%) in the survey to justify why they sold tomatoes to different buyers was that it was a way to guarantee the sale of all their produce (each buyer purchases different quality tomatoes). Traders reiterated this in their survey by claiming that they sold to different types of buyer simultaneously to ensure that they would sell the whole purchased volume (including tomatoes of different qualities). This result was consistent with the lowest average percentage FLW recorded by farmers who sold to different types of buyer (6.7%) in comparison to those who sold only to supermarkets (11.1%) or only to traders (15.1%). In addition, the complementarity and overlap between supermarket and non-supermarket channels likely encouraged the transfer of food products between different marketing channels. Products that did not comply with a given marketing channel (e.g. supermarket) could be transferred to

other more appropriate market outlets to prevent FLW (e.g. non-supermarket channel) thanks to the diverse marketing channels and stakeholders' varied coordination strategies. This seemed to lower the level of FLW observed throughout the tomato supply chain.

6. Discussion and conclusions

In this study, we assessed quantitative FLW in the tomato supply chain from production to retail stages and highlighted the role that supermarket and non-supermarket channels play in terms of FLW. Although the analysis was limited to a case study, may not have been representative of FLW throughout Colombia, and did not take FLW into account at the consumer stage, the results were in line with the findings of other case studies that found lower FLW estimates than those highlighted by the literature in developing countries as they were less than 30% (Kaminski and Christiaensen, 2014; Minten et al., 2016). These lower FLW rates found here may be due to a number of factors. First, the tomato supply chain benefitted from relatively favorable conditions (agroclimatic features of the production area and infrastructure). Second, unsold produce levels were relatively low along the tomato supply chain, due to: 1) the diversity of consumer preferences regarding tomato quality, 2) the short harvest-to-retail delivery times, 3) the marketing strategies adopted by stakeholders to sell downgraded and damaged products, and 4) the complementarity and overlap between supermarket and non-supermarket channels.

In addition, the case study findings partially invalidated the assumption that the supermarket channel had significantly lower FLW levels than the non-supermarket channel. The supermarket channel had slightly lower FLW levels than the non-supermarket channel yet the FLW differences were not significant. FLW levels were similar for supermarkets and corner stores at the retailing stages. Greater differences in FLW were observed between

farmers who only sold to traders and those who only sold to supermarkets, but these differences were not significant. The findings confirmed that supermarket suppliers were better off in terms of human and material capital than those who sold their tomatoes to the non-supermarket channel (assumption A was confirmed). However, the logistical facilities used and the handling and postharvest management practices adopted (e.g. delivery time, storage time, packaging facility used for transport, harvest frequency, etc.) did not significantly differ between the supermarket and the non-supermarket channels (assumption B was refuted). Moreover, regardless of the observed differences in quality requirements between supermarkets and traders, farmers who sold only to traders or only to supermarkets both declared that they sometimes had a hard time meeting the buyers' expectations (assumption C was partially invalidated). This was seldom the case for farmers who sold to different buyers. Stakeholders were able to ensure a commercial outlet for both high and low quality tomatoes by selling to different partners with different quality requirements. They thus took full advantage of the complementarity of buyers and marketing channels. These farmers recorded the lowest FLW levels compared to other producers.

Table 6. Summary of the results

Key results	Explanations

(1) FLW estimates (less than 30%) were lower than those highlighted by the literature in low and middle-income countries (Kaminski and Christiaensen, 2014; Minten et al., 2016)	• Favorable specific conditions of the case study (i.e. agroclimatic conditions, market access, infrastructure, etc.)
	• Short harvest-to-retail times
	• Demand for different produce quality and high market acceptability for substandard produce:
	  o Diversity of food consumers' preferences regarding produce quality
	  o Socioeconomic context marked by huge income disparities
	• Market conditions facilitated the sale of different produce qualities, including substandard produce:
	  o Flexible institutional framework (enforcement and monitoring)
	  o Specific marketing strategies adopted by stakeholders to avoid being left with unsold food products
	• Complementarity and overlap between supermarket and non-supermarket channels facilitated the transfer of food products between different marketing channels

(2) FLW did not significantly differ between the supermarket and the non-supermarket channels	• Supermarket suppliers were better off in terms of human and material capital than those who sold to the non-supermarket channel (assumption A was confirmed) • The logistical facilities used and the handling and postharvest management practices adopted did not significantly differ between the supermarket and the non-supermarket channels (assumption B was refuted) • The link between quality criteria and FLW was still uncertain (assumption C was partially invalidated) o Regardless of the differences in quality requirements observed between supermarkets and traders, farmers who sold only to traders as well as farmers selling to supermarkets only declared that they experienced difficulties in meeting buyers' expectations
(3) Farmers who sold to different types of buyer recorded the lowest average ratio of unsold food products in comparison to farmers who sold only to a single type of buyer	• Farmers who sold to different buyers were far less exposed to situations where products did not meet the buyers' requirements compared to other farmers • They sold tomatoes to different buyers as it was a way to guarantee the sale of all their produce (each buyer purchased different quality tomatoes).

