

# TOWARDS SUSTAINABLE FOOD SUPPLY CHAINS

## Reducing post-harvest losses in the Avocado supply chain through innovative collaboration



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## ABSTRACT

To produce food that is never consumed, a surface area larger than Canada and India together is used, three times the water volume of Lake Geneva is squandered and large areas of high biodiversity are deforested. Yet, roughly one third to half of all food globally produced is lost or wasted along food supply chains (FSCs). The food losses and waste that occur after harvesting and before reaching the consumer, i.e., postharvest losses, are of particular interest, since addressing losses early in the FSC would avoid the environmental, social and economic costs that add up with every additional step of the food supply chain. The reduction of postharvest losses is therefore increasingly recognized as crucial to the sustainability of food supply chains. In global food supply chains the focus of postharvest losses lies on developing countries, since it is there where the majority of agricultural exports are produced and where postharvest losses are the highest. Fresh fruit and vegetables have the highest postharvest losses worldwide along food supply chains, losing roughly 45% to 50% of all the yearly production.

Previous research on postharvest losses has mainly focused on quantitative problems and technological solutions. This research focuses on understanding the organizational inefficiencies that lead to postharvest losses, and suggests that innovative collaboration along the FSC can contribute to their reduction. Innovative collaboration is defined here as the improvement or creation of inter-organizational relationships through which FSC participants can **exchange information, align incentives, engage in effective partnerships and improve their use of technology**. The global aim of this research is therefore to explore how innovative collaboration influences the sustainability of global food supply chains through the reduction of the organizational inefficiencies that cause postharvest losses. Due to the empirical extensiveness of this topic, it has been chosen to use a multiple case study, exploring the supply chain of avocados, especially due to their high susceptibility to postharvest losses, their rapidly increasing global demand and supply, and the global nature of avocados' trade. The case study focuses on avocados from Mexico and Colombia imported into Europe, and particularly into the Netherlands.

The multiple case study is explored through a conceptual model, linking the concepts of - *Innovative collaboration*, *Postharvest losses reduction* and *Sustainable food supply chains*, thereby proposing that FSC participants that engage in innovative collaboration have a positive influence on the sustainability of the FSC through the reduction of postharvest losses. From this proposition, hypotheses were derived on the influence of, information exchange, incentives alignment, effective partnerships and adequate use of technology, on the sustainability of FSCs through the reduction of postharvest losses. Information was gathered through 25 semi-structured interviews with avocado importers, producers/exporters, packers and growers' associations, and with governmental organizations, and knowledge institutions. 7 informal interviews were held with producers and suppliers of other agricultural products traded globally, thereby offering an external and informed point of view on the organizational inefficiencies leading to postharvest losses in global FSCs.

The findings revealed three categories of organizational inefficiencies leading (directly or indirectly) to postharvest losses, (1) *Corporate governance inefficiencies*, including flaws in the processes, corporate structures and managerial mechanisms underlying the coordination of

activities along the FSC, (2) *Cognitive & Affective inefficiencies* , including the perceptions, expectations, beliefs, emotions, values, behaviours and feelings of FSC participants along the FSC, and (3) *Tangible inefficiencies* , including infrastructural or operational flaws in the production, in the use of resources or in the handling of avocados along the FSC. It was also found that each of the components of innovative collaboration (information exchange, incentive alignment, effective partnerships and adequate use of technology) contributes in different degrees to the reduction of postharvest losses, not only individually, but also through the interrelated dynamics that take place between them. Herein, effective partnerships were found to be the backbone of innovative collaboration, and the largest contributor to the reduction of postharvest losses within the framework of this study, functioning as catalysts of, trust, communication, cooperation and innovation, in addition to contributing to reduce organizational inefficiencies along the FSC. The findings on this dynamic suggest that (a) the mutual influence that the components of innovative collaboration exert on each other might enhance their potential to contribute to the reduction of postharvest losses, and (b) as FSCs become more sustainable due to the reduction of postharvest losses achieved through innovative collaboration, a self-reinforcing feedback might amplify this reduction as positive changes in the behavior of FSC participants become embedded in their organizational culture.

Finally, it was found that engaging in innovative collaboration might not always succeed in addressing the organizational inefficiencies that cause postharvest losses, since many other factors of the food system have influence on the FSC chain (such as regulatory frameworks and government policies), and that therefore, without an integrated approach to postharvest losses, interventions could only result in a shift of the stage of the FSC in which postharvest losses take place.

Key concepts: *Sustainable food supply chains- Reduction of postharvest losses- Innovative collaboration- Organizational inefficiencies*

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This thesis is dedicated to my family, whose love reaches me every day from the other side of the Atlantic. Finally, a very special Thank you goes to Vincent, my love, for encouraging me every day to pursue my goals, for his unconditional love and for the soothing sound of his bass beats while I was writing. Thanks to him this thesis was written to the rhythm of the jungle boogie.

*Carolina Arias Bustos*  
*8<sup>th</sup> januari 2017*



## GLOSSARY

- **Food Losses and Waste (FLW):** Decrease in mass of food at any stage of the FSC, regardless of the cause.
- **Food losses:** Food that spills, spoils, incurs an abnormal reduction in quality such as bruising or wilting, or otherwise gets lost before it reaches the consumer.
- **Food waste:** Food that is of good quality and fit for human consumption but that does not get consumed because it is discarded, either before or after it spoils.
- **Food Supply Chain (FSC):** The sequence of activities to produce, distribute, source import and consume food.
- **Food Supply Chain Participants:** The group of stakeholders and shareholders involved in all the stages of the FSC, from production to consumption.
- **Innovative Collaboration:** Improvement or creation of inter-organizational relationships through which FSC participants can exchange information, align incentives, engage in effective partnerships and improve their use of technology.
- **Organizational Inefficiencies:** Flaws within the large set of managerial decisions, commitments, incentives and human relationships leading to PHL along FSC/organizational causes of PHL.
- **Post-harvest losses (PHL):** The measurable quantitative and qualitative food losses from harvest through crop processing, marketing and food preparation, to the final decision by the consumer to eat or discard the food.
- **Sustainable Development Goals (SDG):** Intergovernmental and overarching set of aspiration goals with targets proposed by the UN General Assembly in order to attain global social, environmental and economic sustainability.
- **Sustainable Food Supply Chain:** A FSC whereby the greatest value is produced at the lowest possible environmental, social and economic costs.





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## **PREFACE**

This thesis submitted as a partial fulfillment of the requirements to get the degree of Master of Science in Sustainable Business & Innovation from the Utrecht University in the Netherlands. The research has been commissioned by the Postharvest Network and the Division Fresh Food Chains of Wageningen Food & Biobased Research, to which the author is much grateful for their assistance and internship placement. The Postharvest Network is a community of Dutch companies, NGOs, knowledge institutes and governmental organizations that work together to reduce postharvest losses in developing and emerging countries. It does so by providing access to a network of Dutch specialists and their expertise in postharvest technology and supply chain efficiency. The Postharvest Network analyses the causes of food losses, offers practical effective solutions that target the whole postharvest chain and tailor-makes them for a specific situation and demand.

I hope that this research contributes to their noble mission.





# 1. INTRODUCTION

## 1.1 BACKGROUND OF THE RESEARCH

To produce food that is never consumed, a surface area larger than Canada and India together is used<sup>1</sup>, three times the water volume of Lake Geneva is squandered<sup>2</sup> and large areas of high biodiversity are deforested<sup>3</sup> (FAO, 2013). If food losses and waste were a country, it would be the third largest greenhouse gas emitter country in the world (FAO, 2013). Aside of being a waste of land, water and energy, food losses and waste (FLW) can lead to hunger, poverty, reduced income generation and reduced economic growth in developing countries (Rijpkema, Rossi & van der Vorst, 2014). Currently, food is increasingly produced to be traded globally, making more countries dependent to meet either, the necessary food requirements of poor consumers or the healthy and luxurious food demands of affluent ones (Porkka, Kummu, Siebert & Varis, 2013). Yet, roughly one third to half of all food globally produced<sup>4</sup> is lost or wasted along food supply chains (FSC) (Lundqvist, Fraiture & Molden 2008; Kummu, et al., 2012; FAO, 2013).

Arguably, any production endeavor in which half of the production is wasted or lost due to an inefficient allocation of natural and social resources can be considered unsustainable and a market failure (Daly & Farley, 2011). For companies involved in global food trade, efficiency and sustainability are no longer autonomous endeavors but rather the collaborative effort of a network of companies mutually influencing each other's operations (Lambert, Cooper & Pagh, 1998). According to Manzini & Accorsi (2013), *“sustainability in FSC is increasingly a ‘must’ and one of the most important challenges is to ensure sustainable development and growth starting from the sharing of information among all the actors of the sector (Manzini & Accorsi, 2013:255).* Therefore, the challenge of avoiding food losses and waste calls for a sustainable supply chain approach, i.e., an approach that optimizes the sequence of steps involved in the production of a product, whereby the greatest value is produced at the lowest possible environmental, social and economic cost (Linton, Klassen & Jayaraman, 2007).

Increasingly, governments' attention has been drawn to food losses and waste as people become aware of their severity, leading to changes in policy to specifically address them. In this context, the United Nations General Assembly adopted in 2015 the target of halving food losses and waste along food supply chains per capita, under the Sustainable Development Goal of *Sustainable consumption and production* (UN, 2016). Such ambitious target in combination with civil society demands for sustainably produced food has been persuading companies, governments and research institutions to explore innovative options to improve the sustainability of operations across food supply chains by reducing food losses and waste (FAO, 2011; Lipinski et al., 2013). A distinction is made between food losses and food waste; food losses refer to food that *“spills, spoils, incurs an abnormal reduction in quality such as bruising or wilting, or otherwise gets lost before it reaches the consumer”* Lipinski et al., (2013:1). Such losses are often a consequence of poor infrastructure, technology, transportation, refrigeration and

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<sup>1</sup> Roughly 1,4 billion hectares of land in 2007

<sup>2</sup> Roughly 250km<sup>3</sup> of water in 2007

<sup>3</sup> Total food production causes 70% of annual deforestation

<sup>4</sup> In weight

packaging (Gustavsson et al., 2011) as well as of the extent to which key segments of the market engage in collaborative relationships (Barratt, 2004). Food waste is described as “*food that is of good quality and fit for human consumption but that does not get consumed because it is discarded, either before or after it spoils*” (Lipinski et al., 2013:1).

The food losses and waste that occur after harvesting and before reaching the consumer, i.e., postharvest losses (PHL) are of particular interest, since addressing losses early in the FSC would avoid the environmental, social and economic costs that add up with every additional step of the FSC (FAO, 2013). The reduction of PHL is therefore increasingly recognized as crucial to the sustainability of food supply chains (Kiaya, 2014). Postharvest losses refer to the measurable quantity and quality of food that get lost after harvest through crop processing, distribution marketing and retailing, just before reaching the consumer (Hodges, Buzby, & Bennett, 2011). Food discarded at the consumer level is regarded as food waste and is not part of PHL. Postharvest losses “[...] represent not only a resource problem but also an environmental and economic one, on top of being a moral challenge for the modern society” (Mirabella, Castellani & Sala, 2014:2). Reducing PHL could save money for farmers and companies, increase the availability of food, and reduce the pressure on water, land and the climate (WRI, 2016). The reduction of PHL was aptly called the “*hidden harvest*” by Spurgeon (1976) and has been since the seventies on the agenda of governments, companies and knowledge institutions in developed countries (Bourne, 1977). In global FSCs the focus of postharvest losses lies on developing countries since it is there where the majority of agricultural exports are produced and where PHL are the highest (Timmermans, Ambuko, Belik & Huang, 2014).

## 1.2 PROBLEM DESCRIPTION

Ever since attention from developed countries has been drawn to the reduction of PHL in developing countries, innovation has been regarded as a key component of the solution, being considered a cornerstone of sustainable FSCs (Trienekens & Willems, 2007). Most FSC investments heavily focus on mechanical and technological innovations (Barratt, 2004), such as custom-made storage facilities, cooling technology and temperature control devices. In this respect, Leach et al., (2012) argue that to meet ambitious Sustainable Development Goals, such as halving global FLW by 2030, not only new technologies and an ***adequate use of technologies*** are required, but also modes of organizational innovation that give more recognition to the people involved. In this way, the organizational inefficiencies that lead to PHL and that limit the PHL’ reduction potential of the available technology need to be addressed, especially since organizational innovations are often required to enhance technological innovations (Pippel, 2014). Here, ***organizational inefficiencies*** refer to flaws within the large set of managerial decisions, commitments, incentives and human relationships leading to PHL along FSCs.

The “*human element*” as coined by Kader (2004), is central to the reduction of postharvest losses since many FSC participants in developing countries lack the information that prompts the appreciation for quality beyond their own gate. Simatupang & Sridharan (2002) call this phenomenon ***incentive misalignment***, and argue that it arises as a consequence of companies lacking the means to align their priorities and policies, resulting in uncompensated costs and benefits for the different FSC participants. In this regard, Soosay, Hyland & Ferrer (2008) recommend that FSC participants engage in new forms of collaboration through which FSC

participants agree to jointly make decisions and solve problems by aligning their goals and exchanging, resources, rewards, responsibilities and information.

*Information exchange* however, has been recognized as one of the most difficult components of collaborative relationships (Pibernik, Zhanga, Kerschbaum & Schröpfer, 2011). The reticence of FSC participants to exchange information lies on their fear of losing competitive advantages by sharing sensitive data that can expose them to opportunism and through which their bargaining power can be reduced (Pibernik et al., 2011). Barratt (2004) states that, additional main barriers to engage in collaborative relationships along FSC are the lack of a contextualized understanding of what collaboration actually means for each FSC participant and the confusion of companies about when to collaborate and with whom. Regarding the latter he argues that, before implementing a wide-scale collaborative approach, a set of segmented key collaborative agreements and *effective partnerships* between FSC participants would be more appropriate.

Several authors assert that increasing the sustainability of food supply chains and reducing the organizational inefficiencies that cause postharvest losses requires new forms of collaboration through which FSC participants can agree to jointly make decisions, solve problems, align their goals and exchange resources, rewards, responsibilities and information (Soosay, Hyland & Ferrer, 2008; Kaipia et al., 2013; Timmermans et al., 2014; WRI, 2016). Likewise, it has been asserted that new forms of collaboration between FSC participants have the potential to fully develop and exploit supply chain capabilities while continuously improving the sustainability of its products and processes (Barratt, 2004; Chapman & Corso, 2005; Swink, 2006; Blomqvist & Levi, 2006). A prioritization of PHL reduction interventions is also recommended, in order to make collaboration more effective and aligned to the overall sustainability of FSC (Timmermans et al., 2014; Kaipia et al., 2013; WRI, 2016).

The findings of various scientific studies about collaboration, innovation and food supply chains (Fearne & Hughes, 1999; Lambert & Cooper, 2000; Simatupang & Sridharan, 2002; Barratt, 2004; Soosay, Hyland & Ferrer, 2008; Pibernik et al., 2011; Kaipia et al., 2013; Timmermans et al., 2014; WRI, 2016) show recurrent concepts that separately have been found to contribute to the sustainability of food supply chains, but that hitherto have not been jointly studied and applied to the specific problem of postharvest losses. Drawing upon the findings of these authors, four of these most recurrent concepts are selected (*Information exchange*, *Incentives' alignment*, *Effective partnerships* and *Adequate use of technology*) to be jointly used in this research under the umbrella term of *Innovative collaboration*. Soosay, Hyland & Ferrer (2008) mention the concept of innovative collaboration in the contexts of collaborative relationships, efficient allocation of resources, and firms' capabilities to innovate in collaborative FSCs; however they don't further develop or describe the concept. Including these four recurrent concepts into Soosay, Hyland & Ferrer (2008)'s line of thought, innovative collaboration is defined here as the improvement or creation of inter-organizational relationships through which FSC participants can exchange information, align incentives, engage in effective partnerships and improve their use of technology.

### 1.3 RELEVANCE AND AIM OF THE RESEARCH

Innovation literature highlights the importance of collaborative relationships in order to innovate (Soosay, Hyland & Ferrer, 2008) while sustainability literature considers organizational innovation as a cornerstone of sustainable food supply chains (Trienekens & Willems, 2007). However, these concepts are underrepresented in literature on postharvest losses within global FSCs, as it mainly focuses on postharvest technologies (Barratt, 2004). Global food supply chains are linked by materials, capital, information flows and people (Seuring & Müller, 2008), however previous research has been criticized for lacking methodological diversity due to its heavy focus on material, capital and other quantitative problems (Golicic & Davis, 2012). Although quantitative problems are central in the quest to develop sustainable food supply chains, they fall short in addressing the organizational and human elements, which are ultimately determinants of action and change within FSCs towards the reduction of postharvest losses (Kader, 2004).

In this context, Lowe, Phillipson & Lee (2008) recognize that natural scientists and technologists working on solutions for PHL acknowledge the need to increase their understanding of the social, organizational and qualitative parameters of their work. Furthermore, Thompson and Scoones (2009) assert that modern approaches to agricultural science and innovation often fail to provide sustainable outcomes in developing countries and lack the capacity to timely understand and react to unexpected outcomes. According to Soman (2014), recent research on social problems in developing countries has a narrow focus, developing solutions rather than developing an understanding of the processes that individuals use to adopt such solutions. He refers to this literature gap as the “*Last mile problem*”, denoting the lack of research’s attention to the behavioral and organizational aspects that determine the adoption of innovations. On the other hand, literature on innovation and sustainable food supply chains (Fearne & Hughes, 1999; Simatupang & Sridharan, 2002; Pibernik et al., 2011; Barratt, 2004; Soosay, Hyland & Ferrer, 2008; Lambert & Cooper, 2000 Kaipia et al., 2013; Timmermans et al., 2014; WRI, 2016) that touches upon behavioral and organizational aspects, does so in a disperse manner through which the dynamics between the different behavioral and organizational aspects is not fully explored.

Consequently, the theoretical contribution of this research is that, (a) it groups concepts (information exchange, incentives’ alignment, effective partnerships and adequate use of technology) that separately have been demonstrated to be relevant to the sustainability of food supply chains, and applies them to the problem of postharvest losses, (b) it links these concepts in order to find dynamics between them that could influence their potential to contribute to the reduction of PHL and, (c) it deepens the understanding on the organizational inefficiencies that cause postharvest losses. From a social and practical perspective, the findings of this research might support companies, knowledge institutions and governments prioritize collaborative efforts that contribute to the sustainability of food supply chains, and in particular to the reduction of postharvest losses.

Consequently, the global aim of this research is to provide a clear understanding on how innovative collaboration influences the sustainability of global food supply chains through the reduction of the organizational inefficiencies that cause postharvest losses. There are three main objectives: (1) to lay the groundwork towards a better understanding of innovative collaboration, and the contribution of its components, on the reduction of postharvest losses within the context

of sustainable global FSC; (2) to find out how FSC participants interact with each other and what kind of organizational inefficiencies lead to postharvest losses in global FSCs; and (3) to inquire into the drivers and barriers that influence FSC participants' engagement in innovative collaboration to reduce postharvest losses within food supply chains.

To that end, an exemplary case study of a fresh global food supply chain in the fruit and vegetables industry is used, since due to their perishable nature, fresh fruit and vegetables have the highest postharvest losses worldwide along food supply chains, (approximately 492 million tons worldwide in 2011), accounting for roughly 45% to 50% of the global yearly production of fruits and vegetables (Gustavsson et al., 2011; Van Gogh, Aramyan, van der Sluis, Soethoudt & Scheer, 2013). Following this, the supply chain of avocados has been chosen, especially due to the global nature of avocados' trade, their high susceptibility to postharvest losses (Bill et. al., 2014) and their rapidly increasing global demand and supply (CBI, 2015). The case study focuses on avocados from Mexico and Colombia imported into the Netherlands; the reasoning for this choice is presented in 3.1.1. It is expected that the results could provide insights to assist in understanding how other FSCs could reduce postharvest losses and enhance the sustainability of their FSCs through innovative collaboration.

#### **1.4 RESEARCH QUESTION AND SUB-QUESTIONS**

From the research's aim the following question is formulated:

*How does innovative collaboration influence the sustainability of global food supply chains through the reduction of postharvest losses?*

Sub question 1: How do participants in global food supply chains interact with each other and which organizational inefficiencies leading to postharvest losses can be identified therein?

Sub-question 2: What are the main drivers and barriers of FSC participants to engage in innovative collaboration to reduce postharvest losses within global food supply chains?

Sub-question 3: How do information exchange, incentive alignment, effective partnerships and adequate use of technology contribute to the reduction of postharvest losses along global food supply chains?

Sub-question 4: How can interventions to reduce postharvest losses be prioritized in relation to the sustainability of global food supply chains?

Sub-question 4 is answered in an advisory way through an advice to the Postharvest Network, the commissioner of this research.

The remainder of this thesis is structured as follow. Chapter 2 presents the theoretical framework, and describes postharvest losses within the context of sustainable food supply chains (2.1). This chapter also describes the concept of innovative collaboration and its components (information exchange, incentives alignment, effective partnerships and adequate use of technology) (2.2). The chapter ends with a conceptual model linking all elements of the theoretical framework. Chapter 3 presents the methods used in his research. Chapter 4 presents

the findings and analysis. The discussion is presented in chapter 5, followed by the conclusions in chapter 6. Finally, an advice for the internships organization is given in chapter 7.

## 2. THEORETICAL FRAMEWORK

This research takes a food supply chain approach in order to explore the ways in which innovative collaboration influence the sustainability of global food supply chains by addressing the organizational inefficiencies that lead to postharvest losses. To do so, this chapter is divided in three main sections presenting the main research concepts as described in the existent literature. The first section (2.1) presents the concept of *postharvest losses* within the context of *sustainable food supply chains*. Therein, the role of companies is highlighted followed by the main causes and impacts of postharvest losses, emphasizing those of organizational nature, i.e., those stemming from *organizational inefficiencies* along the FSC. The second section (2.2) presents a description of the components of innovative collaboration, namely *information exchange, incentive alignment, effective partnerships and adequate use of technology*, linking them in order to derive hypotheses. Finally, a conceptual model showing the relations between the concepts of the theoretical framework is presented in the third section (2.3).

### 2.1 SUSTAINABLE GLOBAL FOOD SUPPLY CHAINS

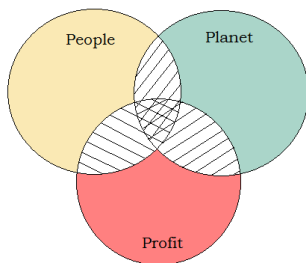
This section introduces the concept of sustainable food chains, followed by the roles of companies at the front-end (companies in the importer country) and at back-end (companies in the exporter country) of the food supply chain. Then, postharvest losses (PHL) and their causes are presented within the context of sustainable food supply chains (FSC). Thereafter, the most common causes and impacts of PHL are identified emphasizing those of organizational nature, i.e., those stemming from organizational inefficiencies. Understanding the organizational inefficiencies that cause postharvest losses is key in addressing them (Timmermans et al., 2014), especially since improving intra-organizational practices has been recognized to promote sustainable behaviors along the food supply chain (Cantor, Morrow & Montabon, 2012).

#### 2.1.1 Definition of sustainable food supply chains

*“Food production, in all its diversity, will remain the single most important form of human land use, and in the centuries to come, the vast majority of our calories will continue to be produced on land”* (Fresco, 2009:381). Various authors have studied the ways in which the sustainability of current food systems could be attained, thereby defining the concept of sustainable FSCs from different perspectives. From the first definition of sustainability coined by Brundtland et al., (1987:8) as *“development that meets the needs of the present without compromising the ability of future generations to meet their needs”*, several other definitions have been developed. Carter & Rogers (2008) take a supply chain management perspective and define it as the ability of a firm to understand and manage its economic, environmental, and social risks in the food supply chain. They state that FSCs that manage those risks create value for all FSC participants and may be better equipped to evolve and be profitable for lengthy timeframes. Fresco (2009) studies the adaptability of current food systems to changing environmental and social conditions. She has proposed a systematic application of existing science in the entire FSC to rethink food systems in terms of globalization, multi-functionality, transparency of production and distribution, consumer behavior, food politics and food prices. She further argues that sustainable FSC should be (a) productive and responsive to the changing demands of an increasing population, especially in developing countries, (b) resource and energy efficient, (c) responsive to changes in the opportunity costs of labor, and (d) encompassing of all activities to produce the product, from farm to fork.



Several other authors researching the sustainability of FSCs take a perspective on nutrition and food security, especially within the context of food losses and waste (Gustavsson et al., 2011; Hodges et al., 2011; Lang & Barling, 2012; Kummu et al., 2012; FAO, 2011, 2013, 2015). They consider the reduction of food losses and waste as one of the most promising measures to improve food security. In this respect, Tielens & Candel (2014) argue that the link between reduction of food losses and waste (FLW) and current food insecurity often lacks a sound empirical foundation. They do however recognize that there is evidence that reductions of FLW could increase future food availability by alleviating the pressure on the natural resources that allow food to be grown, such as land, water and energy. All these perspectives have in common the intersection of environmental, social and economic performances, depicted first by Elkington (1998) as the, now iconic, Triple Bottom Line (TBL) (fig 1).



**Figure 1: Social, environmental and economic intersections within the Triple Bottom Line of Sustainability**

Following these definitions, a sustainable FSC is defined in the context of postharvest losses as the sequence of activities to produce food, in which the FSC participants avoid the environmental, social and economic burdens caused by post-harvest losses, and pursue increased shared value without compromising the ability of future generations to meet their food needs.

### 2.1.2 The role of companies in sustainable food supply chains

The Triple Bottom Line holds the intersections between the environmental, social and economic burdens incurred during the different FSC stages, for which especially focal companies are held responsible. Focal companies are those that govern the FSC, provide the direct contact to the customer, or design the product offered (Seuring & Muller, 2008). Thus, focal companies of imported food products reside generally in the importing country, at the front-end of the FSC. Recent food scandals have shown that incidents at the back-end of the FSC can have repercussions in the costs and brand image of focal companies (retailers, importers and manufacturers), and of food authorities (Green, 2010), triggering them to take responsibility for previous FSC stages in order to meet sustainability and quality requirements.

Figure 2 shows a conventional global supply chain in the fresh food export as proposed by Muller, Vermeulen & Glasbergen (2012). These authors make a differentiation between direct and indirect FSC participants. According to them, direct actors are economically active as buyers and sellers and operationally active in the physical processes; indirect actors have influence upon these economic and operational processes by exerting some kind of influence (such as NGO's advocating for social and environmental causes). FSC participants at the back-end of a conventional FSC include suppliers, producers, packers, cold storage companies, transporters and exporters. FSC participants at the front-end of a conventional FSC include importers, retailers and consumers.

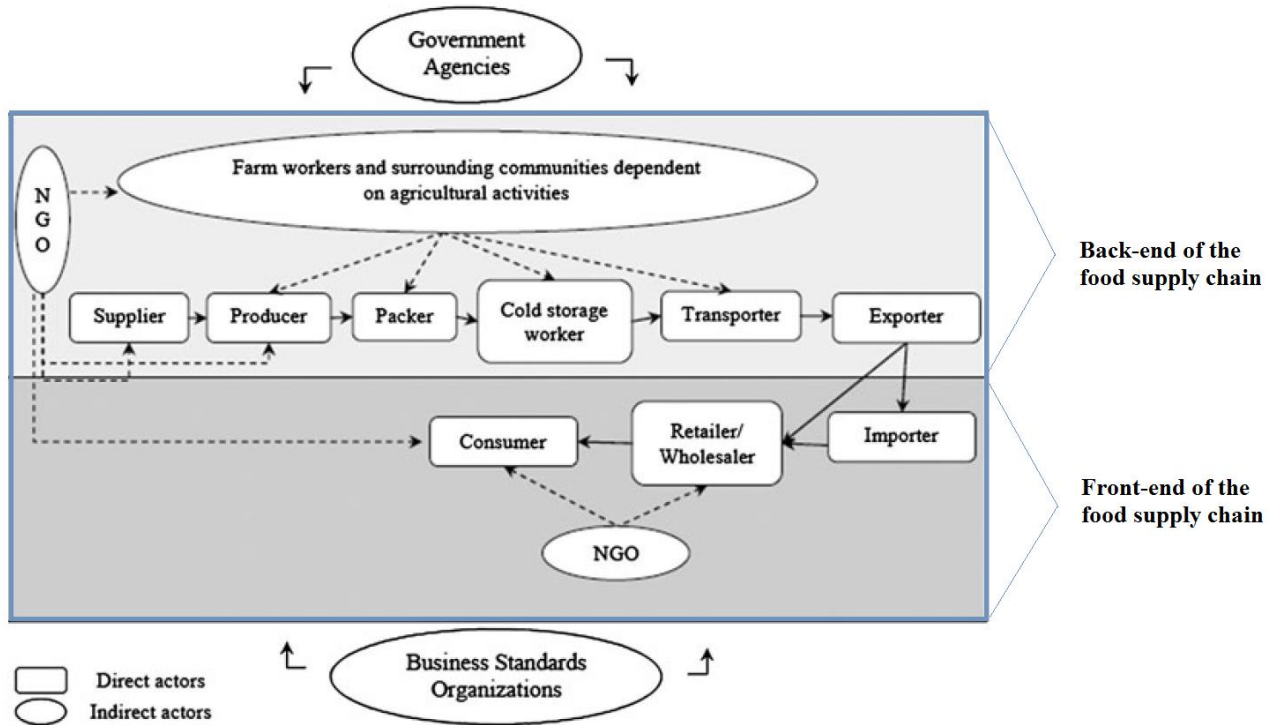


Figure 2: Direct and indirect actors in a global supply chain (Adapted from: Muller, Vermeulen and Glasbergen, 2012:130)

Sustainability and quality requirements for companies in global FSCs have been largely leaning towards a culture of innovation and value creation (Fearne and Hughes, 1999). This has been driven by increasingly strict food safety regulations and the industrialization of production processes, in addition to the growing importance attached to corporate social responsibility, growing competition and the demand for high quality and customized products (Kaipia, et al., 2013). Meeting environmental and social requirements entails initial expenses for which “*someone has to pay [...]*” (Green, 2010:56), thereby inciting reticence from some companies towards sustainable practices. In this regard, Smith (2008) argues that, investments in sustainability can improve medium and long-term profitability of companies through the generation of products with higher value. When these costs are internalized and openly communicated, environmentally and socially driven consumers perceive an increased value and quality of the product, endorsing it with increased trust and willingness to pay higher prices (Smith, 2008). Additionally, meeting sustainability requirements avoids companies the costs related to reputation damage, repairs and business’ disruption from environmental, social and economic impacts (UN Global Compact, 2015). In this context, Smith (2008) argues that the business case for supporting sustainable FSCs is justified by the increased consumer value created by (a) producing and marketing nutritious and convenient products, which are attractive to the customer, not only for their health benefits and accurate and informative labelling, but also for their socially responsible culture; (b) procuring sustainably, which incentivizes FSC participants to comply to standards (such as ISO 9000, GlobalGAP, HACCP, WHO 2005) and allows companies to outsource activities on the base of compliance and reputation, thereby reducing processing, transportation and transaction costs.

### 2.1.3 Postharvest losses and sustainable food supply chains

Postharvest losses are intrinsically unsustainable, being either a result of unsustainable FSC or a cause of them (Timmermans et al., 2014). PHL entail a waste of economic and natural resources, and bring about impacts on society and the environment. Timmermans et al. (2014) identify two types of impacts of PHL, *explicit impacts* and *opportunity impacts*. Explicit impacts are linked to the existence of a physical flow of PHL while opportunity impacts are viewed as the economic, social or environmental lost value in reference to a better alternative with less PHL. Hodges et al., (2011) observe that these impacts get exacerbated within global FSCs, in which more FSC participants are involved within different economic and institutional contexts, some of which are already weakened by other contextual factors. In this context they notice that FSC participants in developing countries are more susceptible to both kinds of impacts, since in many cases their livelihood and food safety are negatively affected by postharvest losses. Accordingly, most studies on food losses and waste show that reducing PHL would not only increase the sustainability of FSCs but also the sustainability of the food systems, which encompass the institutional and policy conditions in which FSCs take place (Timmermans et al., 2014). The World Food Preservation Center (2014, para.2) states that “*we invest 95% of our resources producing food, but only 5% preserving it*” and estimates that the return on investment from postharvest preservation interventions is much higher than that from investments in harvest technologies.

Postharvest losses along FSC have been estimated to differ widely among regions and products (Kummu et al., 2012), but also within the same regions and products due to differences in definitions, metrics, measurement protocols and the lack of standards for data collection (Timmermans et al., 2014). Several authors highlight the need to harmonize methods and definitions around food losses and waste with the aim of increasing the accuracy, reliability, comparability and transparency of data analysis (Gustavsson et al., 2011; Kummu et al., 2012; Timmermans et al., 2014). In June 2016, the WRI released a protocol aimed at standardizing accounting and reporting FLW; therein it is emphasized that although quantification is a valuable input for strategies towards the reduction of FLW, it does not have to necessarily precede taking action (WRI, 2016).

### 2.1.4 Causes and impacts of postharvest losses

Timmermans et al., 2014 classify the causes of postharvest losses in three main levels, microlevel, mesolevel and macrolevel representing respectively individual enterprises, food supply chains, and food systems. Microlevel causes of PHL are actions or inactions of individual FSC participants at a particular stage of the FSC, from production to consumption. Mesolevel causes are *organizational inefficiencies* due to inadequate managerial decisions, commitments, incentives and human relationships along FSC resulting, among others, from the lack of (1) *information exchange*, (2) *incentives alignment* (3) *effective partnerships* and (4) the *inadequate use of technology* among FSC participants (Faems, van Looy & Debackere, 2005; Hodges et al., 2011; Gustavsson et al., 2011; Kaipia et al., 2013; Timmermans et al., 2014). Mesolevel causes of PHL can have impacts at a different stage than where they were originated, and often determine the existence or extent of microlevel causes. For example, lack of adequate manipulation of fruit at early FSC stages due to the lack of good agricultural practices, can lead to a shorter shelf life at the retail and consumer level (Timmermans et al., 2014). Likewise, last minute changes in procurement decisions by retailers or importers could lead to sudden surplus

stocks and bring prices down, thereby eliminating the incentive for FSC participants to keep the product in the FSC and ultimately leading to PHL (Timmermans et al., 2014).

Macrolevel causes occur due to the lack of an enabling institutional environment in which FSC participants can collaborate, invest and adopt good practices. Macrolevel causes allow the existence of causes at other levels. In practice, impacts of PHL are usually the result of an interrelation of these causes rather than specifically dependent on one of them, especially since actions at one FSC stage can impact the whole FSC (Timmermans et al., 2014). Table 1 shows the impacts on the social, environmental and economic dimensions that result from these causes of PHL. Herein, the mesolevel causes, i.e., organizational inefficiencies, and the impacts thereof, are highlighted, since these stem especially from the lack of organizational structures or collaborative relationships enabling the improvement or creation of inter-organizational endeavors at the FSC level (Timmermans et al., 2014). Various studies on FSCs agree that the components of innovative collaboration could bring about positive changes in the inter-relational functionality of FSC participants, thereby enabling them to tackle the organizational inefficiencies of FSCs (Barratt, 2004; Chapman & Corso, 2005; Swink, 2006; Blomqvist & Levi, 2006; Lambert & Cooper, 2000; Pibernik, Zhang, Kerschbaum & Schröpfer, 2011; Kaipia et al., 2013). The lack of the components of innovative collaboration (information exchange, incentives alignment, effective partnerships and adequate use of technology) is therefore included in the highlighted box as part of the mesolevel/organizational inefficiencies causing PHL along food supply chains.

**Table 1: Impacts of PHL due to micro, meso and macro-level causes**

CAUSES OF POSTHARVEST LOSSES	IMPACTS			
	People (a)	Planet (b)	Profit (c)	Source
<b>Microlevel (Individual enterprises)</b>	Lower wages for FSC participants in developing countries	More garbage and waste and increased number of landfills	Lost investment for business and consumers when purchased food is lost or wasted.	a, b, c: Timmermans et al., 2014
	Lower consumer purchasing power	Contamination of rural and urban areas	Smaller margins and high prices, which in turn lead to lower consumption.	a, b: Timmermans et al., 2014; c: Antunes, Miguel & Neves, 2007
	Lower availability of food			a: Gustavsson et al., 2011; Kummu et al., 2012

<b>Mesolevel/ Organizational Inefficiencies (FSC)</b>	<b>Lack of information exchange</b>	Uncertainty of demand	Waste of valuable natural resources	Uncertainty of supply and production flows  Unforeseen investments to construct silos and warehouses for intermediate stocks	a: Lee and Whang, 2000 b: Lambert & Cooper, 2000 c: Timmermans et al., 2014
	<b>Lack of incentives alignment</b>	Low labor productivity	Low compliance with environmental regulations	Increased costs and decreased overall supply chain performance	a: Timmermans et al., 2014 b: Tielens & Candel, 2014) c: Kaipia et al., 2013
		Lack of application of best practices	Mismanagement of natural resources	Unforeseen investments	a,b,c: Timmermans et al., 2014;
	<b>Lack of effective partnerships</b>	Increased power and influence of retailers and traders over farmers <i>“with farms squeezed by new forms of governance of value chains”</i>		Increased costs of disposal and treatment of waste	a: Lang & Barling, 2012:316 c: Timmermans et al., 2014;
	<b>Inadequate use of technology</b>	Increased time investment and lower productivity	Inefficient use of energy and resources	Decreased product quality	a,b: Timmermans et al., 2014; c: Lambert & Cooper, 2000
			Unnecessary CO <sub>2</sub> eq emissions	Long term unviability of current food business model	b,c: Timmermans et al., 2014;
	<b>Macrolevel (Food system)</b>		Increased food prices in food insecure regions	Increased water footprint and pressure on soil, land and biodiversity	Increased spending on production, distribution
		More people below the poverty line	Increased use of non-renewable energy and increased emissions of greenhouse gases	Unrealized economic targets	a, b, c: Timmermans et al., 2014;
			Intensified use of forests and conservation areas for food production	Less financial resources for investment in other areas	b: FAO, 2013; Timmermans et al., 2014 c: Timmermans et al., 2014

		Roughly 1/4 of all water and cropland are used to produce food that is lost or wasted	Roughly 1/4 of all fertilizer is used to produce food that is lost or wasted	b,c: Kummu et al., 2012
		Increased use of synthetic fertilizers that affect biodiversity and water quality	Decreased productivity of public investment in agriculture, becoming an opportunity cost	b: Kummu et al., 2012 c: Timmermans et al., 2014

## 2.2 INNOVATIVE COLLABORATION WITHIN FOOD SUPPLY CHAINS

This section presents the concept of *innovative collaboration* with a description of each of its main components, namely *information exchange*, *incentive alignment*, *effective partnerships* and *adequate use of technology*. These components of innovative collaboration are then put into relation with the concepts of *postharvest losses* and *sustainable food supply chains* in order to propose relationships among them and derive hypotheses.

### 2.2.1 Innovative collaboration

Innovation in food supply chain entails technological or organizational changes towards improving products, processes and services or increasing efficiency and reducing costs, whereby consumer satisfaction increases (Gonzales-Padron, Hult & Calantone, 2008). Lambert & Cooper (2000:81) state that “*much friction, and [...] waste of valuable resources, results when supply chains are not integrated, appropriately streamlined, and managed*”. Innovative collaboration involves the reduction of such friction between FSC participants, by improving or creating inter-organizational relationships through which they can agree to jointly make decisions, solve problems, align their goals and exchange resources, rewards, responsibilities and information (Soosay, Hyland & Ferrer, 2008). Innovative collaboration is defined as the improvement or creation of inter-organizational relationships through which FSC participants can exchange information, align incentives, engage in effective partnerships and improve their use of technology. Through innovative collaboration, FSC participants could therefore reduce the organizational inefficiencies that cause postharvest losses. Improving collaboration among FSC participants is important in order to, not only reduce PHL but also to have a positive influence on the overall sustainability of FSC (Timmermans et al., 2014; Kaipia et al., 2013; WRI, 2016). Furthermore, sustainable FSCs are more responsive to changes in the food system, more resilient and more efficient (Kaipia et al., 2013) (figure 2). The following proposition is presented:

*FSC participants that engage in innovative collaboration have a positive influence on the sustainability of the FSC through the reduction of PHL*

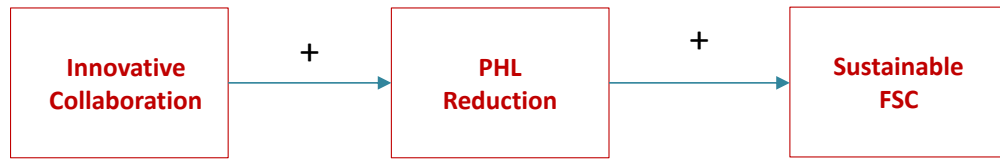


Figure 3: Conceptual representation of proposition

From this proposition, hypotheses are derived and presented below.

### 2.2.2 Information exchange

Exchanging information has been suggested to be one of the most important means to reduce food losses and waste along FSCs (Lambert & Cooper, 2000; Kaipia et al., 2013). Yet, the reticence of FSC participants to exchange information is also one of the most challenging organizational inefficiencies along FSCs (Pibernik et al., 2011). The fear of FSC participants of losing competitive advantages, being exposed to opportunism and losing bargaining power, refrain them from sharing sensitive data (Lee & Wang, 2000; Pibernik et al., 2011). Kaipia et al., (2013) assert that overcoming this limitation is key to the reduction of postharvest losses along FSC. Information exchange is defined as the mutual, proactive, regular and timely share of information (tacit and explicit knowledge) that is relevant and clear to FSC participants (Coronado, Bijman, Omta, & Lansink, 2010; Pibernik et al., 2011). Information exchange contributes to reduce uncertainty of demand and supply, improve coordination and planning (Lee and Whang, 2000), reduce costs, and enhance overall supply chain performance (Kaipia et al., 2013), all of which could contribute to the reduction of PHL. Hence, the following hypothesis is presented:

*H1: Information exchange among FSC participants has a positive influence on the sustainability of FSC by reducing PHL*



Figure 4: Conceptual representation of hypothesis 1

### 2.2.3 Incentive alignment

Lack of incentive alignment arises due to attitudes that are contingent upon short-term results (FAO, 2004), and due to companies lacking the means or sense of importance to resolve their cultural, economic and organizational differences in order to align their policies, priorities, definitions, perceptions and long-term objectives (Simatupang & Sridharan, 2002). The quality of the product, for example, is important for all FSC participants; however, FSC participants may have different definitions or perceptions of quality which can lead to uncoordinated handling of the product, resulting in PHL (Arpaia, 2005). Growers may perceive quality as the absence of diseases, optimal size and return of investment; packinghouse handlers, wholesale distributors, and retailers, may perceive quality as the ease of handling, uniformity of packaging and absence

of physical and physiological defects (Arpaia, 2005), while importers may perceive it as the freshness of the product and the timely delivery of their demand. Incentive alignment involves FSC participants making decisions that consider rewards beyond their own gate and that maximize overall supply chain profitability through a regular assessment of objectives (Simatupang & Sridharan, 2002) while sharing the costs, risks and benefits entailed with collaboration (Hudnurkar, Jakhar & Rathod, 2014). Additionally it entails a cultural, economic and organizational alignment through which differences between FSC participants are first acknowledged in order to be able to use them to the advantage of the FSC (Durnell Cramton & Hinds, 2014).

Hence, the following hypothesis is presented:

*H2: Incentive alignment among FSC participants has a positive influence on the sustainability of FSC by reducing PHL*

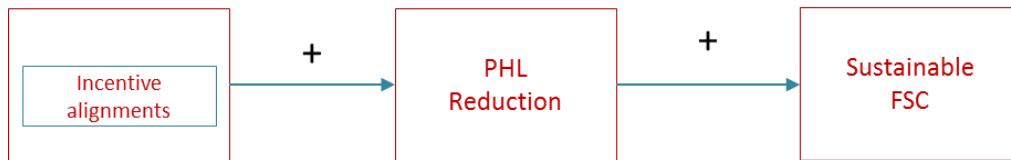


Figure 5: Conceptual representation of hypothesis 2

#### 2.2.4 Effective partnerships

A retailer purchasing from a global FSC needs reliable partners (Ziggers & Trienekens, 1999). Likewise, farmers need reliable markets and the opportunity to negotiate practical rules and regulations (Smith, 2008). An effective partnership is an alliance between FSC participants characterized by its capacity to avoid knowledge spillovers, learning races between the partners, diverging opinions on intended results, and lack of flexibility and adaptability (Faems, van Looy & Debackere, 2005), through which responsibilities and benefits are shared. Effective partnerships can increase the mutual trust, respect and reliability of FSC participants, thereby contributing to increased openness and transparency along the food supply chain (Smith, 2008). Ziggers & Trienekens, (1999) recognize that effective partnerships can, (a) reduce transaction costs, risks and FSC inefficiencies, (b) enhance the FSC participants’ ability to innovate and improve their market position, and (c) “[...] have a profound contribution to a sustainable competitive advantage” (p.278).