Source: the authors

This study was a first attempt to analyze the overlap and complementarity between supermarket and non-supermarket channels and to monitor farmers who sold their produce to different types of buyer. The results did not reveal the superiority of any marketing channel over another in terms of FLW. Instead we found that the coexistence of the supermarket and non-supermarket channels with their complementarities and overlap made the overall tomato supply chain economically efficient in terms of FLW. There were spillovers between supermarket and non-supermarket channels, as also highlighted by Schipmann & Qaim (2010). Contrary to expectations, these spillovers were in both directions. Supermarkets supplemented their food procurement in the wholesale markets by indirectly upgrading the quality of the food products marketed along the non-supermarket channel. In the wholesale market, products were partially marketed using the supermarket classification system (i.e. 1st and 2nd categories). Conversely, by purchasing products on wholesale markets, supermarkets showed greater flexibility in terms of the quality of the tomatoes purchased. They did not sell 'high quality' tomatoes exclusively. They also sold downgraded tomatoes with different packaging (e.g. *bolsas de 1000 COP*) to appeal to more consumers. These results warrant

future studies that should go beyond straightforward comparisons of supermarket and non-supermarket channels and focus more specifically on the spillovers and complementarities between these marketing channels.

In addition, the study highlighted that it would be important to closely examine stakeholders who adopt diverse marketing strategies (and/or diverse procurement strategies) and who simultaneously rely on both supermarket and non-supermarket channels. In the literature, it has been recognized that a number of farmers simultaneously rely on supermarkets and other types of buyer (Hernández et al., 2007; Michelson et al., 2012; Neven et al., 2009; Rao and Qaim, 2011), but these studies did not make the distinction with regard to such farmers, i.e. they were overlooked or classified within one of two categories to facilitate a comparison between those who were part of the supermarket channel and those who were not. This approach may bias the assessment of supermarket impacts on farmers. For example, such impacts (e.g. on income) might be overestimated if farmers are classified as 'strict' supermarket suppliers, although they may actually be also gaining additional income by selling non-compliant products to other types of buyer, which would not be possible if they only traded with supermarkets. Future studies on this trend are needed.

Our study also had some limitations linked to the restrictive sub-samples (e.g. farmers who sold to different buyers and those who only sold to supermarkets) and the descriptive statistics. The restrictive sub-samples did not make it possible to differentiate between the category of farmers who sold tomatoes to different buyers in terms of the combination of buyers and their relative importance. The 'different buyers' category included all producers who relied on supermarket and non-supermarket channels directly (e.g. they sold to supermarkets and traders) or indirectly (e.g. they sold to cooperatives and traders). For a more

accurate and consistent analysis, it would be interesting in future studies to distinguish between each combination of buyers, their relative importance and the implications.

Two other implications should be discussed. In the tomato supply chain, the logistics and handling and postharvest management practices were not fully optimized or very technically advanced, at least from a 'developed world perspective'. However, we explain that the potential adverse impacts of this partial supermarket-oriented process on FLW were partially offset by the diverse marketing channels, the flexible institutional framework and the high degree of acceptability of downgraded and damaged tomatoes. Indeed, some authors have argued that FLW performance might be better in developing countries than in developed countries where quality and cosmetic criteria are more restrictive and where substandard products are often lost and wasted (Guarín, 2013; Kader, 2005; Minten et al., 2016; Parfitt et al., 2010). Yet the degree of acceptability of downgraded and damaged tomatoes largely depends on the target product, the food habits (i.e. food preparation and consumption) and the socioeconomic setting (i.e. consumer priorities). In Colombia, consumers are probably not particularly selective about product attributes such as visual appearance when they buy tomatoes as they are generally consumed and semi-processed at home. Advanced ripeness and most of the damage caused to tomatoes (with the exception of rotten or diseased tomatoes) do not markedly affect their taste, which is not the case for many other food products.

In addition, while the flexibility of the institutional framework and/or the low level of marketing control with regard to tomato quality may avoid the accumulation of unsold tomatoes in the supply chain, major deficiencies exist in relation to the safety and sanitary aspects of the products marketed. Food product safety is not sufficiently controlled as food products are often altered by the presence of pathogenic microorganisms and pesticide residues (CONPES, 2007). "In Colombia, one of the most limiting factors in tomato

production is the mismanagement of pest problems due to improper use of chemical pesticides" (Arias et al., 2014). Although in this study we noted differences in quality requirements between the supermarket and non-supermarket chains, these differences did not necessarily involve safety and sanitary issues related to on-farm pesticide management. First, procurement policies promoting safe and healthy agricultural practices often differed between supermarket brands. Second, some evidence suggested that when specifications existed little effort was made to closely monitor and enforce the associated policies. Some farmers expressed concern during the survey about eating their own tomatoes due to the intensive pesticide and chemical fertilizer inputs. This obviously raises questions about environmental degradation at the farm level, as well as the safety and sanitary risks for consumers (i.e. suspiciously high pesticide residue levels) and farmers, who may not have adequate protection when applying agrochemicals.

Finally, two policy implications emerged from this study. First, the results showed the importance of preserving the diversity of marketing channels to avoid unsold food products, meet the range of consumers' needs, while providing greater marketing opportunities for farmers. Public authorities should therefore aim to preserve the balance between supermarket and non-supermarket channels. Urban planning and public support could be two important levers for potential public action. Moreover, the study highlighted the importance of raising awareness amongst local authorities with regard to setting up a program for monitoring pesticides used on locally consumed produce, such as tomatoes (Arias et al., 2014; Bojacá et al., 2013), and of investing in training and technical assistance to farmers.

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