Hence, the following hypothesis is presented:

*H3: Effective partnerships among FSC participants have a positive influence on the sustainability of FSC by reducing PHL*



Figure 6: Conceptual representation of hypothesis 3



### 2.2.5 Adequate use of technology

In global FSCs, the challenge lies especially in overcoming organizational inefficiencies, rather than technological ones; although proper technology and infrastructure are a necessity, having them does not guarantee their adequate use. Faems, van Looy & Debackere (2005) assert that collaboration among FSC participants could take existent technologies and competences to a further level of development but also stir the development of new ones. Coronado et al., (2010) found that improving the competences of FSC participants and their knowledge in how to use technology and infrastructure (through clear use' instructions, training to handlers and using best handling practices), has a positive impact on the accuracy of planning deliveries, stirred the adoption of complex quality standards and stimulated the use of best practices, such as cold chains. An empirical example of this is the increased energy inefficiency caused by the introduction of cooling technology at the back-end of the FSC without further organizational changes: due to lack of trust regarding cooling practices in other parts of the FSC, each preceding FSC participant would unnecessarily maximize cooling, thereby wasting energy and decreasing product's quality. Hence, the following hypothesis is presented:

*H4: An adequate use of technology has a positive influence on the sustainability of FSC by reducing PHL*

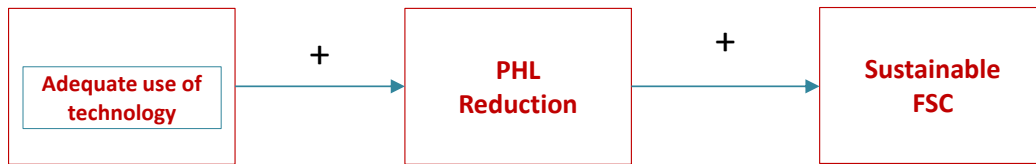


Figure 7: Conceptual representation of hypothesis 4

## 2.3 CONCEPTUAL MODEL

The concepts of the theoretical framework are combined into the conceptual model presented in Figure 8. The linker side of the model shows the FSC participants of a conventional food supply chain: suppliers, producers, packers, cooling storage workers, transporters, exporters, importers, retailers and consumers. The boxes in dashed lines are out of the framework of this research because these are not included in the definition of postharvest losses. Innovation in food supply chains can be of technological or organizational nature; this research focuses on organizational innovation, and specifically on the four selected components of innovative collaboration: information exchange, incentives alignment, effective partnerships and adequate use of technology, as represented by the largest box of the conceptual model. The arrows connecting the boxes represent the relationships between the concepts assumed in the hypotheses H1, H2, H3 and H4, derived from the proposition: *FSC participants that engage in innovative collaboration have a positive influence on the sustainability of the FSC through the reduction of PHL*. The dotted box encompassing the whole conceptual model represents the food system in which food supply chains exist. Some aspects of the food system might be touched upon in this research (such as institutional and policy conditions), however the main focus is on the FSC.

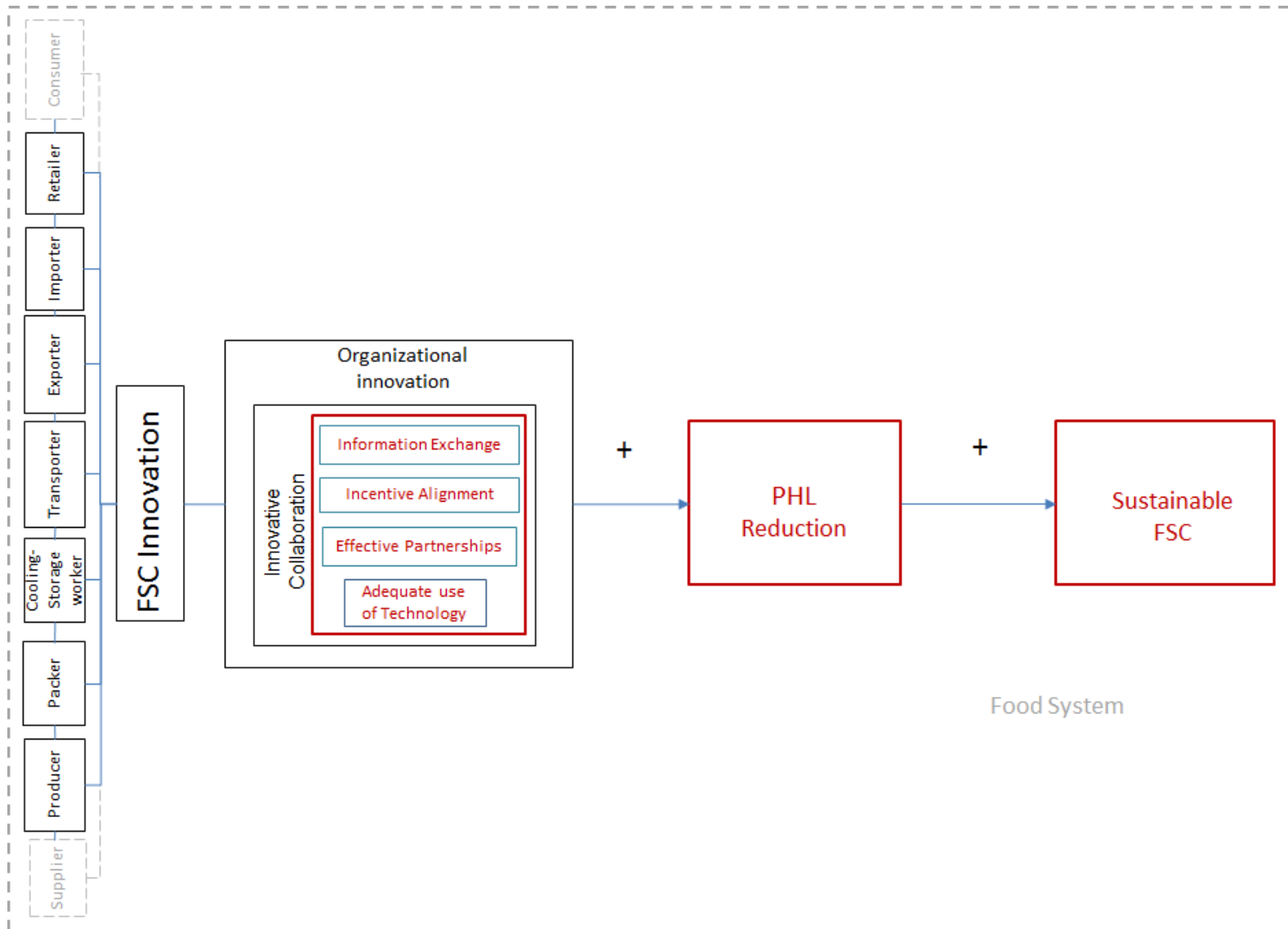


Figure 8: Conceptual framework for Sustainable Food Supply Chains (FSC) by reducing Postharvest losses (PHL) through Innovative Collaboration



### **3. METHODS**

This chapter is divided in four sections. The first section (3.1) presents the design of the research in which the case study is introduced. The second section (3.2) presents the research's approach for data collection (interviews, observations and desk research) including a list of the data sources for the semi-structured interviews. This is followed by the method of data analysis and the operationalization of the main concepts presented in the third section (3.3). The fourth section (3.4) describes the methods through which the validity and reliability of this research is ensured.

#### **3.1 RESEARCH DESIGN**

This research has an exploratory nature and aims at providing a clear understanding on how innovative collaboration influences the sustainability of global food supply chains through the reduction of postharvest losses. The chosen design for this research is a multiple case study, which strengthens the external validity of the findings and facilitates the generalization of results (see 3.3.1). The data collection takes place through triangulation, which entails the combination of various sources and research methods in order to cross-validate the findings (see 3.2). Herein, scientific literature, available documentation of companies, and semi-structured interviews are used, which offer the researcher the flexibility to explore additional issues raised by the interviewees (Soosay, Hyland & Ferrer, 2008).

Yin (2013) suggests to use a case study design when: (a) the study aims to answer “how” and “why” questions; (b) the behavior of those involved in the study cannot be manipulated by the researcher; (c) the researcher wants to cover contextual conditions because they are believed to be relevant to the phenomenon under study; or (d) the boundaries are not clear between the phenomenon and context. The units of analysis within the multiple case study are chosen as recommended by Lijphart (1975) based on their similar geographic, social, environmental or economic conditions, and on base of the assumed differences among them with regard to the hypothesized variables. Consequently, the units of analysis of this research are global food supply chains that meet the following criteria: a) the food supply chains are geographically, socially, environmentally or economically similar, at both, the front-and-back ends; and b) the food supply chains present assumed differences regarding the dependent variables (see 3.1.1).

As the conceptual model shows, this research aims at exploring the ways in which innovative collaboration influences sustainable food supply chains through the reduction of postharvest losses, provided that such PHL reduction occurs at lowest possible environmental, social and economic costs. Specifically, this research is designed to explore patterns, perceptions, behaviors, attitudes, interactions and relations underlying the organizational structure of innovative collaboration within FSCs. This is done to find out whether exchanging information, aligning incentives, engaging in partnerships and enhancing the ways in which technologies are used along FSCs contribute to address the organizational inefficiencies that lead to postharvest losses.

##### **3.1.1 Case Study**

The highest percentages of postharvest losses take place in FSCs of perishable products and especially of fresh fruits and vegetables (Gustavsson et al., 2011; Van Gogh et al., 2013). Therefore, in order to increase the likelihood of this research having a practical impact, and in

consensus with the Postharvest Network, the chosen units of analysis are the FSCs of a fresh product in the fruits and vegetables sector, namely the avocado. The rationale for this choice is twofold: (1) Europe's fast growing import of avocados from developing countries (roughly 300000 tons in 2015), which has shown over 40% increase in volume in the last five years; this upward trend has been especially driven by the growing demand of European consumers for healthy food (CBI, 2015). (2) Although an exact amount of total avocados postharvest losses is not known, avocados are known to be highly susceptible to postharvest losses (Bill et. al., 2014). Losses and waste of avocados are estimated to be of about 5 to 25% in developed countries and of about 20 to 50% in developing countries (FAO, 2004). Notwithstanding the lack of a most recent source for these estimates, it is assumed that postharvest losses of avocados are within the range of overall losses and waste of fruits and vegetables, which have not been ameliorated in the last decade, being 42% in 2009 (Lipinski et al., 2013), 45% in 2012 (FAO, 2013) and expected to increase in absolute terms along with increased production.

For the case study, the food supply chains of avocados exported from Mexico and Colombia into Europe and, in particular, into The Netherlands have been chosen due to the following reasons:

- a) Both Mexico and Colombia have very similar percentages of rural population<sup>5</sup> (respectively, 20% and 24%) and in both countries rural population is steadily declining (The World Bank, 2016 c,d). This is relevant since avocados are produced in the rural areas of both countries.
- b) Mexico and Colombia's openness to foreign investments, free trade agreements, and export coaching programs guided by the Dutch ministry of Foreign Affairs (CBI, 2015).
- c) The overall logistics performance index of both countries is fairly similar (respectively 3,1 and 2,6 in a scale from 1 to 5 in which 1 is low and 5 is high), with Mexico scoring slightly higher than Colombia in all indicators (The World Bank, 2016e). This index contains the following indicators: (1) ability to track and trace consignments, (2) competence and quality of logistics services, (3) ease of arranging competitively priced shipments, (4) efficiency of customs clearance process, (5) frequency with which shipments reach consignee within scheduled or expected time, and (6) quality of trade and transport-related infrastructure. This is relevant since the organizational structure of the FSC depends on the quality of its logistic processes.
- d) The assumed differences of avocados PHL in both countries. Considering that Mexico is the most established exporter of avocados globally, producing roughly half of all avocado worldwide (BBC, 2016), while Colombia is a new incumbent in the export of avocados, producing roughly 5% of avocado worldwide (Minagricultura 2014), it could be assumed that production-and-export<sup>7</sup> experience is positively associated with less PHL. However, following the common perception in the field of innovation that incumbents are less innovative than entrants (Chandy & Tellis, 2000), it can be expected that innovative collaboration is present to a greater extent in the Colombian avocado supply chain. Findings will contribute to either support or reject these assumptions, thereby offering

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<sup>5</sup> Calculated as the difference between total population and urban population

part of the argumentational base to test the proposition: *FSC participants that engage in innovative collaboration have a positive influence on the sustainability of the FSC through the reduction of PHL.*

- e) Both Mexico and Colombia have moderately similar percentages of companies offering formal training to their workers (respectively 50,8% and 65,1 % in 2010) (The World Bank, 2016e).
- f) The direct competition between Mexico and Colombia that arises due to similarities in their annual avocado production calendars (see Figure 9). The largest avocado production in Colombia takes place between October and March, thereby coinciding with Mexico's most productive months and making them direct competitors (LKS, 2013). Additionally, Mexico and Colombia are the only two countries worldwide with any presence in the avocado market between November and February (LKS, 2013).

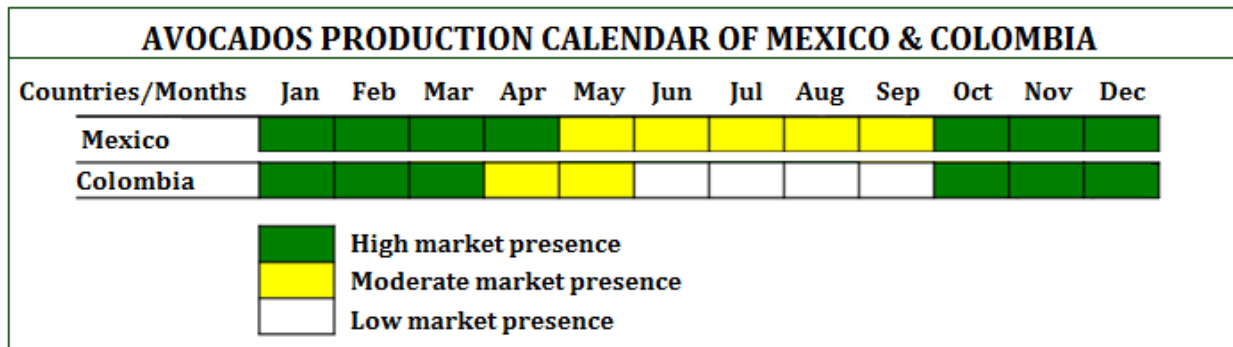


Figure 9: Avocados production calendar of Mexico and Colombia. (Adapted from LKS, 2013).

- g) The Netherlands is the major trade hub for avocados to other European countries, accounting for roughly a third of total EU avocado imports; from the 300,000 tons imported in 2014, about 85% originated in developing countries (CBI, 2015).

Since measurements of PHL are still primitive and known quantities widely differ, the influence of innovative collaboration on the sustainability of the FSC through the reduction of postharvest losses is qualitatively assessed through the perceptions of FSC participants. This research is not designed to compare these countries, but rather to find a replication of patterns (or a lack thereof), whenever collaborative innovation is present, that support or reject the hypotheses of this research.

### 3.2 DATA COLLECTION

The methods of data collection follow the triangulation technique, which entails the combination of various sources and research methods in order to cross-validate the findings, i.e., scientific literature, available documentation of companies along the FSCs and semi-structured interviews with experts and FSC participants. The introduction and theoretical framework of this research

were based on literature found through a combination of key-words regarding four main subjects: (1) Sustainable food supply chains, (2) Food losses, Food waste, Postharvest losses, (3) Food supply chain collaboration and (4) Organizational innovation. The selected literature, added to preliminary informal interviews with experts on food losses and waste from the Food & Bio-based Research Institute and the Postharvest Network in Wageningen, lead to the conceptualization of the theory resulting in the hypotheses.

For this, four of the most recurrent concepts found to contribute to the sustainability of food supply chains in relevant literature on organizational innovation and sustainability, are applied to the specific problem of postharvest losses: Information exchange, Incentives' alignment, Effective partnerships and Adequate use of technology. These concepts are then hypothesized as having a positive influence on the sustainability of FSC through the reduction of postharvest losses. Based on the theoretical framework, interview questions were prepared (see annex 1). The interview was divided in two sections. The first section contains questions regarding the concepts of sustainability and postharvest losses. The second section contains questions regarding the four components of Innovative collaboration. A printed document with the interview questions was used during the interviews as a guideline, as semi-structured interviews offer the research the freedom to stray from the planned questions allowing for a greater possibility of unexpected findings.

The contacts for the semi-structured interviews in the Netherlands were established through the internship position at the Postharvest Network and through a desktop search of avocado importers in the Netherlands. The contacts for the semi-structured interviews in Mexico were established after a first contact with a Business developer from WUR based in Mexico. The contacts for the semi-structured interviews in Colombia were established after a first contact with an investment specialist of a Colombian Governmental organization promoting international trade based in Germany. The interviews with interviewees based in the Netherlands were held face to face whereas interviews with interviewees based in Mexico and Colombia were done by phone. In total 25 semi-structures interviews were held, 8 with Importers, 6 with Producers/Exporters, 2 with Growers' Associations, 3 with Governmental organizations, 1 with an avocados' Packer and 5 with Knowledge Institutions (see Table 2). The estimated average duration time per interview was one hour. The interviews in the Netherlands were held in Dutch. These were recorded, translated to English and transcribed by the author. The interviews in Mexico and Colombia were held in Spanish. These were likewise recorded and translated by the author and transcribed in English. When needed, excerpts of the interviews' transcripts were shared with interviewees for clarification or to be provided of comments or suggestions. The semi-structured interviews took place between July 2016 and September 2016.

Furthermore, 7 informal interviews with FSC participants in the agri-business sector were held at the Amsterdam Produce Show and Conference (2016) from 02 to 04 November 2016; this event was aimed at connecting producers and suppliers of global agricultural products while providing a place for meaningful interaction. These interviewees, although not specifically from avocado supply chains, are from comparable global agricultural sectors, which can add to the validity of the research by offering an external, yet informed point of view on the inefficiencies leading to postharvest losses in FSC. The duration times of the informal interviews ranged between 15 and 40 minutes, taking notes during or after these were finished.

Due to the commercially sensitive information collected in this research and due the high competition in the international avocado market all interviewees are anonymously cited and referenced by a number as showed in Table 2.

Table 2: List of interviewees

a. Semistructured interviews

Organization type	Country of operations	Job title of interviewee	Reference number	Datum interview
Importer	The Netherlands/ Colombia	Product manager	1	30-08-2016
Importer	The Netherlands/Mexico	Business Developer	2	04-07-2016
Importer	The Netherlands	Team manager fruits	3	05-08-2016
Importer	The Netherlands	Manager Sustainability	4	09-08-2016
Importer	The Netherlands	Sales/Purchasing	5	09-08-2016
Importer	The Netherlands	Continuous Improver	6	11-08-2016
Importer	The Netherlands	CSR Officer	7	11-08-2016
Importer	The Netherlands	Manager Sustainability & Marketing	8	08-08-2016
Producer/Exporter	Colombia	Member of Corporation of Producers and Exporters of Avocado	9	19-08-2016
Producer/Exporter	Colombia	Commercial manager	10	15-08-2016
Producer/Exporter	Colombia	Executive director	11	18-08-2016
Governmental organization	Colombia	Secretary of avocado chain	12	17-08-2016
Producer	Mexico	Sales/Purchasing	13	20-09-2016
Producer/Exporter	Mexico	Sales consultant	14	28-09-2016
Producer/Exporter	Mexico	Commercial consultant	15	21-09-2016
Governmental organization promoting international trade	Germany/Colombia	Investment specialist	16	04-07-2016
Governmental organization promoting international trade	The Netherlands/Mexico	Trade and Investment Commissioner	17	08-07-2016
Growers Association	The Netherlands/Mexico	Managing Director	18	22-08-2016
Growers Association	The Netherlands/Mexico	Organizational Development manager	19	22-08-2016
Fruit & Vegetables Sorting, Grading, Packing Technology company	The Netherlands/Mexico	Manager Customer Services	20	24-08-2016
Knowledge Institution	The Netherlands	Expert in management studies	21	03-08-2016
Knowledge	The Netherlands	Project leader innovation	22	08-07-2016



Institution		projects		
Knowledge Institution	The Netherlands	Researcher of food losses and waste	23	06-07-2016
Knowledge Institution	The Netherlands	Researcher	24	05-07-2016
Knowledge Institution	The Netherlands	Researcher	25	05-07-2016

**b. Informal interviews at Amsterdam Produce Show and Conference held on November 02-04, 2016.**

Senior program manager of International Corporate Social Responsibility	26
Lecturer food and international agribusiness	27
Organic farmer and entrepreneur	28
Purchases/sales Fruit and vegetables	29
Sales manager at international grower and packer company	30
Sales manager at Dutch vegetables company	31
Project manager Regional and economic development	32

### 3.3 DATA ANALYSIS

The collected data was coded using the software NVIVO10, which facilitates the identification and examination of relationships in the data, thereby allowing comparisons between literature and empirical findings. In NVIVO, the collected data from interviews, documents and literature was structured through a coding process through which patterns in the data were discerned in order to generate nodes. Initial topic nodes were named after each of the main concepts of this research, namely *sustainable food supply chains*, *postharvest losses*, *information exchange*, *incentives alignment*, *effective partnerships* and *adequate use of technology*. Each of these topic nodes was described using the definitions of the concepts presented in the theoretical framework, into which selected pieces of data relevant to a specific node were categorized. In cases in which frequently repeated information could not fit into one of the initial nodes, secondary nodes were created. In cases in which data already categorized into a certain node could be further divided into sub-categories, sub-nodes were created. Through a case node, the data was demographically classified between the Mexican and the Colombian supply chains based on the FSC participants' home base, coded in NVIVO as an attribute with the values, *Mexico* or *Colombia*. Through the classification of the data, a coding tree was created upon which the results of the research were structured (see annex 3 for an excerpt of the coding tree).

The categorization of the data allowed the following analysis structure with four steps in a funnel-like fashion. First, the results were analysed on a global scale, identifying general interactions and relationships among FSC participants. Second, the results were analyzed within the context of the case study, which allowed for the identification of patterns, organizational inefficiencies, and barriers and drivers of innovative collaboration within the two FSCs. The third part of the analysis involved selecting and bringing together all findings relevant to each component of Innovative collaboration in order to bring analytical depth to the conceptual understanding of the findings. Fourth, the findings were linked to the hypotheses (Yin, 2013). In qualitative research hypotheses are verified as much as possible during the research process by

revising them constantly “until they hold true for all of the evidence concerning the phenomena under study, as gathered in repeated interviews, observations or documents” (Corbin & Strauss, 1990:11).

In order to test the hypotheses, *Innovative collaboration* was operationalized into its components (Information exchange, incentives alignment, effective partnerships and adequate use of technology) (see Table 3). The operationalization of these concepts was derived from the theoretical framework. The indicators are used as sensitizing concepts for the interview questions.

**Table 3: Operationalization of concepts**

<b>Concept</b>	<b>Operational definition</b>	<b>Indicator</b>
Information exchange	Mutual, proactive and timely share of information that is relevant to all FSC participants	<ul style="list-style-type: none"> <li>• Regular communication among FSC participants at all levels</li> <li>• Clear communication channels</li> <li>• Exchange of tacit and explicit knowledge between FSC participants</li> </ul>
Incentive alignment	Process through which FSC participants align their policies, priorities, definitions and perceptions, and share costs, risk and benefits in order to achieve long-term rewards along the whole FSC and maximize FSC' overall profitability	<ul style="list-style-type: none"> <li>• Perception of evidence of cultural, economic and organizational differences</li> <li>• Perception of importance of aligning cultural, economic and organizational incentives</li> <li>• Long-term objectives</li> <li>• Aligned policies, priorities, definitions and perceptions</li> <li>• Regular assessment of objectives</li> <li>• Perception of a fair distribution of costs, risks and benefits</li> </ul>
Effective partnerships	Alliance between FSC participants, characterized by its capacity to avoid knowledge spillovers, learning races, diverging opinions on intended results, and lack of flexibility and adaptability, through which responsibilities and benefits are shared	<ul style="list-style-type: none"> <li>• Trust between FSC participants</li> <li>• Mutual respect</li> <li>• Openness and transparency</li> <li>• Sense of ownership by FSC participants</li> <li>• Sense of responsibility beyond own gate</li> </ul>
Adequate use of technology	Use of available technology with two main characteristics (1) the fulfillment of the daily requirements in a given stage of the FSC and (2) the elimination of avoidable food losses	<ul style="list-style-type: none"> <li>• Clear use' instructions</li> <li>• Training to handlers</li> <li>• Use of best handling practices</li> <li>• Accuracy of planning deliveries</li> <li>• Adoption of complex quality standards</li> </ul>

### 3.3.1 Validity and Reliability

Validity refers to the accuracy and truthfulness of the research findings (Brink, 1993). In order to guarantee the construct validity of this research, i.e., the consistency of the findings with the theory and the degree to which the research measures what it claims to be measuring (Bryman & Bell, 2015), triangulation of data sources is used. As recommended by Baxter & Jack (2008), the interpretation of the data, i.e. the transcripts of the interviews or pieces of interviews, were shared with interviewees whenever further clarification was needed. When the writing of the findings and analysis was finished, a concept document of the research was shared with three interviewees who beforehand had agreed to read it and provide it with comments or suggestions. Two of the interviewees responded with feedback, which was processed into the final version of the research document. Furthermore, the findings were compared with scientific evidence (Brink, 1993). In order to guarantee external validity, i.e., the extent to which the findings are generalizable across groups (Brink, 1993), the findings of two FSCs are compared. Comparing two cases reduces the risk of coincidental findings relative to the use of only one case. The reliability or replicability of this research is facilitated by including every step of the research in detail and the argumentations behind the interpretations. However, as recognized by Yin (2013), replicability of qualitative research may still result in different results due to the implausibility of performing it in the same period of time or of using the same case studies.

## 4. FINDINGS AND ANALYSIS

This chapter is divided in eight main sections. The first section (4.1) describes the trade specificities of the international avocado industry with an emphasis on avocado imports into the Netherlands from Mexico and Colombia as well as the interactions between the food supply chain (FSC) participants therein. This is followed by the contextual background of the avocado industry in Mexico and Colombia and their respective organizational inefficiencies leading to postharvest losses. The second section (4.2) distinguishes two types of collaboration in the avocado industry, horizontal (between competitors) and vertical (between participants of a single FSC). This is followed by the findings on the perceptions of FSC participants regarding the drivers and barriers of FSC participants to engage in innovative collaboration to reduce postharvest losses within the avocado supply chain. From the third section (4.3) to the sixth section (4.6) the findings on the components of Innovative collaboration (information exchange (4.3), incentives alignment (4.4), effective partnerships (4.5) and adequate use of technology (4.6) are separately presented. Each of these sections ends with an analytical interpretation that combines all findings related to each component of innovative collaboration presented in previous sections of chapter 4. Finally, section 4.7 presents an analysis of the case study followed by an analysis of the hypotheses in 4.8, and the dynamics between the components of innovative collaboration in 4.9.

### 4.1 INTERNATIONAL AVOCADO INDUSTRY

This section contributes to answering sub-question 1: *How do participants in global food supply chains interact with each other and which organizational inefficiencies leading to postharvest losses can be identified therein?* Herein, the main product preferences and quality requirements in global avocado supply chains are presented, as well as the processes underlying the global avocado trade. This is followed by the contextual background of the avocado industry in Mexico and Colombia and their respective organizational inefficiencies leading to postharvest losses.

#### 4.1.1 Import of avocados to Europe

The imports of fresh avocados into Europe have grown more than 40% since 2010, reaching a volume of about 340000 tons in 2015 (of which 300000 from developing countries) (CBI, 2015), with an economic value of approximately 420 billion euro (Eurofresh, 2015). The Netherlands is after the USA the largest avocado importer in the world, importing roughly a third of all Europe's avocado imports and re-exporting around 80% of them to other EU markets (Fruit & Vegetable Facts, 2013). According to some interviewees <sup>[1,5,6,8,9]</sup> this puts the Netherlands in a position of power and responsibility to undertake measures towards the reduction of avocado PHL at the import stage, and to stimulate the commitment of other participants along the FSC to do the same. Estimates of interviewees regarding the extent of PHL of export avocado, from production until reaching the import stage, range in Mexico from 20 to 40% and in Colombia from 30 to 50%. Estimates of interviewees regarding the extent of avocado PHL at the import stage alone range from 5 to 10%, depending on weather, transport and market conditions.

#### *Preference along the supply chain for avocados less prone to losses*

The preferred variety of export avocados worldwide is the Hass, since the quality upon arrival of Hass avocados is considered to be superior to that of other commercial varieties; 80% of the avocados consumed in the world are of this variety (Corpoica Colombia, 2010). The Hass variety has a thick and corrugated dark skin, which makes it more resistant for long transport; it has a

personal size, is easily peelable and has a high oil content, which delivers a rich nutty and buttery flavor. The EU market has also a preference for avocados in smaller sizes, therefore the export market for bigger varieties, traditionally produced at large scales in Mexico and Colombia (such as the Fuerte variety) is exponentially declining, thereby discouraging their further production. Mexico has already adapted to this market change and Hass makes up 95% of the total avocado production of the country <sup>[2,15,18,19]</sup>. This has been especially due to the similar product demand of the American market and due to the wide acceptance of Hass in the Mexican domestic market. In Colombia, only 20% of the entire avocado production is Hass, while the domestic market still prefers the traditional varieties, such as the Fuerte variety which has a bigger size and a more delicate, smooth green skin, making it more susceptible to diseases and bruises, and therefore less suited for export <sup>[11]</sup>. The Fuerte variety has been produced for a longer time in the country thereby gaining cultural preference by the local population <sup>[9]</sup>. This situation poses a dilemma for Colombian avocado producers wishing to expand their production with the main intention of meeting international markets demands. A producer states: *“Our best option is to try to change the preferences of the domestic market to match those of the international markets”* <sup>[10]</sup>. According to various interviewees <sup>[9,10,11,16]</sup> roughly 20 to 30 % of the production intended for export does not meet international quality standards and has to be traded internally. Without a domestic demand most of this product would be lost, especially since alternative options, such as the valorization of side streams by processing avocados into derived products such as oil, are just starting to emerge in Colombia (LKS, 2013).

An investment specialist for a Colombian governmental organization promoting international trade asserts: *“the high international demand is pressing and we expect to see a rapid increase in the production of Hass and a decreased production of Fuerte. It is therefore imperative that the domestic market for Hass grows if we want to avoid further losses”* <sup>[16]</sup>. In order to increase the consumption of Hass in Colombia, and in a cooperative effort between producers, distributors and Universities, the campaign ‘Consume mas Hass’ (Consume more Hass) has been recently launched, consisting of radio and television commercials, recipes and informational posters. The Executive director of an avocados’ producing company asserts: *“Consumers are not acquainted with Hass avocados, and many believe that the dark coloration of the skin is a sign of damage or decay; [...] the goal of the campaign is to correct misconceptions and to offer accurate product’ information”* <sup>[11]</sup>. Figure 9 shows the average appearance and size of Hass and Fuerte avocado varieties.

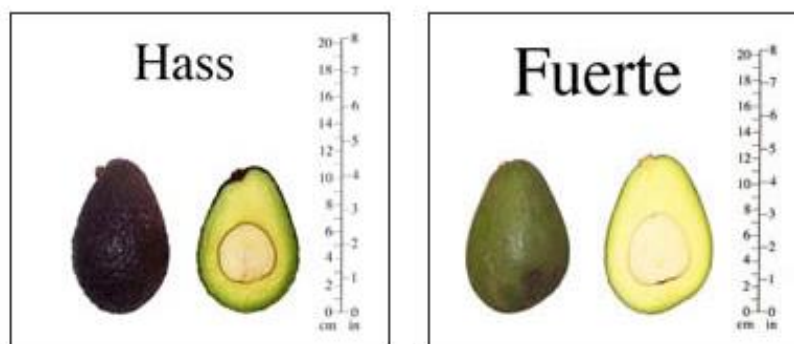


Figure 10: Avocado’s variety Hass and Fuerte (adapted from Avocadosource, 2015)

### ***Strict and detailed quality requirements***

The quality controls of export avocados are increasingly detailed and strict, and rejecting fruit with quality defects is becoming an increasing trend <sup>[2,6,18]</sup>. The quality of the production processes of avocado imported into Europe is guided by the Global GAP certification. As of 2016, Colombia has 61 Global GAP certified avocado producers ready to export to Europe (Global GAP, 2016), however only about 16 of them are currently exporting <sup>[16]</sup>. In 2012 Mexico had 200 Global GAP certified avocado producers, with 2000 more in the process of being certified (Global GAP, 2012). The quality of the product is determined by market preferences and by the CODEX standard for avocados<sup>6</sup>, to which all exporters are required to comply. The CODEX standard provides product specifications for the uniformity, quality, size, color, appearance, packaging, labelling, and containerization of the product, and establishes a degree of tolerance for avocados that not meet the requirements. These requirements serve to classify the product into quality categories, through which avocados can be disqualified before export, at the production stage, at the trade agencies, and sometimes and non-ideally, after export <sup>[3,10,15]</sup>.

Table 4 presents an overview of the three main categories of export avocados (Extra, I and II) and the requirements pertinent to PHL.

**Table 4: Overview of the three main categories of export avocados (Extra, I and II) and the export requirements pertinent to postharvest losses (Data retrieved from company document CODEX STAN, 2013).**

<b>Extra</b>	<b>I</b>	<b>II</b>
Superior quality	Good quality	Acceptable quality
No defects or very slight superficial defects	Some superficial defects smaller than 4cm regarding: <ul style="list-style-type: none"> <li>• shape and coloring</li> <li>• scars from healed lenticels or sunburns</li> </ul>	Superficial defects smaller than 6cm regarding: <ul style="list-style-type: none"> <li>• shape and coloring</li> <li>• scars from healed lenticels or sunburns</li> </ul>
Excellent appearance and presentation	Good appearance and presentation	Acceptable appearance and presentation
The stem must be 0,50cm and be intact	Slight stem damage	Significant stem damage
Perfect condition of fruit flesh	Perfect condition of fruit flesh	Perfect condition of fruit flesh
21% dry matter content (Hass)	21% dry matter content (Hass)	21% dry matter content (Hass)
Quality tolerance: <ul style="list-style-type: none"> <li>• 5% by number or weigh of avocados that not meet the requirements</li> </ul>	Quality tolerance: <ul style="list-style-type: none"> <li>• 10% by number or weigh of avocados that not meet the requirements.</li> <li>• Not more than 1% for avocados affected by decay</li> </ul>	Quality tolerance: <ul style="list-style-type: none"> <li>• 10% by number or weigh of avocados that not meet the requirements</li> <li>• Not more than 2% for avocados affected by decay</li> </ul>
Size tolerance: <ul style="list-style-type: none"> <li>• 10% by number or weight of avocados</li> </ul>	Size tolerance: <ul style="list-style-type: none"> <li>• 10% by number or weight of avocados corresponding to the size</li> </ul>	Size tolerance: <ul style="list-style-type: none"> <li>• 10% by number or weight of avocados corresponding to the</li> </ul>

<sup>6</sup> Jointly drafted by the FAO and the WHO.

corresponding to the size immediately above or below that indicated on the package.	immediately above or below that indicated on the package.	size immediately above or below that indicated on the package.
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Most importers prefer to buy top quality avocados that meet all the preferences of the market, such as qualities Extra and I. Some importers however make agreements with producers to buy all their production, regardless of their size or their just acceptable quality. An importer asserts: *“we buy all sizes from the producer, since it makes us an interesting partner for them, as opposed to buying only what is convenient for us; then we look for clients in Europe that could be interested in the different sizes”*<sup>[3]</sup>. Yet, according to a postharvest expert, the market has a limited demand for each size and quality per week, and still many avocados could remain unsold: *“although choosing to buy all the production from a supplier decreases the risks for producers and is corporate responsibly sound, it could result in a shift of the stage of the supply chain in which postharvest losses occur, rather than in a reduction of total losses”*<sup>[23]</sup>.

One of the most reliable criteria of avocado quality is the fat content; however, fat content is difficult to measure due to the need of specialized technology and high costs. Nonetheless, there is a high correlation between fat content and dry matter content, which can be measured through a standardized process that only requires a microwave and a calculator, facilitating its application along all the phases of the FSC. As avocados ripen, the oil content of the fruit increases while the amount of water decreases, thereby increasing their percentage of dry matter. Dry matter is an indicator of ripeness and its optimum varies across the different avocado varieties. The optimum percentage of dry matter in Hass avocado according to importers is between 20, 8 and 23%<sup>[3]</sup> and the CODEX standard requires it to be 21% (Table 4). Having a too high percentage of dry matter makes the fruit more susceptible to damages caused by transport delays or other factors, while having a low percentage of dry matter makes the fruit firm but watery and bland in flavor<sup>[20]</sup>.

Avocados are climacteric fruits and as such they mature on the tree but ripen off the tree; and although they can be kept on the tree without spoiling for up to six months, the moment of harvest is determinant to the quality of the product upon consumption<sup>[18,19]</sup>. Choosing the right harvest time is not an easy task and adding the knowledge of the dry matter content to the physical maturity indicators (color, opacity and texture of the skin) facilitates the decision<sup>[1,3]</sup>. Consequently, producers that are able to accurately derive dry matter contents and maturity indicators and communicate regularly with buyers to keep updated on market information, can strategically use the trees as natural buffer warehouses<sup>[1]</sup>. Under natural conditions, avocados will be ready for consumption one or two weeks after harvest. However, most export avocados from Mexico and Colombia have a ship journey ahead of two weeks to up to a month for which optimal temperature, humidity and ventilation conditions are needed in order to delay the ripeness process<sup>7</sup>. An unbroken cold chain is essential in order to keep respiration as low as possible and to avoid water losses caused by increased transpiration<sup>[25]</sup>. However, keeping the cold chain unbroken is a challenge, especially during the supply chain stages that take place within the producing developing countries. From the initial storage place after harvest, avocados are transported to pack houses on trucks, which may not always offer proper refrigeration. From

<sup>7</sup> optimal temperatures depend on the ripeness of the fruit , between 8-12°C for unripe and 5-7°C for ripe avocados

the pack houses they are transported again by truck to be loaded into containers for shipping. This process takes roughly a week, and changes in temperature added to the “*hustle and bustle*” of transport can increase the risks of mechanical and physiological damage, thereby making the fruit more susceptible to pathogens <sup>[14, 17, 25]</sup>. Due to the firmness of avocado during early transport stages, most mechanical damage does not become visible until the fruit is ripe, i.e., at the importer, retailer or consumer phases. This means that the product goes through several FSC stages before being discarded and the front-end of the FSC.

Since approximately 2012, some producers in Mexico have been experimenting and observing the benefits of an earlier inland containerization, whereby the product is loaded into the containers right after being packed, thereby reducing the risks of damage due to temperature changes caused by changing vehicles <sup>[17,29]</sup>. Since the year 2000, when the demand for avocado worldwide offered an established enough market base for avocado exports, investments in the transport conditions of overseas exports started to increase <sup>[17]</sup>. Ever since, there has been a transition from transporting avocados in regular cooled atmospheres to transporting them in controlled atmospheres, in which CO<sub>2</sub> is increased and O<sub>2</sub> reduced; this has allegedly increased the quality of the product upon arrival and its shelf life by more than a week <sup>[17]</sup>. Once at the import destination, another selection round takes place in which avocados with visible quality defects are discarded, out of which roughly one quarter is sold as input for by-products such as avocado oil and guacamole <sup>[1,3]</sup>. An importer states: “*Losses under 5% are acceptable and everything above that decreases our efficiency.*”<sup>[6]</sup> At the import stage, the ripening of avocados can take place naturally at approximately 21 °C or by placing them in ethylene chambers which induce the ripening process. Most imported avocados in the Netherlands and other European countries use the latter due to the predictable and reliable ripening schedule it offers <sup>[1,3,5,19,20]</sup>.

Currently, there is no reliable way to measure, quantify and anticipate how the initial conditions of the product will develop along the FSC and how these will reflect on the quality of the final product <sup>[25]</sup>. However, it is well understood that avocados are highly sensitive to their environment and to handling. In this context interviewees assert that “*two avocados grown in the same tree can vary greatly in their quality if, for example, one of them is slightly more exposed to the sun than the other*” <sup>[1]</sup> and that “*dropping an avocado from a 10 cm height, even when it is still firm, is enough to cause bruises that could grow as the avocado ripens, resulting in PHL at later stages of the FSC*” <sup>[15]</sup>. Increasing the understanding and knowledge of FSC participants regarding the sensitivity, delayed responses and cumulative damage of avocados is a very important component of the solution to postharvest losses. However, such understanding and knowledge have to penetrate into the organizational culture of companies along the avocado supply chain if tangible changes are to be made.



#### 4.1.2 The Mexican avocado supply chain

##### *Contextual background*

The Mexican avocado supply chain has been, from its modern inception, one of collaborative relationships between the domestic FSC participants. Since the 60's, producers have been forming associations (such as APEAM, AALPAUM, UDECAM, COMA and UPM 8) working together with scientific and technological institutions (such as the National institute for agriculture, livestock and forestry, INIFAP), and with governmental bodies to generate and exchange knowledge on conservation techniques, the sustainable use of natural resources and the qualitative classification of avocado (Carbajal & Hernandez, 2008). Not only these collaborations, but also the fierce competence from Californian producers, have contributed to the improvements and subsequent growth of the avocado production in recent decades. On grounds of the alleged presence of pests in Mexican avocado plants and presumably to protect domestic production, the USA issued a veto to Mexican avocados in 1914 thereby triggering Mexican producers' responses in the form of plant health campaigns and anonymous societies of powerful avocado stakeholders (such as packers) looking to improve the phytosanitary quality of avocados along the FSC; less powerful stakeholders however (such as small producers), were largely excluded from these campaigns and anonymous societies, leaving them behind in terms of development and innovation (Bellamore, 2003).

After more than 80 years of export prohibition, only Mexican avocados from Michoacán (92% of total production) were granted permission to enter the USA, due to both, improvements in plant health and due to the North American Free Trade Agreement (NAFTA), through which sanitary and phytosanitary measures between trading partners were harmonized (Bellamore, 2003). Ever since, the avocado production in Mexico has presented an exponential increase, with a 240% growth in the last 5 years (BBC, 2016). Since June 2016 the ban to other avocado producing regions in Mexico was lifted, thereby increasing domestic competition and generating a greater export supply<sup>[17]</sup>. However, as producers give preference to higher-paying international markets, the domestic supply is being gradually reduced, resulting in higher domestic prices (+132% in May-June 2016), exacerbated by unfavourable agro-climatic conditions and higher production costs (El Financiero, 2016). Currently, Mexico produces nearly 50% of the world' avocados (BBC, 2016), 70 % of which are consumed domestically, and 30% of which are exported (20% to the USA and 10% to Japan, Central America, Canada, and Europe) (Coronado, Bijman, Omta & Lansink, 2015).

##### *Interaction between FSC participants and organizational inefficiencies*

The majority of small producers sells unsorted avocados at the spot market<sup>9</sup> to packers, whom cover the costs entailed with harvest and transport, and perform the cleaning, sorting and packaging of the product (Coronado et al., 2015). Packers are one of the most powerful

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<sup>8</sup> APEAM: Association of Producers and Packers Exporters of Avocado of Mexico

AALPAUM: Local Agricultural Association of Avocado Producers of Uruapan

UDECAM: Union of Avocados Marketers of Michoacán

COMA: Michoacán Avocado Commission

UPM: nited Producers of Michoacan

<sup>9</sup> The spot market is a public market in which sellers and buyers negotiate orders instantly and for immediate delivery.

participants of the Mexican avocado export business (USDA Foreign Agricultural Service, 2014), acting as a bridge between producers and buyers, designing safety norms and supervision systems, and enabling communication and information exchange (Coronado et al., 2015). The Organizational Development manager of a growers association asserts: *“Since exports started to grow, many big producers united to create their own packaging systems thereby reducing the costs entailed with intermediaries [...], now they are making contractual agreements with small and medium producers and dealing directly with importers to further spread their share of exports in Europe and Japan”*<sup>[19]</sup>. However, for small and medium producers these agreements are not always the best option, since their payments are often delayed<sup>[19]</sup> or the conditions of the contracts changed<sup>[7]</sup>. In turn, unfulfilled contract conditions decrease the motivation and willingness of producers to strive for improvements in the production<sup>[9]</sup>. Still, according to various interviewees<sup>[2,17,19]</sup>, this *“umbrella system”* created by packers has increased the supervision of processes from harvest to export, thereby increasing the quality of export avocados and decreasing the postharvest losses at these stages of the supply chain.

Mexico’s ambition to expand their exports in Europe has been slowed down by the low expertise of the avocado industry in transatlantic shipping, since their current largest export market, USA, is reached mostly by land. An importer asserts that *“the risk of PHL of avocado exports to Europe is very high; approximately 30% gets lost during shipping or because of it”*<sup>[2]</sup>. Much of the PHL caused by shipping are due to insufficient transatlantic shipping facilities or due to delays. *“One week after harvest and selection, avocados still have a three-week ship journey ahead. So, any delay will be determinant in their quality, especially for avocados produced during (EU’s) fall and winter, because these have more dry matter (28-29 %) compared to summertime avocados (21-22%)”*<sup>[3]</sup>. According to The World Bank (2016b) the average time to export other goods in Mexico is 12 days, and has decreased by only one day since 2005. This reflects both, a lower export-time’ performance of the avocado industry (roughly 3 weeks) compared to the national average of other goods, and a meager improvement of export times of total national exports in the last ten years. In line with this, investments in transport with private participation in the country decreased by almost 83% from 1984 to 2015, going down to 787 US million dollars in 2015 (The World Bank, 2016).

As a way to reduce PHL caused by shipping, companies have been turning to aircraft transport in the recent past, which considerably reduces PHL, but increases the prices and environmental footprints of avocados<sup>[23]</sup>. One of the main organizational inefficiencies identified in the Mexican avocado industry is therefore the lack of overseas export expertise, which is paradoxically due to two main comparative advantages of the country: (1) the high domestic demand of roughly 10Kg/person/year and the US demand of roughly 3,5Kg/person/year (Agricultural Marketing Resource Center, AgMRC, 2016), which by creating a secure market for producers, have until recently, limited the urgency and willingness to produce for other export markets<sup>[3]</sup>. (2) The *“effortless”* premium quality and superior taste of export avocados that grow in Mexican volcanic soil, for which, according to an importer, *“there will be always nearby buyers willing to pay premium prices”*<sup>[3]</sup>. According to an expert in management studies, this in turn, reduces producers’ motivation to increase yields<sup>[21]</sup>, which are already inferior to those of other avocado producing countries (9 MT/ha yield for the period 2015/mid 2016, compared to 10-18 MT/ha of Colombia)<sup>[1]</sup>. Additionally, the current high return on investment in the avocado producing sector may discourage small and medium producers from incurring in further

investments to improve yields, since “[...with a] fairly low yield [of 100 avocados a year] farmers can make as much as \$500,000 (£383,000) annually from the plot” (The Guardian, 2016). An importer asserts that this privileged position of the Mexican avocado industry can be counterproductive since large producers have developed a limited willingness to adapt their product to new markets

Notwithstanding, large Mexican avocado export companies are increasingly engaging in collaborative efforts with international FSC participants in order to improve the quality of the production and reduce the inefficiencies of the avocado chain. In this respect, an Organizational development manager of a growers association asserts that, Mexico’s need to reduce PHL due to inadequate shipping, is currently being met through a specialized center for transatlantic exports that is being implemented through the collaboration between a group of Mexican exporters, Wageningen Food & Bio-based Research and a Dutch company specialized in the design and manufacture of fruit and vegetables’ packaging, palletizing and quality controls: *“We believe that this investment has the potential to reduce 20 to 25% of the PHL caused due to inadequate shipping conditions”* <sup>[19]</sup>.

Another important organizational inefficiency mentioned by interviewees is the lack of attention from the Mexican avocado industry to the threat posed by competitors, especially new entrants from developing countries. An Organizational development manager asserts: *“We have been so focused in our own competitive advantage for so long that we have not been paying enough attention to the incredible growth potential of new producers from countries like Peru, Colombia, Chili and South Africa”* <sup>[19]</sup>. One importer <sup>[6]</sup> asserts that the EU’ demand from these countries has been steadily increasing, especially due to the higher yields of their harvest and lower PHL during shipping compared to Mexico’s. Nonetheless, the president of the Mexican National Agricultural Council (CNA) stated recently that there are currently no strong competitors for Mexican avocados in the international market, due to the country having the largest producing area and most of the total demand (Diario ABC de Michoacán, 2016). In this respect, a commercial consultant asserts that underestimating the competition discourages people from investing in improvements of processes and products: *“Resting in our laurels is not the way to stay competitive [...] and in order to reduce the inefficiencies of our production we’ll need to do more than just the usual”* <sup>[15]</sup>.

Recently, Mexican avocado production has been under the press’ inspection as raising avocado prices are blamed for spurring deforestation and perturbing natural habitats in the country. *“Mexican farmers can make much higher profits growing avocados than from most other crops and so are thinning out pine forests to plant young avocado trees”* (The Guardian, 2016). Additionally, the lack of landownership by small and medium producers <sup>[16]</sup>, lack of trained staff <sup>[21]</sup>, the lack of organization and supervision from regulatory bodies <sup>[21]</sup> and the price mechanisms unadjusted for externalities ruling the avocado industry <sup>[25]</sup>, are considered to be some of the main organizational inefficiencies leading to environmental impacts in the avocado supply chain, including postharvest losses. Furthermore, although the sanitary and phytosanitary conditions of the avocado have improved, they still pose a serious threat to the export industry, as demonstrated by Costa Rica’s recent suspension of imports from Mexico due to alleged health risks caused by the fruit (BBC, 2015b).

The findings on organizational inefficiencies for Mexico lend themselves to be categorized into three groups: *Corporate governance inefficiencies*, *Cognitive & Affective inefficiencies* and *Tangible inefficiencies* in relation to their underlying causes. Corporate governance inefficiencies refer here to flaws in the processes, corporate structures and managerial mechanisms underlying the coordination of activities along the avocado supply chain leading to postharvest losses. Cognitive & affective inefficiencies refer here to the perceptions, expectations, beliefs, emotions, values, behaviours and feelings of FSC participants along the avocado supply chain leading to postharvest losses. Tangible inefficiencies refer here to infrastructural or operational flaws in the production, in the use of resources or in the handling of avocados along the supply chain leading to postharvest losses. Table 5 shows the findings on the organizational inefficiencies in the Mexican avocado supply leading to PHL.

**Table 5: Findings on the organizational inefficiencies leading to postharvest losses in the Mexican avocado supply chain**

<b>Organizational inefficiencies in the Mexican Avocado supply chain</b>	
<b><i>Corporate governance inefficiencies</i></b>	Unfulfilled commitments such as contract conditions
	Price variations that limit the planning potential
	Lack of attention to increased competition
	Lack of overseas export expertise
	Untrained staff
	Importers' uncertainty of demand leading to overbuying
	Lack of organization of small and medium producers
	Lack of supervision from regulatory bodies
	Price mechanisms unadjusted for externalities
	Lack of land ownership
<b><i>Cognitive &amp; Affective inefficiencies</i></b>	Limited willingness (small-medium producers) to invest in the improvement of production processes and product
	Disregard of quality in forthcoming FSC stages
	Limited willingness to adapt product to new markets
	Limited motivation to increase yields
	Limited urgency for improved production
	Disregard for environmental impacts caused by the industry
<b><i>Tangible inefficiencies</i></b>	Alleged inadequacy of sanitary and phytosanitary conditions
	Limited offshore transport infrastructure
	Inadequate containerization
	Lack of adequate offshore refrigeration or broken cold chain
	Long shipping times (3 to 4 weeks)

### 4.1.3 The Colombian Avocado Chain

#### *Contextual Background*

Avocado is produced in 15 departments of Colombia, 8 of which account for 90% of the total production (Minagricultura, 2014). The Colombian avocado chain consists mainly of producers, cooperatives, traders, processors and exporters, working closely with universities, governments and private and public research institutes. The recent global upswing of avocados has reinvigorated the national industry, prompting technological investments and gaining increasing attention from the government <sup>[16]</sup>. This is reflected by the government’s establishment of the National Avocado Council in 2008, which serves as a consultative body for the sustainability and competitiveness of the avocado chain. The specific aim of the council is to strengthen the international presence of the industry by, increasing exports, improving marketing and logistics, improving traceability and safety, increasing training and specialization and increasing the number of Global GAP certified producers (Minagricultura 2014).

The production and export of Hass avocado in Colombia, is represented since 2013, by the non-profit National Corporation of Producers and Exporters, CORPOHASS. The goal of CORPOHASS is to act as a single representative of the Colombian avocado industry before national and international markets in order to a) work towards maintaining and improving the reputation of the country as producer and exporter, b) increase the compliance of producers with international standards, c) increase the market share of Colombian avocados exports and d) increase the quality of the product and of the trade’ transactions (CORPOHASS, n.d). Currently, around 75% of all producers and exporters are members of CORPOHASS <sup>[9]</sup>. The need to meet CORPOHASS’s goal is reflected in the fact that from the total Hass production currently only an estimate of 5 to 10% gets exported to Europe because, according to a member of a Corporation of Producers and Exporters of Avocado “it falls short of European standards” <sup>[9]</sup>. However as Figure 11 shows, avocado exports have presented an staggering increase from 2013, reaching more than 3000 tons of exports to Europe in 2015 (Instituto Colombiano Agropecuario, ICA, 2015 ).

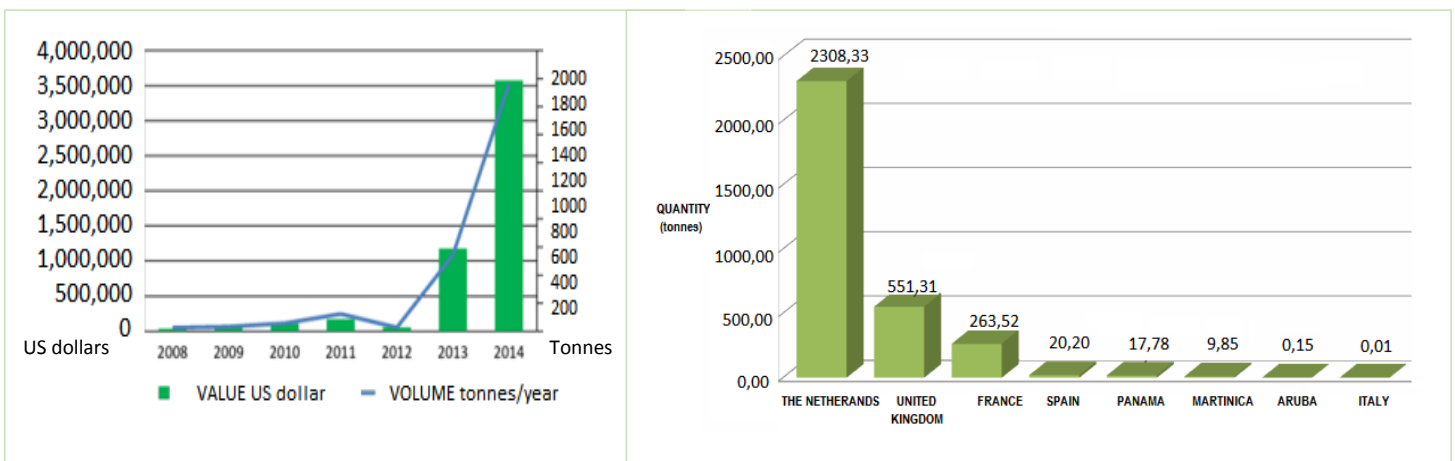


Figure 11: (left) Colombian avocado exports from 2008 to 2014 (Adapted from: Avocadosource, 2015); (right) Destinations and quantity of exported avocados in 2015. (Sourced from: Instituto Colombiano Agropecuario, 2015)

Currently, avocado is the third most important export fruit commodity of the country (Corpoica Colombia, 2010) because avocado production, demand and economic value is one of the fastest growing in the country. In order to further increase Hass exports, the Ministry of Agriculture & Rural development (2015) together with CORPOHASS and several other avocado stakeholders, approved a plan of action for 2016 dedicated to a) implement support programs for producers and deploy resources along the avocado supply chain; b) align regional practices with those proposed by the National Avocado Council by working closely with local producers; c) reduce 30% of the input costs entailed to the production; d) become an example of good production practices, not only of Hass but of all varieties; and e) implement monitoring programs in all producing regions (Ministry of Agriculture & Rural development, 2015). An investment specialist asserts that it is expected that the rapidly increasing demand for export avocado creates new opportunities for small producers previously inactive or involved in illicit cultivations <sup>[16]</sup>.

### ***Interaction between FSC participants and organizational inefficiencies***

Colombia has a competitive advantage above other avocado producing countries, regarding its expertise in unbroken cold chains in shipping transport, gained through the established flowers' industry<sup>10</sup>. The country has 11 cargo shippings with cooling systems and direct routes to the Netherlands, and 4 more with indirect routes with respective travel times of 13 and 18 days (Procolombia, 2014). Generally, export avocados are sent through the direct routes, thereby having a travel time of roughly 2 weeks <sup>[1,9]</sup>. According to The World Bank (2016b) the average time to export goods from Colombia has decreased from 34 days in 2005 to 14 days in 2014. This reflects that the export time performance of the avocado industry has improved hand in hand with the national exports, and that export times of the export sector as a whole has greatly improved in the last 10 years. However, Colombia's internal transport infrastructure is still very poor, even so that it is currently three times cheaper to send a shipping container across the ocean than inside the country (BBC, 2015).

An investment specialist asserts: *“The quality of our product is highly dependent on the infrastructural conditions of the country; the whole avocado chain must therefore work hand in hand with the government to plan and carry out infrastructural improvements, as well as be willing to invest in them if we don't want to see the export potential of the industry hampered”*<sup>[16]</sup>. Nonetheless, investments, financial support and credits in the avocado chain increased more than 250% from 2010 to 2013 (Minagricultura, 2014), while investments in transport with private participation have been rapidly increasing, reaching almost 12 US billion dollars in 2015 (World Bank, 2016).

Due to the early stage of development of the Colombian avocado industry, small and medium producers are still poorly structured, with a very high failure rate of new small productions enterprises, and with a low or inadequate legal regulatory framework offered by cooperatives (LKS, 2013). An organizational inefficiency often mentioned by interviewees is the lack of standardization of harvest and postharvest processes. Most small and medium producers produce avocados with great variations in sizes, appearance and quality, being thereby of less interest for most large exporters to close long term export agreements <sup>[11,12]</sup>. An exporter asserts that *“much of the avocado produced for export gets disqualified due to their lack of uniformity, which is in*

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<sup>10</sup> Ten containers are weekly sent overseas and two to three-times more during high seasons

turn caused by a lack of awareness among small and medium producers regarding the benefits of adapting their product for the export market”<sup>[12]</sup>. In order to avoid the complexities of export, many producers still prefer to focus on the domestic market, which presents a high and unsatisfied demand. However, production for domestic markets takes place under less strict phytosanitary and quality conditions, thereby resulting in PHL of roughly 40 to 50% caused largely by pests and diseases, lack of infrastructure and materials and inadequate inland transport conditions. Figure 12 shows the typical way in which production for domestic markets is packed and transported, causing an increased risk of injury and postharvest losses.



Figure 12: Inadequate packing and transport conditions of avocados for the Colombian domestic market. (Source: Corpoica Colombia, 2010).

According to an investment specialist <sup>[16]</sup>, postharvest losses of avocados for domestic markets can influence the prices of both, domestic and export avocados, due to a reduced domestic supply and due to a subsequent shift of the demand to other producers. Consequently, another important organizational inefficiency is the dependence on the national market of small and medium producers caused by a “*lack of training and support to produce avocados suitable for export*” <sup>[10]</sup>. In this context, the Executive director of a producer/exporter company points out that due to the high international demand, local governments of avocado producing regions have been trying to stimulate the production of Hass by giving seedlings to producers, “*however, in some cases, no further recommendations or training on the specific treatment of this avocado variety was offered to them*” <sup>[11]</sup>. In line with this, interviewees identify a lack of effective monitoring and of monitoring tools along the whole supply chain, but especially when it comes to small and medium producers <sup>[1,9,11,12,16]</sup>. The causes of this organizational inefficiency are related to the costs entailed with the implementation of monitoring systems <sup>[12]</sup>, to the instability of the production that difficults the audit of processes <sup>[16]</sup> and to the highly segmentation of the production, partly caused by the difficult access to land and unregulated land tenure (LKS, 2013).

On the other hand, researches, exporters and importers often visit producers to assess the conditions of the production in order to offer advice for better postharvest practices and to find long term suppliers <sup>[1,3,23]</sup>. According to a senior program manager of International Corporate Social Responsibility, the lack of good practices, especially among small producers is “*not caused by sloppiness or laziness but by unawareness regarding the consequences of inadequate*



actions” <sup>[26]</sup>. In this context (Camero, 2009) elucidates the kind of practical problems encountered in the field: “[...] we asked the farmer if he had a basket for the harvest, he said no; we asked if he had avocado-harvest scissors, we got the same answer. The farmer proposed instead to use empty bags of fertilizer as baskets, obviously we replied that that was a bad practice” (p: 1). Inadequate practices are therefore also a consequence of small and medium producers’ low level of mechanization, tool implementation and use of technological instruments (LKS, 2013).

Although interviewees express having positive expectations of the industry and government’s plans to improve the avocado chain and expand exports <sup>[10]</sup>, international avocado markets are currently entered almost exclusively by large producers, because small and medium producers in Colombia don’t have the status, production capacity, marketing strategies, organizational culture and business models necessary to compete successfully (AgloGoldAshanti Colombia, n.d). In some cases, however, this is not only due to large exporters not wanting to close long term agreements with them, but also due to small producers presenting individualistic features and being reluctant to establish contracts and long-term agreements with large (LKS, 2013) or foreign companies <sup>[27]</sup>. The findings on the organizational inefficiencies leading to PHL along the Colombian avocado supply chain are presented in Table 6.

**Table 6: Findings of the organizational inefficiencies leading to postharvest losses in the Colombian avocado supply chain**

<b>Organizational inefficiencies in the Colombian Avocado supply chain</b>	
<i>Corporate governance inefficiencies</i>	Lack of standardization of harvest and postharvest processes
	Lack of effective monitoring and of monitoring tools
	Low number of producers certified for export
	Lack of training and support to produce avocados suitable for export
	Organizational culture and business models misaligned with international markets
	Uncertainty of demand leading to overbuying or underbuying
	Preference for/dependence on domestic market due to less strict phytosanitary and quality conditions
	Lack of land ownership
	Segmentation and instability production that difficults the audit of processes
	Low or inadequate legal regulatory framework offered by cooperatives
	Small and medium producers are poorly structured
	Very high failure rate of new small productions enterprises
<i>Cognitive &amp; affective inefficiencies</i>	Lack of awareness among small and medium producers regarding the benefits of adapting their product for the export market
	Low interest from large exporters to close long term agreements with small and medium producers



	Individualism and reluctance to close long term agreements with large or foreign companies.
	Unawareness regarding the consequences of inadequate handling of the product
	Lack of status of small producers in international markets
<b><i>Tangible inefficiencies</i></b>	Use of contaminated vehicles (with fertilizers or chemicals)
	Low level of mechanization, tool implementation and use of technological instruments by small and medium producers
	Inadequate internal transport infrastructure
	Rough handling of boxes
	Broken cold chain due to inadequate inland transport
	Large variations in sizes, appearance and quality
	Inadequate loading and overfilling of boxes
	Inadequate phytosanitary conditions of domestic product

This chapter presented the findings on the interactions between FSC participants within the Mexican and the Colombian food supply chains, in which especially the roles of Producers/Exporters and Importers were highlighted. Herein, it was found that interviewees perceive importers to be powerful FSC participants as they are the gateway to a growing avocado market. Importers often decide *what and from whom* to buy, therefore they are expected to contribute to the reduction of avocado PHL by adopting more sustainably devised and responsible buying practices. It was also found that importers are already inclined to buy high quality avocados that are more resistant to the “*hustle and bustle*” entailed with export, which automatically leads to less PHL during export, but can however lead to PHL at the back-end of the FSC by eliciting a product selection based on aesthetic aspects. This highlights the finding that, without an integrated approach to postharvest losses, interventions could only result in a shift of the stage of the FSC in which postharvest losses take place. Finally, this chapter identified the main organizational inefficiencies within the Mexican and the Colombian FSCs that lead to postharvest losses. These inefficiencies may not always lead directly to PHL (such as broken cold chain due to inadequate inland transport), but also indirectly (such as a segmented production). Herein it was found that these organizational inefficiencies stem from three main groups of underlying causes. By classifying the roots of these organizational inefficiencies, this chapter also contributes to pointing the direction of needed interventions to reduce postharvest losses. These findings will serve as an input for the analysis sections presented in chapter 4.3.

## 4.2 HORIZONTAL & VERTICAL COLLABORATION IN THE AVOCADO SUPPLY CHAIN

This section adds further depth to answering sub-question 1 regarding the interactions between FSC participants, and contributes to answering sub-question 2: *What are the main drivers and barriers of FSC participants to engage in innovative collaboration to reduce postharvest losses within global food supply chains?* First, general drivers and barriers to innovative collaboration are presented in the context of the global avocado industry by distinguishing two types of collaboration, horizontal (between competitors) and vertical (between participants of a single FSC). This is followed by the findings on the barriers and drivers of FSC participants to engage in innovative collaboration within the avocado supply chain.

### 4.2.1 Horizontal Collaboration driven by Competition

The current competitive environment of the global avocado supply chain goes beyond the traditional fundamentals of quality and price, towards a more overarching set of good practice' conditions and a need for product differentiation based not only in quality but also in social and environmental responsibility. This quest for differentiation has been driving competition in the avocado sector, bringing about improvements in the quality of the final product as in its production processes. Competition has not only stimulated innovation by companies but also collaboration among them. With the mottos "*Cooperation of competitors*" and "*Free competition with free information*", the Avocado Marketing and Promotion Working Group, AMAP (2011: p2) has since 1999 been bringing together avocado FSC participants from all over the world with the aim of stimulating them to rather "*act together on enlarging the cake than to fight on its slices*" (p.2). Mexico and Colombia are members of AMAP, and as such they are expected but not binded to engage in free information exchange of, crop forecasts, weekly shipment forecasts, week by week actual shipments, ongoing and planned promotion programs and ideas or activities to promote consumption of avocado (AMAP, 2011). This global collaboration has supported members to learn from the operational, tactical and strategic practices of comparable companies by "*opening a window to real life problems and real life solutions*"<sup>[12]</sup>

The World Avocado Congress (WAC), another global collaborative initiative, was repeatedly mentioned throughout the interviews and regarded as "*an opportunity to find new business partners*"<sup>[4]</sup>, "*the place to be for state of the art developments in the sector*"<sup>[10]</sup>, and "*an enabler of networks*"<sup>[16]</sup>. The WAC is held every four years since 1987, and organized by the International Avocado Society (IAS), attracting between 1000 and 1500 participants from the industry (IAS, 2011).<sup>11</sup> One importer<sup>[5]</sup> considers however that "*waiting four years from congress to congress is a very long time in view of the rapid developments driven by the increasing global demand of avocados*". In this context, the California Avocado Society (CAS, 2016) offers stakeholders a more frequent chance of networking through the arrangement of annual meetings aimed at sharing information on marketing, research, governmental issues and cultural trends surrounding the global avocado market. Additionally, avocado FSC participants have other web-based platforms at their disposal to create networks and share information on market developments and on recent research on postharvest technologies, such as

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<sup>11</sup> It was during the second WAC held in California in 1991, when every assistant received a grafted seedling from the original tree of the avocado variety Hass, which is currently the most demanded for export, in order to stimulate the spread of the crop abroad. Ever since, all commercial Hass avocado has been a fruit o that single tree, developed in California by Rudolph Hass in 1926 (California Avocados, 2016).

Avocadosource, the Hass Avocado Board, InfoHass.net and UC Davis Postharvest technology. The Ministries of Agriculture of both Mexico and Colombia also have informational websites dedicated to the domestic and international market opportunities of avocado. Since early 2016, various avocado producing countries (Brazil, Mexico, Peru, South Africa and the United States) have been joining efforts to create the Avocado World Trade Organization (WAO), with the aim of promoting avocado consumption in the European Union, Asia and other parts of the world (Alimentacion Revista Enfasis, 2016).

#### 4.2.2 Vertical Collaboration along Avocado supply chains

From secondary data sources such as websites and newspaper' articles, collaboration in the avocado sector seems more evident across FSCs of competitors (horizontal) than along a single FSC (vertical). Interviewees attribute this to the public attention given to horizontal collaboration, for example through media publicity upon the creation of a new partnership or through the companies' own disclosure. Vertical collaboration on the other hand is a more private endeavor, arguably due to the higher sensitivity of the information involved. They assert however, that in their daily activities, vertical collaboration with other FSC participants has a more prominent role. A Project leader of innovation projects (a.o. on postharvest losses) asserts: *"Although horizontal collaboration is strategically advantageous, vertical collaboration is functionally essential"* <sup>[22]</sup>. Most of the interviewees assert that both, horizontal and vertical collaboration are high when it is in aid of improving the product or when there are risks of diseases or pests in plants or fruits that need to be mitigated to contain their propagation along the FSC. In this context, Hoddle, Arpaia and Hofshi (2009: 53) assert that *"it is of great significance that collaborative programs [...] have yielded significant new information to our understanding of avocado fruit pest complexes"*. On the other hand, interviewees agree that when it comes to the optimization of postharvest logistics, the degree of collaboration is lower, because the benefits are perceived to be compartmentalized <sup>[18,21,22]</sup> and the industry-wide benefits are perceived to be less tangible <sup>[11,13,18,19]</sup>. Collaborating vertically with other participants of the same supply chain is done with caution in order to avoid disclosing sensitive information <sup>[18]</sup>.

Nonetheless, interviewees assert that long term vertical collaboration has brought them benefits such as cost savings from increased efficiency due to recurrent procedures that become habitual <sup>[1]</sup>, reduced transactional friction due to regular communication <sup>[15]</sup>, increased alignment of the organizational culture <sup>[7]</sup> and increased risk-taking attitudes towards innovation due to risk-sharing practices <sup>[16]</sup>. They point out that, although short-term collaborative efforts have benefits, these are not always long lasting and in some cases can have negative effects, as relationships stagnate or as the participants have yet to adapt to a new situation. Accordingly, interviewees emphasize that long term vertical collaboration increases the expectations of positive results and the stability of the relationship, thereby increasing the commitment of the participants involved. An importer asserts: *"Not having to constantly worry about the reliability of daily transactions increases our flexibility to innovate in the way we interact with our partners, such as planning promotions together, setting up pricing mechanisms that benefit us both, or jointly optimizing the chain to reduce product losses"* <sup>[3]</sup>.

Notwithstanding the unanimity of interviewees regarding the importance of vertical collaboration, its benefits are sometimes perceived as asymmetric and as occurring at expenses

of the autonomy of the less powerful FSC participants in the relationship. Some producers perceived a decrease in their autonomy after engaging in long term agreements with importers due to the imposition of exclusivity agreements or other demands <sup>[13,15]</sup>: “*We have the best tasting avocados in the global market and therefore some importers demand exclusivity to create a competitive advantage based on taste*”<sup>[13]</sup>. Exclusivity agreements are also desirable for importers whenever a more resistant or cost-productive variety is produced <sup>[17]</sup>. For producers, this entails being unavailable for other market opportunities <sup>[13]</sup> or having to submit to changes in their production practices <sup>[15]</sup>. However, other interviewees at the back-end of the FSC pointed out that changes brought about by collaboration with importers have often led to efficiency improvements <sup>[10]</sup>, smoother logistics <sup>[11]</sup> and empowerment of the working staff <sup>[14]</sup> as the exchange of ideas is encouraged and people get culturally integrated.

Differences in working culture and opinions are considered an important barrier to collaboration, often in the Mexican context <sup>[2,4,6,13,15,18,19]</sup> and sometimes in the Colombian context <sup>[3,10,16]</sup>. Various participants downstream the FSC expressed their discontent due to the resistance to change of some producers and farmers <sup>[4]</sup> and due to an increase in opportunistic behavior as exports from developing countries increase. An importer asserts: “*The rapid pace of increase of exports does not match the pace at which organizational improvements in exporting countries take place*”<sup>[5]</sup>. An Expert in management studies states that, “*in such a business environment there is an increased risk of opportunism in the form of selling products of poor quality, delaying deliveries or not following through with agreements and contracts*”<sup>[21]</sup>. Opportunism can also take place due to FSC participants having asymmetric extents of power and due to business strategies based on having such power. In this context a Business developer asserts: “*some buyers are awful; they think they can change their orders at any time*”<sup>[2]</sup>. To avoid PHL due to sudden changes in product requirements from buyers and to ensure that suppliers take into consideration the quality expected by buyers, they are increasingly turning to Service Level Agreements (SLAs) <sup>[23]</sup>. SLAs are contracts between suppliers and buyers through which a common understanding regarding the minimum acceptable service and responsibilities is established. However, according to one interviewee <sup>[16]</sup> SLA's are sometimes used as stopgaps for troublesome transactions and using them unaccompanied by long-term goals to improve the relationship, disregards the benefits entailed with strengthening the transparency and trust of the collaboration.

Several interviewees <sup>[1, 3, 7, 13, 15, 19, 22, 23]</sup> identified the lack of trust between FSC participants as one of the most important barriers to collaboration within the avocado FSC. Trust is especially important in long food supply chains, where producers and consumers are divided by numerous other FSC participants, such as packers, brokers, transporters, importers and retailers. A Researcher of food losses and waste asserts that “*vertical integration partly solves the lack of trust that limits the potential benefits of collaboration [...]; but in a sense, this newly acquired trust [that comes from supply chain integration] is imposed upon [the FSC participants] rather than earned*”<sup>[23]</sup>. One importer affirms that in the avocado industry, as in every food industry “*trust takes long to win but can be easily lost*”<sup>[1]</sup>. Yet, another importer goes beyond this statement by asserting that succeeding in reviving the trust between business partners after a problem is solved, may result in a strengthening of the relationship beyond that of a faultless relationship. This importer states:

*“After months of having established a commercial relationship with an export company, we realized that every consignment from them resulted in higher amounts of avocados being disqualified due to the presence of unrequested sizes or qualities. We communicated this to them but to our disappointment, not much changed in the following orders [...]. We didn’t give up because we had invested a lot of effort in establishing the relationship, so we went physically to them and explained why their product was being disqualified [...]. We said nothing different than before, but this time we said it face to face. Ever since, orders have been meeting our criteria and we are happy now of having them as suppliers”<sup>[3]</sup>.*

Most interviewees agree that often, the barrier to innovative collaboration is not a lack of communication between FSC participants, but rather a lack of *effective communication* able to penetrate the organizational culture in all the stages of the FSC until leading to change. Consequently, ineffective communication can lead to increased transaction costs, since more efforts have to be made in order to reach the desired outcome, and to bad planning, which in turn leads to postharvest losses. An importer states: *“As importers, it is crucial to calculate the volume needed by our clients and to communicate this clearly to the producer, [...] for this, knowledge of the market is required in order to forecast the selling volumes in a determined week”<sup>[1]</sup>*. A strategy often used to avoid coming short of product is to buy larger quantities than those demanded by the market. *“We buy a little more than the expected demand in order to be sure of covering it all. Buying much more than needed will put a lot of pressure on the market, making prices increase, which will be at our disadvantage”<sup>[4]</sup>*.

Interviewees acknowledge that a more detailed <sup>[1,2,7,22]</sup>, regular <sup>[1,3,6,9,16]</sup> and honest <sup>[4,5,7,18,24]</sup> communication would improve the accuracy of forecasted demands at all supply chain stages, thereby decreasing the risk of PHL. In this context, technological developments are being increasingly used to improve the detail and frequency of communication; however their use is still mostly limited to the front-end of the supply chain. At the front-end of the FSC, retailers and suppliers often have electronic-based demand planning systems to synchronize order and deliveries. However at the back-end of the FSC, communication technologies are implemented only to a certain degree by large companies and almost never by small and medium ones <sup>[6,19,22,27]</sup>. Small and medium producers, packers and exporters still share demand information through traditional channels, in both Colombia and Mexico. Some importers assert that to facilitate communication, they are increasingly establishing direct relations with producers <sup>[1,3,4,8]</sup>. However, others argue that although vertical integration is generally desired, when importers trade directly with small and medium producers, the differences in their organizational cultures and in the communication technologies used may in some cases slow the development of the relationship <sup>[21,22]</sup>.

In some cases, collaborative innovation gets hindered by old-fashioned ways of thinking and obstructive behaviours of FSC participants to innovation and collaborative developments. Interviewees expressed their frustration regarding the desinterest of some brokers in being a part of the solution. *“They use arguments such as: - ‘why should I care if some product gets lost along the way if i still can buy enough of it every day?’ - or - ‘if we decrease the losses there would be an oversupply thereby bringing down the prices’ -”<sup>[22]</sup>*. Most of the interviewees agree that such behaviours are old-fashioned and obstructive to innovation and collaborative developments.

Table 7 presents an overview of the findings on the main drivers and barriers of innovative collaboration within the global avocado food supply chain.

Table 7: Barriers and drivers of innovative collaboration along the avocado supply chain

Barriers to Innovative collaboration along the avocado FSC	Drivers of Innovative collaboration long the avocado FSC
Benefits are compartmentalized and asymmetrical	Access to new information
Industry-wide benefits are less tangible than sectoral benefits	Increased understanding of crop features and treatments
Benefits occur at expenses of the autonomy of the less powerful participants in the relationship.	Cost savings from increased efficiency due to recurrent procedures that become habitual
Some agreements reduce the availability of FSC participants to participate in other market opportunities	Reduced transactional friction due to regular communication
Reluctance to share sensitive information	Increased alignment of the organizational culture
Differences in working culture and opinions	Increased risk-taking attitudes towards innovation due to risk-sharing practices
Resistance to change	Increased expectations of positive results that increase commitment from participants
Opportunistic behaviour	Increased stability of the relationship
Asymmetric extents of power	Empowerment of the working staff as the exchange of ideas is encouraged and people get culturally integrated.
Lack of trust regarding compliance with agreements	Increased FSC efficiency and smoother logistics
Bad planning and incomplete communication	Increased access to knowledge
Lack of interest and obstructive behaviors to innovation and collaborative developments	Increased access to new technologies
Lack of effective, detailed, regular and honest communication	Increased supervision of processes from harvest to export, thereby increasing quality of product and risk of PHL.

This chapter highlighted the horizontal and vertical collaborative relationships among participants of the avocado supply chain in Mexico and Colombia. Herein it was found that interviewees consider horizontal collaboration to generate strategic advantages, specially through mutual learning, while vertical collaboration is considered to have a more functional or practical value through an increase of efficiency, innovation, communication and alignment of the organizational culture, and a reduction of costs and transactional friction. This chapter also presented the findings on the main drivers and barriers of innovative collaboration along the global avocado supply chain. It is observed that most of the barriers to innovative collaboration perceived by interviewees are specially related to the *cognitive & affective* and the *corporate governance* inefficiencies presented in Table 5 and Table 6, in the sense that these stem from feelings (such as lack of trust) and behaviour (such as resistance to change) and from inappropriate corporate structures (such as asymmetric extents of power) and managerial mechanisms (such as compartmentalized benefits). Some of the perceived drivers on the other hand, seem to have a more *tangible* nature as many of these pertain to operational improvements

(such as costs savings, increased efficiency and smoother logistics) and an increased access to resources (such as information, knowledge and technologies). The findings of this chapter will serve as an input for the analysis sections presented in chapter 4.3.

### 4.3 INFORMATION EXCHANGE

This section contributes to answering the first component of sub-question 3: *How does information exchange [...] contribute to the reduction of postharvest losses along global food supply chains?* First, the findings on Information exchange are presented, followed by an analytical interpretation that combines all findings related to this component of innovative collaboration presented in previous sections in chapter 4.

#### 4.3.1 Giving and receiving feedback

Information along FSCs is often exchanged in the form of feedback. Most interviewees agree that giving and receiving direct feedback is one of the most effective practices to assess performance and stimulate change. Although not all FSC participants have formal procedures to give or receive feedback, interviewees assert that *“feedback is implicitly given every time a problem arises”* <sup>[3]</sup> and that *“every transaction goes accompanied by informal feedback”* <sup>[1]</sup>. Against this backdrop, an importer asserts that by giving feedback on the quality of the product, and by sharing prices’ information with producers, they have been able to stimulate a more commercial vision among them as producers can see which avocado qualities sell better and adapt their product to the needs of the market: *“Since we started sharing price information with producers, they have been able to choose what qualities to produce according to the best prices in the market. Due to this practice, we have halved our postharvest losses in the last three years, which were caused by discarding avocados that our producers used to send us but our buyers didn’t want”* <sup>[4]</sup>. Interviewees <sup>[6,18]</sup> also assert that the timing of giving and receiving feedback also matters, since it is more efficient and relevant the sooner it takes place after the evaluated event.

Some companies are reluctant to share information through formal feedback procedures, and relying in informal feedback procedures can result in irregular or unthorough exchanges of information. On the other hand, formal feedback procedures tend to be rigid <sup>[13]</sup> and in some cases don’t provide the room to evaluate the issues that need to be assessed <sup>[24]</sup>. Even so, both kinds of feedback, formal and informal, are still highly valued by interviewees as these are considered to increase the visibility of the whole food supply chain. The desire to increase the visibility and transparency of the FSC was repeatedly mentioned across the interviews. However, also often mentioned was the perception that some FSC participants are reluctant to exchange information in transparent ways. In this context, a Lecturer on food and international agribusiness asserts that *“[...] behaviours along FSCs can be contradictory since as a group we want openness but individually we prefer to stay closed”* <sup>[27]</sup>. In some cases, the lack, irregularity or unthoroughness of information exchange gets partly offset by large and capital intensive companies engaging in research and development and generating new knowledge. However, exchanging information in the form of feedback, in particular real time and continuous feedback, is still essential to increase the transparency of the FSC, since there is *“no sustainability without transparency”* (MVO Nederland, 2016:32).

#### 4.3.2 Real-time feedback and information exchange through trace systems

Information regarding the product and the production conditions can be exchanged throughout the whole FSC by means of trace systems. Tracing a product back to its production makes it easy for FSC participants to be held accountable by stakeholders (MVO Nederland, 2016). One



importer company with an established trace system asserts that *“using only a sticker with a quick response code on the product, we share information regarding the social and environmental conditions in which the avocado is produced as well as the social and environmental impacts caused by its production [...] end-consumers can leave messages behind for producers, while producers learn about consumer preferences and get stimulated by their direct feedback”*<sup>[13]</sup>. This is especially important since, the further a FSC participant is from the consumer market, the fewer standards are adopted and the less information is exchanged<sup>[20,22,27]</sup>. Moreover, the current trend in the avocado industry, as in many food industries, is letting the consumer be the main driver of business strategies and the steerer of innovation. According to a senior program manager of International Corporate Social Responsibility, connecting producers with consumers is a logical, yet new business construct *“with a very high potential to increase the demand for more sustainably produced products”*<sup>[26]</sup>.

#### **4.3.3 Having the guts to exchange information**

The exchange of information along the avocado FSC is an implicit part of the industry's daily operations, not only among participants of vertically integrated FSCs, but also among competing ones. All interviewees stressed the importance of exchanging information and recognized that it improve logistics, stimulates innovation and reduce some of the inefficiencies that lead to postharvest losses, such as the lack of awareness on the importance of reducing PHL. Despite of recognizing the benefits of information exchange, not all interviewees engage in it due to the perception of an asymmetric reaping of benefits. Therefore, some choose to sell their produce through channels where information exchange is more limited. A producer asserts: *“Selling our product on the spot market does not require us to share much information [...]. Sure, we lose some of our product, but we spare in costs that would be necessary in order to comply with the demands of a specific client”*<sup>[13]</sup>. A Project leader in innovation projects asserts that such arguments are a characteristic response to the fear of engaging in risky or uncertain situations<sup>[22]</sup>. However, trying to keep the status-quo in a competitive environment often entails higher risks, such as being left behind by competitors in terms of innovation and sustainability. In this regard, exchanging information of poor quality is considered by some interviewees as being even more risky than not exchanging information at all<sup>[21,25]</sup>. Poor quality information could lead to FSC participants making sub-optimal decisions, such as overbuying, underbuying or cancelling orders, or to misunderstandings regarding each other's responsibilities, all of which could lead to postharvest losses. Regarding the ways in which companies can overcome their fear to exchange information, a Project leader of innovation projects asserts: *“It is a question of who dares to be the first, who wants to distinguish itself from others and especially, who has the guts to do so”*<sup>[22]</sup>.

#### **4.3.4 Analyzing the influence of Information exchange on the reduction of postharvest losses**

##### ***Information quality above information quantity***

Some of the findings seem to reflect that the higher the degree of information exchange between FSC participants, the greater the potential reduction of postharvest losses. However, on closer inspection, the quality, regularity and thoroughness of the information exchanged rather than its mere quantity, seem to have a more important effect on the reduction of postharvest losses. In

this regard, a lack of flexible, regular and objective feedback procedures could result in observations biased by subjectivity, thereby possibly leading to inadequate perceptions of the reality and the adoption of inadequate solutions. In this context, as information exchange is considered to reduce the uncertainty of demand and supply, improve coordination and planning, reduce costs, and enhance overall supply chain performance, providing misinformation could create the perception of an apparent transparency, thereby distorting the efficiency of the market mechanism. Although formal feedback procedures are not without their flaws, in a highly competitive food supply chain, information exchanged without the rigor and supervision of formal procedures could lead to an intensification of the asymmetric extents of power between FSC participants due to an opportunistic use of sensitive information. However, formal procedures alone may not always render the expected results; accompanying them with face to face interactions or personal communication seem to increase the effectiveness and depth of feedback and information exchange, as these add credibility and urgency to the issue at stake.

Contradictory behaviours regarding the pursue of transparency and the lack of will to exchange information, seem to stem especially from a) the fear that the quality of information received in exchange is not proportionally high, b) the risks of losing competitiveness, and c) the uncertainty regarding the future costs of sharing certain information in the present. These barriers to information exchange are more evident within vertical collaboration settings, which are characterized by dealing with corporate sensitive and detailed information. Information exchanged vertically, along a single FSC, seems mainly aimed at increasing short and long term economic gains and company-individual competitiveness. The stakes of collaboration in such settings are considered high by FSC participants since any misuse of the exchanged information could represent an immediate economic downturn. Correspondingly, the benefits of exchanging ‘the right kind of information’ vertically are considered high and value-adding by FSC participants. Within horizontal collaboration settings, the information exchanged has a more public and industry-wide nature and a much lower level of detail. It seems mainly aimed at inter-company social networking and at sharing scientific and empirical developments relevant to the industry. This kind of information exchange is highly valued by FSC participants as it may contribute to balancing the knowledge-base of the industry.

#### ***A consumer approach to postharvest losses***

Notwithstanding its limitations, a reliable information exchange, especially in the view of asymmetric bargaining power between small producers and importers, could strengthen the market position of the less powerful participants by aligning their production to the needs of the market. In this context, by exchanging accurate information, producers can get a hold on developments at the front-end of the supply chain, whereby production can be aligned with consumer preferences. Following this, it is important to point out that, although the attention from the avocado industry towards consumer preferences has become an influential concept underlining companies’ strategies, it hasn’t yet been grasped or embraced by most FSC participants at the back-end of the food supply chain, especially not by those reluctant to engage in collaborative endeavors. As a consequence, still large quantities of product don’t meet the specifications of the end-market, resulting thereby in postharvest losses.

The increasing adoption of a consumer’ approach in food supply chains, added to consumers’ increasing demand of transparency, presents an opportunity for a reduction of postharvest losses

driven by consumer preferences; especially since as asserted by Smith (2008) sustainability performance in the FSC can be appreciated by consumers as a quality attribute. Hitherto, transparency towards consumers has been, in most FSCs, limited to the sharing of information regarding the origin of the product and the environmental, social and economic conditions at the production stage, for example by means of trace systems. Information regarding the conditions of the subsequent FSC' stages is practically not made available to consumers, partly due to the desire of some FSC participants to withhold such information, and partly due to consumers' lack of demand for such information. The opportunity lies then in drawing consumers' attention towards the impacts of their choices on FSC stages others than merely those of production and consumption. Consumers' awareness of the extent of losses that occur before the purchase of the product could boost consumers' demand for increased visibility along the FSC, thereby stimulating FSC participants to act on it. Harnessing this opportunity would have implications on the current approaches taken by stakeholders (such as research institutes) within the food system to reduce postharvest losses, which generally do not consider consumers as determinant actors in the causes of, and solutions to postharvest losses as they do to food waste.

Finally, the findings suggest that information exchange contributes directly or indirectly to the reduction of postharvest losses by: Reducing the uncertainty of demand and supply and reducing the costs related to such uncertainty; improving coordination and planning; enhancing overall supply chain performance; balancing the knowledge-base of the industry; strengthening the market position of the less powerful FSC participants; aligning production with consumer preferences; improving the management of temperature along the FSC; increasing transparency and visibility of the FSC and by keeping FSC participants informed of market trends.

#### 4.4 INCENTIVES ALIGNMENT

This section contributes to answering the second component of sub-question 3: *How does [...] incentives' alignment [...] contribute to the reduction of postharvest losses along global food supply chains?* First, the findings on Incentives alignment are presented. This is then followed by an analytical interpretation that combines all findings related to this component of innovative collaboration presented in previous sections in chapter 4.

##### 4.4.1 Cultural alignment

Cultural differences are considered by 62% of the interviewees<sup>12</sup> as very evident when trading internationally; however only 24% of them consider that is very important to align incentives based on the cultural patterns that influence everyday practices along supply chains. 72 % consider it to be more or less important (Table 8<sup>13</sup>). To this regard, interviewees assert that due to fierce competition, the relationships within the avocado industry are largely driven by economic incentives and by price/quality ratios <sup>[21,25,30]</sup> rather than by cultural alikeness. However some assertions during the interviews reveal that cultural differences may play a more important role than that granted by interviewees. In this context an importer points out the annoyance felt by the import company due to the lack of growth mentality of some Mexican producers asserting that “[...they] have so much buyers to choose from, that only a low effort is expended towards the improvement of yields' efficiency <sup>[4]</sup>”. To this regard a Mexican producer <sup>[15]</sup> asserts that their business culture gives preference to spending efforts on nurturing and adding value to existing relationships than on the expansion of production per se.

Various interviewees <sup>[1,4,2,16]</sup> stressed the importance of building personal relationships when trading with Latin American partners and recognize the high value they concede to face to face encounters and traditional practices and local beliefs. An extract of an interview from a local newspaper to a Colombian small producer reflects this, as the producer refers to the particular bad conditions of the roads due to bad weather: “-God sent us an abundant production of avocado this year, but nature took our roads away- says Ramón Vásquez, a farmer from the town of San Isidro, while he hurries his donkey loaded with 270 avocados that were harvested before the new moon, because during new moon fruits cannot be collected, according to the beliefs of the grandparents of the area” (El Heraldo, 2011). On the other hand, some producers <sup>[10,13,16]</sup> stress the high value conceded by European importers to time-and-production efficiency and how it may lead to avoid spending efforts in matters that, on the surface, turn from the main business concerns, such as local beliefs.

##### 4.4.2 Economic alignment

Differences in economic power between FSC participants are considered by 52% of the interviewees as very evident when trading internationally. 62% of the interviewees think it is very important to align economic incentives. To this regard an importer points out that there is a big difference in the way sales processes are approached at the different stages of the FSC: “Producers are interested in selling the fruit per kilogram, regardless of the different sizes and qualities. Importers and exporters on the other hand are only interested in certain sizes and quality <sup>[3]</sup>”. Therefore, aligning incentives could serve to align individual goals with business

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<sup>12</sup> Based on 22 responses from the semi-structured interviews and 7 responses from informal interviews

<sup>13</sup> The results presented in table 7 are derived from the answers of interviewees to the interview questions 7 and 8 under the section incentives alignment. These answers are presented in annex 2

priorities, and companies' goals with FSC priorities thereby contributing to the reduction of PHL caused by differences in market approaches of FSC participants. The economic growth and profitability of the avocado industry has also meant a high involvement of local and national governments in both countries, but especially in Colombia, by means of programs of financing, investment and insurance for small and medium producers. However, the difficulty to measure PHL has limited the adoption of explicit PHL-reduction key indicators to assess the performance of such programs. Besides, small producers that aren't yet part of any cooperative are less likely to be included in such programs due to their high geographic dispersion, as is the case in Colombia. Consequently, some interviewees<sup>[1,16,19]</sup> agree that producers that are not integrated in some sort of collaboration are less motivated to reduce PHL and tend to obtain lower economic benefits from supply chain collaboration. According to an Expert in management studies<sup>[21]</sup>, economic misalignment between partners in a collaborative endeavor, can lead in some cases to failure in the adoption of innovations and hinder processes that create shared value along the FSC.

#### 4.4.3 Organizational alignment

Organizational differences are considered to be very evident (86%) and organizational incentives very important to be aligned in order to enhance collaboration (72%). This suggests that the alignment of organizational incentives between FSC participants is considered more important than cultural and economic alignment by the interviewees. Following this, an Expert in management studies<sup>[21]</sup> asserts that when organizational incentives are aligned between partners in a collaborative endeavor, they are more willing to commit to the same goals thereby positively influencing each other's performances. In this context, a Sales manager at an international grower and packer company asserts: *"We need to think who are the clients of our clients and align our procedures in order to adapt our product to their needs"*<sup>[30]</sup>. Most importers<sup>[1,2,3,4,6,7,8]</sup> assert that aligning organizational incentives, by tying the success of the whole FSC to the success of individual companies, is intrinsically linked with having common long term objectives.

In this respect, most importers are willing to invest in driving and supporting innovation and improvements to reduce PHL of unexperienced or new producers, provided that they are willing to engage in long term relationships. In this respect an importer states: *"Our experience shows us that new producers generate much more PHL than established ones, especially if they lack export expertise. However, we often endure such losses because we believe in the producer's potential. So, after a messy year with lots of headaches we see an improvement of the product's quality and reduction of the losses."*<sup>[3]</sup> According to an expert in postharvest losses<sup>[25]</sup>, long term agreements are significant incentives to the reduction of PHL and have the potential to balance the asymmetry in the way efforts are spent in many food supply chains: *"Most efforts are aimed at increasing production, for which often one-time, high value investments are deployed; however less efforts are aimed at improving postharvest handling and logistical inefficiencies, for which long term collaboration is pertinent"*<sup>[25]</sup>.

Table 8 presents the responses of interviewees regarding their perceptions of evidence of economic, organizational and cultural differences along the FSC and their perceptions of importance of economic, organizational and cultural alignment along the FSC.

**Table 8: Interviewees’ responses regarding their perceptions of the evidence of economic, organizational and cultural differences along the FSC and their perception of importance of economic, organizational and cultural alignment along the FSC**

Perception of evidence	Non evident	More or less evident	Very evident	Perception of importance	Non important	More or less important	Very important
<b>Economic differences</b>	0%	48%	52%	<b>Economic alignment</b>	0%	38%	62%
<b>Organizational differences</b>	0%	14%	86%	<b>Organizational alignment</b>	0%	28%	72%
<b>Cultural differences</b>	3%	34%	62%	<b>Cultural alignment</b>	3%	72%	24%

#### 4.4.4 Analyzing the influence of Incentives alignment on the reduction of postharvest losses

As the international trade of avocados gains prominence, the cultural, organizational and economic differences of the industry’ participants become more important and difficult to ignore when establishing long term objectives and priorities along the whole FSC.

##### *Economic, organizational and cultural alignment*

The findings show a high variance between the perception of evidence of cultural differences and the perceived importance of cultural alignment along the FSC. Likewise, there seems to be a discrepancy between the explicit and implicit assertions of interviewees regarding the importance of aligning incentives based on the resolution of cultural differences. This may suggest that FSC participants aren’t fully aware of the extent to which cultural alignment could benefit the functioning of the FSC. Interviews reflect that not only the internal culture of companies, but also the culture of the countries involved in the trade can influence the performance of the relationship. In this context, understanding and sensitizing mutual cultural differences may as well influence the willingness of companies to upgrade a simple seller-buyer relationship to a long-term partnership. Additionally, recognizing that business priorities may differ in accordance with cultural preferences and adapting FSC objectives accordingly, may reduce frictions between FSC participants, especially those between small producers and importers. The evidence of economic and organizational differences seems to be aligned with the importance that FSC participants confer to their alignment, suggesting that these are deemed more urgent than cultural ones.

##### *Incentives to reduce postharvest losses can backfire*

Small producers are exposed to various incentives to align their production to the preferences of the other FSC participants. The global high demand and high prices of avocados serve to align incentives along the FSC in order to supply a high quality product at a high margin of profit. This incentive is inherently linked to an alignment of the perceptions of quality among the FSC participants. However this incentive could decrease as prices stabilize due to the growing production of avocado worldwide. Programs of financing, investment and insurance offered by governments help to improve the steadiness of the national supply and are an incentive for small producers to align their production practices and the quality of their product to the rest of the FSC. These programs do so by (1) requiring producers to use good agricultural practices and deploying stimulus for GAP certification, and (2) by approximating production to the expectations of other FSC participants, especially those at the back end of the FSC who value

steady amounts and quality. However, if for example financing programs are poorly monitored or unaccompanied by PHL awareness, the incentives to reduce PHL for producers could backfire and turn into disincentives as producers could become less economically affected by them.

Another incentive that could turn into a disincentive, if unaccompanied by other production enhancement measures, is that of importers buying all products from producers, disregarding its high variation in quality. Although buying all production from small producers can be considered socially responsible and can reduce small producers' uncertainty and risks, it also may cause a shift of PHL down the supply chain as low quality avocados are discarded further on. This practice also represents a major misalignment of the drivers underlying selling and buying behaviours in which producers focus on quantities while buyers give priority to quality.

Horizontally, incentives at the strategic level of companies along the whole FSC seem fairly aligned as sustainability is often embedded through the adoption of long term objectives aiming at a continuous improvement of environmental, social and economic performances. However, vertically, there seems to be a misalignment between the strategic and operational levels of some companies, especially those with small producers making up the majority of their production base. This misalignment is arguably due to (1) a deficient support at the tactical levels of the FSC that appropriately translates strategic plans into practical applications and (2) an individualistic behavior of some companies lacking the adoption of a global FSC perspective. Finally, the findings suggest that aligning incentives along the food supply chain contribute directly or indirectly to the reduction of postharvest losses by: Aligning individual goals with business priorities; aligning companies' goals with FSC' priorities; aligning the perceptions of quality among the FSC participants; aligning the organizational culture of FSC participants; understanding and sensitizing mutual cultural differences; incentivizing the establishment of common long term objectives; facilitating the building of personal and business relationships, and increasing the awareness of FSC participants regarding the interconnectedness of their actions.

## 4.5 EFFECTIVE PARTNERSHIPS

This section contributes to answering the third component of sub-question 3: *How do [...] effective partnerships [...] contribute to the reduction of postharvest losses along global food supply chains?* First, the findings on Effective partnerships are presented and followed by an analytical interpretation that combines all findings related to this component of innovative collaboration presented in previous sections in chapter 4.

### 4.5.1 Partnerships founded on trust and reputation

Some of the importers expressed a clear preference to engage in partnerships with new entrants to the avocado market due to their flexibility to adapt their production to the client's demands <sup>[1.6]</sup> and due to their lower resistance to change inefficient production practices and behaviours <sup>[3]</sup>. Others assert that partnerships with established FSC participants are more efficient and effective since many of the initial *"bumps in the road"* have already been solved <sup>[2]</sup>, the communication channels are clear <sup>[5]</sup> and the degree of detail of the exchanged information is higher due to *"an earned trust between partners"* <sup>[8]</sup>. Due to the cultural diversity of the various avocado producing regions in Colombia, the formation of partnerships has been hitherto challenging (Banco de comercio exterior de Colombia, nd). However, the Colombian government has taken on the task of keenly stimulating partnerships as a means to confront the challenges of the avocado supply chain faced by small and medium producers. *"Partnerships are one of the best business strategies to face serious threats and limitations posed by the environment, unequal competition and international trends"* (AgloGoldAshanti Colombia, n.d). In Mexico, partnerships have in general, been facilitated by the cultural similarities that result from the majority of producers being part of a clustered avocado production in the state of Michoacán (Banco de comercio exterior de Colombia, nd). Although, since the beginning of 2016, the state of Jalisco has been emerging as a probable contender for the established production region of Michoacán, both have been collaborating towards the strengthening of the national avocado industry in international markets (El Diario NTR, 2015).

Having a good reputation has been identified by interviewees as an important pre-requisite to engage in partnerships with other FSC participants. An importer asserts: *"Reputation is very important in this business. If we have reliable producers, we could focus our efforts on market expansion rather than on producers' recruitment"* <sup>[1]</sup>. Mexican avocados have an excellent reputation regarding their quality and taste. However, the reliability of their supply has been recently (September, 2016) put at risk due to an interruption of operations caused by the discontent of producers regarding an alleged price manipulation by packers, thereby causing an export delay of about 25,000 tons (Expansion en alianza con CNN, 2016). For its part, the Colombian avocado industry as a new entrant to the sector, is still building its reputation in Europe, without significant setbacks hitherto. According to some interviewees, maintaining a good reputation is one of the biggest challenges of the Colombian avocado industry, especially in the view of a rapidly increasing demand. An investment specialist of a Colombian governmental organization promoting international trade asserts that *"the challenge is to keep meeting the quality expectations, assuring adequate postharvest processes and complying to standards also when the demand escalates"* <sup>[16]</sup>.



Based on the interviews, three main types of partnerships have been identified along the avocado supply chain of both countries: (1) Partnerships between competitors, (2) partnerships between buyers and suppliers and (3) Research & Development partnerships with national and international knowledge institutions.

#### 4.5.2 Partnerships between competitors

Colombian producers from different regions have been engaging in partnerships among them with the aim of strengthening the commercialization of avocado in international markets. A producer/exporter states: *“International markets demand large amounts of product at a time, that small or medium producers alone are not able to meet. Therefore, in order to meet the international demand and consolidate our market, partnerships between small and medium producers make sense”*<sup>[19]</sup>. Mexican small and medium producers, which make up roughly 90% of the total production in the country<sup>14</sup> (Comercio Exterior, n.d.), have since long been engaging in partnerships among them and with packers in order to increase their market share, improve the logistics of the export avocado chain and improve the work conditions of producers<sup>[17,19,20]</sup>. Short-term partnerships are also created to supply the peak demand of temporal events, such as the Super Bowl and the Cinco de Mayo in the US (The Produce News, 2015). Partnerships between competitors serve to decrease the uncertainty of small producers who otherwise would sell their product on the spot market, and thereby decrease the risk of postharvest losses caused by unsold product<sup>[23]</sup>. According to an expert in management studies, partnerships between small avocado producers also *“[...] increase their power in relation to more powerful participants of the FSC thereby increasing their bargaining power”*<sup>[21]</sup>. Experts in PHL assert that partnerships between producers accelerate the adoption of adequate postharvest practices as they see each other results<sup>[22]</sup>, and facilitate both, the approachability to the industry from knowledge institutions to provide technical advice and from governmental bodies to provide financial support<sup>[24,25]</sup>. Producers in both countries are often united through partnerships, cooperatives or through producers associations. However, a prevalent problem is the lack of deeds or documents proving their ownership of the productive lands, which in most cases impedes their legal participation in such collaborative arrangements<sup>[16]</sup>. Interviewees estimate that currently 50 to 60% of all producers in Mexico are part of some sort of legal group<sup>[2,14,15,17]</sup>, while in 2003 only 30% of producers were integrated in such way (Fundacion Produce Michoacán, 2003).

#### 4.5.3 Partnerships between buyers and suppliers

Partnerships between buyers and suppliers are often implemented in order to avoid delays caused by logistical deficiencies and to increase the reliability of the supply. An importer asserts: *“Avocado is a difficult product to be judged only by its external appearance; therefore, we rely on the trust that our suppliers live by the same quality standards and business values; partnerships are the catalyst of such trust”*<sup>[3]</sup>. Experts in PHL assert that this kind of partnership serves to stimulate investments from the FSC participants towards the reduction of resources inefficiencies, thereby ultimately contributing to a reduction of costs<sup>[23,25]</sup>. Furthermore, partnerships between buyers and suppliers often stimulate further cooperation between producers as well as cooperation with knowledge institutions<sup>[26]</sup>. In this regard, the manager of a Mexican growers association asserts: *“We strive to improve the lives of our producers and their communities by uniting them into a solid exporting social enterprise that brings producers and*

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<sup>14</sup> Aproximately 75% with less than 5 hectares and 15% with less than 10 hectares

*buyers closer together*”<sup>[18]</sup>. In Colombia some importers have since recently been installing their own packing plants in partnership with local producers. In Mexico, packers-producers partnerships have been established since 1997 through the APEAM, starting with 5 packers and 60 producers, and currently encompassing 42 packers and more than 17000 producers (Revista Comercio Exterior, 2016). With respect to buyers-suppliers partnerships, interviewees assert that these serve to “*increase the mutual trust between partners*”<sup>[1,16]</sup>; “*improve the managerial practices of producers*”<sup>[21]</sup>, and “[...] *expand the mutual cultural knowledge of the parties involved, thereby also strengthening their mutual respect*”<sup>[17]</sup>. However, others assert that partnerships not always succeed in reducing the friction between FSC participants since, as stated by a producer “*we feel that for some partners it is more important to find the financially-proper partners than to nurture the relationships between the people involved in those partnerships*”<sup>[13]</sup>.

#### **4.5.4 Research & Development partnerships**

Research and Development (R&D) partnerships with national and international knowledge institutions are often stimulated by the governments of the exporting and importing countries and sometimes by large companies with interests of market expansion. In Colombia, a partnership between national and regional governments (Antioquia), universities, research institutes and producers aims at overcoming the main problems in the cultivation of Hass avocado in the country through research and action programs; the action programs are directed, a.o., towards training and Global GAP certification of small producers, technical assistance, dissemination and transfer of knowledge, standardization of postharvest parameters, and implementation of a web-based information and management system to stimulate sustainable practices<sup>15</sup> (Ruiz, 2015). In Mexico, the Ministry of Agriculture in collaboration with Wageningen Food & Biobased Research has established in 2014 a program in Agrologistics through which a.o., a 10% reduction in postharvest losses could be achieved while creating 9000 new jobs in the country (AGF, 2014). Interviewees agree that this kind of partnerships is necessary in order to build capacity in the producing countries and to facilitate the trade between them. Some interviewees assert however that in some cases, governments have difficulties going through with established plans, due to the entailed high costs or due to a shift of political priorities, thereby limiting the reach of the partnerships<sup>[2, 23]</sup>.

#### **4.5.5 Analyzing the influence of Effective partnerships on the reduction of postharvest losses**

The partnerships between buyers and suppliers, FSC participants seem to be driven by the expectation of high short-term rewards, as they believe these could result in more prompt and direct individual financial benefits, such as costs reductions. In addition, every transaction within a buyer-supplier partnership generates immediate feedback that can be used in forthcoming partnerships, thereby also adding value to it. It seems however that these partnerships have been gradually transitioning from purely transactional to cooperative, which is encouraged by the benefits that go beyond individual financial gain towards long term FSC-wide value creation. Partnerships between packers and producers for example, increase producers’ visibility of the following production steps in the FSC, thereby increasing their awareness and sense of responsibility regarding the quality of the product beyond their own gate. Such a partnership has

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<sup>15</sup> To achieve this, 7,4 US million dollars have been allocated for a four year period (2014-2017)

then the potential of aligning the definition of quality between the FSC participants, thereby decreasing the risk of PHL due to different quality perceptions. Likewise, these partnerships seem to increase the awareness of packers and exporters regarding the importance of improving social and environmental conditions at the back end of the FSC.

### ***An opportunity to ‘nip postharvest losses in the bud’***

The results indicate that in spite of established partnerships between producers and packers, opportunistic behavior may still be present and benefits may still be asymmetric. This asymmetry is reflected in the overall perception that small producers with very low bargaining power are still the least likely to gain significant economic and social benefits from some partnerships. On the other hand, in Colombia for example, the rapidly increasing demand for export avocado has been posing an opportunity for small farmers previously inactive or involved in illicit cultivations, for which benefits from partnerships with existing producers or importers could presumably bring about significant economic and social improvements, regardless of their low bargaining power. The upsurge of new small producers offers also an opportunity to ‘nip PHL in the bud,’ by promulgating the creation of a new business culture that integrates sustainable, collaborative and good agricultural practices from its inception. In this context, engaging in R&D partnerships with knowledge institutions can serve to expand the knowledge-base of new FSC participants as well as their capacity building. However, from the findings it seems that very few partnerships are directly aimed at reducing postharvest losses, although many of them have a positive indirect impact on them. In this regard, various partnerships seem aimed at offering tools to small producers (such as training and transfer of knowledge) to enhance their capacity to catch up with developments along FSC, thereby reducing organizational inefficiencies, balancing the power between FSC participants and increasing the symmetry in the reaping of benefits.

### ***Learning relationships & learning races***

Established partnerships of one type seem to be conducive to the creation of partnerships of other types or other forms of collaboration, as trust between partners has already been earned and they become more open and transparent; besides, partnerships of different types are not mutually exclusive. In this context, partnerships between competitors and between buyers and suppliers seem to increase the interest and urgency from FSC participants to (1) engage in mutual learning relationships with other FSC participants or (2) to engage in R&D partnerships with knowledge institutions in order to avoid being left behind by others. Learning relationships however, may often turn into learning races (or extended competitions to learn), in which competition becomes progressively more important than collaboration. This is especially the case within the context of vertical collaboration in which reticence to exchange information and lack of trust are important barriers. In the case of some large import and producer companies in the avocado sector for example, learning races can be described as a resourceful seek of knowledge to improve quality, taste, packaging, promotions and marketing beyond that of the competition and at the expense of collaborative investments.

### ***The contextual environment of partnerships matter***

Sometimes, the well-functioning of partnerships gets constrained by political, geographical and cultural factors in their contextual environment. Prominent encountered political factors are the lack of legal instruments that facilitate the ownership of land by small producers, and the relative lower importance granted to sustainability compared to other pressing political issues. This is

especially the case of Mexico and Colombia, since both are countries currently facing civil conflicts and great social inequality. Geographical closeness has also been found to facilitate the creation of cooperations and partnerships. In this context, the quality of communication seems to benefit from the greater exposure of FSC participants to their partners and from regular face to face encounters. Importers are increasingly attempting to reduce the geographical distance by installing packaging or export companies near the production sites. Cultural differences, as showed in 4.3.3 might always be present; being aware of them can lead to a productive resolution of conflicts through which both parties can learn to feel comfortable giving each other honest feedback.

Finally, the findings suggest that effective partnerships contribute directly or indirectly to the reduction of postharvest losses by: Offering clear communication channels along the FSC; exchanging more detailed information; preparing FSC participants to cope better with environmental threats, unequal competition and international trends; strengthening the commercialization of products in international markets; improving logistic processes along the FSC and the work conditions of small producers; decreasing the uncertainty of small producers and the amounts of unsold product; increasing the bargaining power of small FSC participants; accelerating the adoption of adequate postharvest practices; facilitating access to technical advice from knowledge institutions, and financial support from governmental bodies; avoiding delays caused by logistical deficiencies; increasing reliability of supply; stimulating investments from FSC participants; reducing time of transactions; stimulating capacity building of small producers; increasing the awareness of FSC participants regarding the importance of improving social and environmental conditions at the back-end of the FSC; catalyzing trusts, communication, cooperation and innovation along FSCs, and by increasing the sense of responsibility of FSC participants regarding the quality of the product beyond their own gate.

## 4.6 ADEQUATE USE OF TECHNOLOGY

This section contributes to answering the fourth component of sub-question 3: *How does [...] adequate use of technology contribute to the reduction of postharvest losses along global food supply chains?* First, the findings on adequate use of technology are presented and followed by an analytical interpretation that combines all findings related to this component of innovative collaboration presented in previous sections in chapter 4.

### 4.6.1 Transfer of technologies and skills

Small producers in Colombia lack appropriate technologies, underutilize raw materials, don't add value to the product, don't valorize side streams (Corpoica Colombia, 2010) or don't use any technology at all <sup>[16]</sup>. In Mexico, small producers mostly use obsolete technology and carry out most of the tasks manually (Coronado et al., 2015). The use of technologies by medium producers in both countries varies greatly among them, which in turn leads to a great variability in productivity and quality <sup>[2,3,22,26]</sup>. The transfer of agricultural technologies, such as fertility and soil management technologies is often stimulated through partnerships between producers and knowledge institutions or governmental instances. However, most of the interviewees in Mexico and Colombia agree that the majority of these technology transfers are specially aimed at improving harvest stages rather than at improving postharvest stages <sup>[1,2,5,6,11,14,12,16,17,22,23,24,26,28]</sup>.

A researcher of food waste and losses asserts that “*agricultural investments in avocado chains often overlook postharvest problems and focus heavily on the enhancement of harvest techniques*” <sup>[23]</sup>. Thus, the transfers of postharvest technologies, such as sorting, grading, packaging or information technologies, take place to a lower extent, but do find their way through partnerships between buyers and suppliers <sup>[20]</sup>, and are specially driven by commercial factors. The transfer of harvest and postharvest technologies between large and small producers is sometimes stimulated by cooperatives. Generally, large producers use state of the art technology and best agricultural and handling practices which become (partially) accessible to smaller producers through cooperatives <sup>[26]</sup>.

The effectivity and adequate use of transferred technologies, depends on the extent to which skills are also transferred or training is offered. Herein, the participation of knowledge institutions is particularly important since, in Mexico for example, many of the large producers are investors without agricultural backgrounds, applying sophisticated technologies but considered to have a low ecological and collaborative culture (Fundacion Produce Michoacán, 2003). To counteract this, Mexico has since 2003 a strategic program <sup>16</sup> to identify research needs, adequate transfers of technology and transfers of skills in order to maintain and improve the positioning of the avocado on the global market; in this context, it is argued that “*an orchard that receives adequate technical assistance raises its production to more than 50% and improves its quality considerably*” (Fundacion Produce Michoacán, 2003:14).

In Colombia, the government of one of the largest hass avocado producing regions (Antioquia) recently invested 5, 5 million US dollars on harvest technologies and production developments (El Mundo.com, 2014). However, FSC participants in the avocado sector are aware that not all available technologies in the global avocado industry are economically viable in all avocado

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<sup>16</sup> Carried out by the *Coordinadora Nacional de Fundaciones Produce (COFUPRO)*, which is a coordinating and representative agency of 32 foundations with the aim of generating technological innovation for the benefit of the actors of agroindustrial chains in Mexico

growing countries or regions; “therefore, great care must be taken when transferring technologies from one environment to another, even though they have proven to be successful in countries with greater technical advance”(Corpoica Colombia, 2014:116). In order to promote a further transfer of postharvest technologies, production areas are increasingly being complemented with packing plants endowed with modern technologies, which are often managed by importer companies. This has facilitated the suitability of Colombian avocados to the European markets (Portal Fruticola.com, n.d.) and has reduced the unnecessary use of resources <sup>[10]</sup>.

#### 4.6.2 Valorization of side streams

Emerging technologies that make the valorization of side stream possible are gradually being applied in the avocado FSC. Since only about a decade ago in Mexico, and only a few years ago in Colombia, companies have been discovering the business value of avocados’ side streams through the use of technology <sup>[10,18]</sup>. Avocados that are disqualified for export can for example, be transformed into high value cold pressed avocado oil (see figure 11 left). Currently, there is only a little more than a handful of companies producing avocado oil in each of these countries; however its production has been steadily increasing in recent years <sup>[16]</sup>. Using avocados disqualified for export to produce side-products, such as avocado oil, has a greater positive impact the closest it takes place to the back-end of the FSC, where carbon footprint related to transport and packaging is still relatively low. Even so, producing side-products closer to the front-end of the FSC is still desirable from the perspective of postharvest losses; whether it is desirable from the perspective of carbon emissions depends largely on the production methods used <sup>[4]</sup>. Producing side products from avocados streams could reduce the amount of avocados that would have to be traded in local markets (as seen in 4.1.1), which according to Woolf et. al., (2008) would benefit producers by increasing the price of avocado at local markets. In Mexico, where local consumption of avocados is very high, the production of side-products fluctuates according to the consumption, but in general avocados disqualified for export are easily traded at local markets, whereby their transformation into side-products is not encouraged <sup>[18]</sup>.



Figure 13: (left) Avocado oil production in Medellin, Colombia (Extract from youtube video, Terravocado, 2010) ; (right) Bioplastic resin from the avocado seed. (Biofase, 2016)

Avocado seeds are also being transformed into bioplastic thanks to the research and consequent insulation of a biopolymer made by a Mexican company in 2012 (see figure 11 right) (Biofase, 2016). Although the definition of PHL used in this research does not include not edible parts of the fruit, bioplastics from avocados' seeds present an opportunity for collaboration between avocado processing companies and companies in other sectors. Such an example is found in other fruits sectors: The tomato processor company Heinz, engaged in 2014 in a collaborative partnership with cars' manufacturer Ford, in order to use dried tomato skin as a bio-plastic material replacing petrochemical materials used in the vehicles (Ford, 2014). Similar applications could be stimulated within the avocado industry.

#### 4.6.3 The 'human element' of technology

As seen in 4.1, temperature management during transport is a crucial factor along the avocado supply chain, especially after the product is transferred from one FSC stage to another. In this regard an importer <sup>[3]</sup> asserts that short temperature deviations at transfer points are not as consequential as are prolonged temperature deviations after the transfer. Therefore, a detailed exchange of temperature information between FSC participants at transfer points is not only desirable but necessary. This exchange of information can be automated through online temperature monitors such as Radio Frequency Identification (RFID) technologies in the containers <sup>[1]</sup>. However, the International Institute of Refrigeration IIR (2008) identifies various organizational barriers that could limit their adequate functioning, such as lack of uniformity in global standards, high costs, misinterpretation of data and lack of collaboration in the supply chain. In line with Kader (2004), the IIR (2008) asserts that an adequate use of technologies needs to take into account the human element of FSCs, such as people's individual interests, personalities and their willingness to engage in collaborative relationships: *"Obtaining the required level of trust and cooperation across the supply chain is probably one of the greatest challenges for the successful adoption of RFID technologies"* (p.2). The high cost of new technologies is also considered by interviewees as one of the main limiting factors for small and medium producers to implement them <sup>[9,11,13,15]</sup>. The manager of a Mexican growers association exemplifies this:

*"The problem we repeatedly saw was the high variety of dry matter percentages of export avocados. Until last year we didn't have a structured and standardized way to select avocados on basis of their dry matter content, but now due to our collaboration with a Dutch company specialized in postharvest technologies, we can select the product through a scanning process. However, due to the high costs of this technology, for now, it is only being applied by our partners once the product has arrived at its export destination and not yet by our producers."*<sup>[18]</sup>

#### 4.6.4 Regional networks to spread knowledge

In Colombia, the scattered production of avocado has diffculted the spread of knowledge of new techniques and practices, thereby delaying the reduction of costs that normally occur when a given technology is widely adopted <sup>[16]</sup>. From the interviews it is derived that information technologies, such as portals dedicated to the exchange of avocado data and supply chain management systems, have particularly improved the performance of those FSC participants that were already accounted with similar kinds of technologies. Such FSC participants are generally medium to large producers, packers, importers and retailers. One reason for this, according to interviewees, is that for those FSC participants, the marginal effort to implement a

new technology is lower than the rewards and costs entailed with its implementation. For small producers, however, the marginal effort and cost entailed with the implementation of a new technology can be perceived as being higher than the rewards, even after subsidies are granted. According to a Researcher of food losses and waste “[...this perception], although not always accurate, is an important determinant of technology adoption or its adequate use”<sup>[23]</sup>.

Interviewees point out that an intensive stimulation of regional networks by governmental institutions and by larger producers could accelerate the integration of secluded producers, provided that training and monitoring are also offered, especially since mere technologization does not mend the inefficient practices embedded in the culture of workers <sup>[16,17,21,25]</sup>. Interviewees further assert that developing and adopting technologies to measure postharvest losses would increase the urgency with which these are agendaed in legislation, business guidelines and people’s behavior <sup>[23,25]</sup>. Against this backdrop a commercial manager contends that “*mismeasurement can result in mismanagement [...] for the time being we don’t need to know exactly how high our PHL are, but simply strive at not generating any*”<sup>[10]</sup>.

#### **4.6.5 Analyzing the influence of adequate use of technology on the reduction of postharvest losses**

The use of postharvest technologies, such as inland containerization and storage of avocados in modified atmospheres, has allowed the avocado industries in Mexico and Colombia to grow their supply as global demand increases. However, a great deal of technological investments along the avocado FSC is still heavily directed at the harvest stage, which is considered by various interviewees as unjust to postharvest technological investments. Yet, investments at the harvest stage are seemingly pertinent, especially in the view of the scarce capacity building and low technology transfer reaching small producers. Nonetheless, this might entail that there is still a great potential for reduction of postharvest losses through the further and adequate application of postharvest technologies along the FSC.

More than an inadequate use of technologies in the avocado supply chain, there seems to be (1) a lack of adequate work materials and technologies, especially at the back end of the FSC, (2) a reticence of small producers to adapt technologies due to a lack of conviction regarding their benefits, and 3) a low valorization of side streams along the FSC. The perception of high costs and high efforts entailed with the adoption of technologies seems to be an important barrier to implement them, particularly for small and medium producers. Such perception seems to generate a resistance between small producers to adapt technologies at the same rate as other FSC participants do.

The valorization of side streams entails not only a business opportunity for companies along the avocado supply chain, but also a potential reduction of postharvest losses, as avocados that otherwise would be lost can be transformed into a valuable product, such as avocado oil. It is well known that most PHL take place at the back end of the supply chain; therefore valorizing side streams as close as possible to the source makes sense. This would require further investments in research, training and machineries at the avocado producing countries, as well as the disposition of FSC participants there to participate in the endeavor. At the import stage, valorization of side streams could also contribute to the reduction of PHL. Considering that, as the results suggest, 5 to 10% of avocados imported into the Netherlands, not only from Mexico and Colombia, but from all developing countries (300000 tons) are disqualified for fresh



consumption, means that roughly 15000 to 30000 tons of avocados were virtually eligible in 2015 for valorization.

Finally, the findings suggest that an adequate use of technology contributes directly or indirectly to the reduction of postharvest losses by: transferring technology and skills; increasing quantity of production; reducing inadequate handling; improving the quality of the production and the product; reducing unnecessary use of resources; facilitating the use of side-streams; improving temperature management and by stimulating the integration of secluded producers.

#### 4.7 ANALYZING THE TWO CASE STUDIES

The two case studies show that the Mexican avocado industry as an established incumbent is being challenged by ambitious entrants like the Colombian avocado industry, which has been increasingly positioning itself as a reliable business partner in the global avocado trade.

The extent of experience that each country has in the avocado industry does not seem to be a direct determinant of the extent to which organizational inefficiencies lead to postharvest losses. In this context, Colombia's shorter experience is sometimes portrayed as a major cause of the industry's weaknesses in its legal regulatory framework; however Mexico's larger experience is not reflected in a stronger regulatory framework. Mexico's larger experience and comparative advantages are not translated into more information exchange, better alignment of incentives, more effective partnerships or less inadequate uses of technology; neither is it reflected in less postharvest losses. A difference is yet evident regarding the nature of tangible inefficiencies of both countries, which for Colombia relate to inshore infrastructural or operational inadequacies while for Mexico relate specially to offshore ones.

Another noticeable difference relates to the different extents of motivation and willingness of FSC participants of both countries to invest time, energy and money in improvements along the FSC. Mexican FSC participants have accumulated enough experience to improve productivity and to get rid of some organizational inefficiencies, but still they seem to lack the motivation to do so, presumably due to the "*good enough*" economic rewards of the industry as it is. Furthermore, the fact that the country is still by far the largest avocado producer in the world seems to lead the Mexican avocado industry to underestimate their competition, thereby discouraging FSC participants from investing in further FSC improvements. On the other hand, having a strong competitor with an established experience seems to be a motivator for the Colombian avocado industry to accelerate its improvement rate. In this context, Colombia seems to be on a faster track to a more resource-efficient trade, with higher crop yields and less overseas' postharvest losses. At the same time, thanks to the industry's horizontal collaboration, these improvements have been partly based upon the experiences of more established avocado industries, especially that of the Mexican incumbent.

A difference regarding the types of collaborative relationships seems to be also present between the two cases. The Mexican avocado industry has, throughout the years, been creating a collaborative environment for domestic FSC participants in order to strengthen their position in international markets. Herein, packers act as "*champions*", guiding FSC participants from harvest to export, thereby enhancing the quality of export avocados and decreasing the postharvest losses at these stages of the food supply chain. In some cases, however, powerful investors without agricultural backgrounds or ecological and collaborative cultures, take prominent roles in the Mexican avocado industry, thereby turning the attention of the industry away from sustainability aspects. In the Colombian avocado supply chain there is no evidence of a champion taking a leading role in the FSC. Herein, collaborative endeavors seem to be promoted from outside the FSC, by government and research institutions showing a strong will to create an enabling environment for environmental, social and economic improvements along the FSC. However, the realization of such an environment continues to be challenged by several organizational inefficiencies as seen in Table 6. In both cases, whenever the adoption of sustainable practices is promulgated, it seems to be generally from the top down.

In terms of collaborative innovation both countries present similar performances. Both FSCs show similarities regarding the parts of the FSC in which organizational inefficiencies are more evident, namely at the back-end of the FSC, and particularly across small producers. Small producers struggle to deliver products of consistent quality and are susceptible to small environmental and political changes. Various examples suggest that innovative collaboration creates an enabling environment in which small producers can gain increased access to technology, knowledge, information, financing and feedback, which can be used to, (1) improve and align the quality of the product to the quality demand, thereby reducing postharvest losses at latter FSC stages, (2) increase the reliability of their supply whereby the possibility of long-term contracts with buyers increases, and (3) improve their livelihood, whereby the migratory pattern of rural producers to the cities can be mitigated (see 3.1.1 c). Consequently, by positively influencing various aspects of the environmental, economic and social dimensions of the avocado FSC, innovative collaboration seems to have a positive influence on the sustainability of the supply chain, beyond that of reducing postharvest losses. Not in all cases, however innovative collaboration seems to succeed in addressing the organizational inefficiencies that cause postharvest losses. In this context, similar for both countries is the lack of documents proving the ownership of the productive lands by small or medium producers and the price mechanisms unadjusted for externalities, which require to be addressed through a broader approach, beyond the boundaries of the food supply chain system.

The perceived barriers and drivers of innovative collaboration along the FSC show an interesting arrangement. Most of the perceived barriers are related to *cognitive & affective inefficiencies* and the *corporate governance inefficiencies*, stemming from feelings and behaviours or from inappropriate corporate structures and managerial mechanisms. The perceived drivers seem to relate to more to *tangible* improvements in logistics, operations and efficiency. These findings could suggest that FSC participants perceive barriers to innovative collaboration from a wider perspective, as a broad set of institutional, governmental and behavioral conditions that negatively influence their functioning within the FSC. Drivers of innovative collaboration on the other hand, are perceived as a set of more specific and operational terms, which might have a motivational effect on FSC participants to work towards improvements, as these seem to represent individual benefits. In this context, reframing barriers in more pragmatic terms through which FSC participants perceive the influence of their individual actions on the FSC, could be a step forward towards overcoming them.

## 4.8 ANALYSIS OF THE HYPOTHESES

Some of the findings presented and analyzed above support the main proposition that *FSC participants that engage in innovative collaboration have a positive influence on the sustainability of the FSC through the reduction of PHL*. However, some of the findings also suggest that the hypotheses need to be refined in order to gain more insightful results in further research. This section reflects on the hypotheses and arguments whether these are fully supported, partially supported or not supported by the findings. Based on the results gathered in this research, refined hypotheses are proposed for future research.

### 4.8.1 Hypothesis 1

*H: 1 Information exchange among FSC participants has a positive influence on the sustainability of FSC by reducing PHL*

Hypothesis 1 is considered to be partially supported because the findings suggest that not all kinds of information exchange have a positive influence on the sustainability of food supply chains by reducing postharvest losses. It can be argued that the ‘right kind’ of information exchange is needed in order for this hypothesis to be held true. The ‘right kind’ of information can be described from the findings as information that is reliable, accurate, regular, detailed, current, useful, understandable, manageable and perceived as beneficial by the FSC participants. The ‘right kind’ of information exchange seems to be potentially effective in addressing *corporate governance inefficiencies* (such as uncertainty of demand leading to overbuying or underbuying, or lack of effective monitoring); this is especially due to a) the potential of the right kind’ of information exchange to reduce flaws in strategies, processes, corporate structures and managerial mechanisms leading to PHL, top-down, and b) the current milieu of agricultural FSC, in which operational levels seem to be less involved in information exchange activities, which in itself, can be considered as an organizational inefficiency. Following this, the following refined hypothesis (RH) is proposed:

*RH1: Exchanging the ‘right kind of information’ is positively associated with the sustainability of FSCs through the reduction of corporate governance inefficiencies that lead to postharvest losses*

Likewise, the media through which information is exchanged (documents, electronically, telephonic, face to face) seem to influence the effectiveness of the act of communication, being more effective as the communication requires more personal involvement (such as face to face). Following this, the following refined hypothesis is proposed:

*RH1(a): Communication that requires personal involvement is positively associated with the effectiveness of information exchange*

Feedback has also been found to be an effective way of assessing performance and stimulating positive change towards PHL reduction, especially when it is given and received in real time or soon after the evaluated event takes place. Following this, the following refined hypothesis is proposed:

*RH1(b): Giving and receiving direct feedback is positively associated with stimulating positive change towards the reduction of postharvest losses*

#### 4.8.2 Hypothesis 2

*H2: Incentives alignment among FSC participants has a positive influence on the sustainability of FSC by reducing PHL*

Hypothesis 2 is considered to be partially supported because the findings suggest that aligning incentives without proper monitoring and adequate measures to increase awareness regarding the importance of reducing postharvest losses could backfire. The importance of proper monitoring is reflected in the lack of further recommendations and training, particularly to small and medium producers, following initial interventions towards the reduction of postharvest losses. This lack of monitoring, especially at the back-end of the FSC, is caused by high costs and unstable and segmented production difficulting the auditability of processes. The importance of awareness campaigns lies in the fact that, although postharvest losses are influenced by current business objectives, policies and priorities, only very few are directly aimed at their reduction. The alignment of incentives along FSCs needs therefore to be accompanied by (1) a proper monitoring through which further recommendations are made as changes develop over time, and (2) awareness campaigns highlighting the importance of reducing postharvest losses at strategic and operational levels. Following this, the following refined hypothesis is proposed:

*RH2(a): The effectiveness of aligning incentives to reduce postharvest losses is positively associated with the presence of proper and continuous monitoring*

*RH2(b): The effectiveness of aligning incentives to reduce postharvest losses is positively associated with the awareness of FSC participants regarding the importance of reducing postharvest losses*

The findings suggest that there is a deficient support from the tactical levels of FSCs through which strategic plans are appropriately translated into practical applications. In this context, closing the gap between strategic objectives and operational actions with the support of tactical levels of FSCs, could stimulate the establishment of common long term goals along the FSC. The importance of this lies on the potential of common long term goals in enhancing productivity and efficiency, stimulating innovation and retention of personnel and aligning the definition of quality along the FSC. Following this, the following refined hypothesis is proposed:

*RH2(c): The presence of a long-term tactical support that appropriately translates strategic plans into practical applications is positively associated with an alignment of incentives along FSC*

Finally, aligning incentives seems to be potentially effective in addressing *cognitive & affective governance inefficiencies* (such as individualism and reluctance to close long term agreements) by (a) changing FSC participants' behaviors, perceptions, expectations, beliefs, emotions, values and feelings which underlay their individual interests, and (b) by making the interests of

individual FSC participants match the objectives of the whole FSC. Following this, the following refined hypothesis is proposed:

*RH2(d): Aligning incentives is positively associated with the sustainability of FSCs through the reduction of cognitive & affective inefficiencies that lead to postharvest losses*

#### 4.8.3 Hypothesis 3

*H3: Effective partnerships among FSC participants have a positive influence on the sustainability of FSC by reducing PHL*

Hypothesis 3 is considered to be fully supported because the findings suggest that effective partnerships (a) accelerate the adoption of adequate postharvest practices (b) stimulate the transfer of knowledge, technology and skills from knowledge institutions to companies and (c) provide the financial and technical support that -especially small and medium producers- are not able to get from their governments; all of which have a potential positive influence on the reduction of postharvest losses. Effective partnerships have thus a positive influence on social, environmental and economic aspects along the FSC through the reduction of organizational inefficiencies that cause postharvest losses. Effective partnerships are suggested by the findings as the backbone of innovative collaboration as these function as catalysts of, trust, communication, cooperation and innovation, in addition to contributing to reduce organizational inefficiencies throughout the three groups: *Corporate governance inefficiencies, Cognitive & Affective inefficiencies* and *Tangible inefficiencies*.

This hypothesis could however be further specified by proposing the following refined hypothesis:

*RH3: Effective partnerships are positively associated with the sustainability of FSCs through the reduction of corporate governance inefficiencies, cognitive & affective inefficiencies and tangible inefficiencies that lead to postharvest losses*

The findings seem to also suggest that, geographical closeness between the FSC participants, in addition to their cultural, organizational and economic alignment boosts the effectiveness of partnerships through the reduction of their transactional, communicative and organizational frictions. Following this, the following refined hypothesis is proposed:

*RH3(a): The effectiveness of partnerships is positively associated with the geographical, cultural, organizational and economic closeness of the FSC participants involved*

#### 4.8.4 Hypothesis 4

*H4: An adequate use of technology has a positive influence on the sustainability of FSC by reducing PHL*

Hypothesis 4 is considered to be partially supported because the findings suggest that rather than using technology inadequately, FSC participants at the back end of the FSC still have low access to technologies or are reticent to adapt them, while throughout the whole FSC valorization of side streams is under implemented. In this context, it seems that a) increasing access to

technologies, b) adapting and internalizing available technologies and c) valorizing side streams could be especially effective in addressing some of the tangible inefficiencies of the FSC. Following this, the following refined hypotheses are proposed:

*TH4: An increased access to technology at the back end of the FSC is positively associated with the sustainability of FSCs through the reduction of tangible inefficiencies that lead to postharvest losses*

*TH4(a): An increased adaptation and internalization of technology at the back end of the FSC is positively associated with the sustainability of FSCs through the reduction of tangible inefficiencies that lead to postharvest losses*

*TH4(b): An increased valorization of side streams throughout the whole FSC is positively associated with the sustainability of FSCs through the reduction of tangible inefficiencies that lead to postharvest losses*

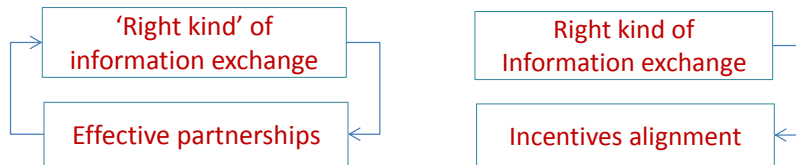
Table 9 shows the results of hypotheses H1, H2, H3 and H4 and depicts whether these are fully supported, partially supported or not supported by the findings.

**Table 9: Result of hypotheses**

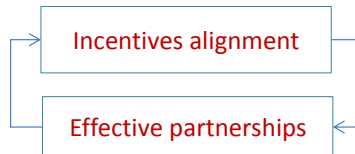
<b>Hypotheses</b>	<b>Fully supported</b>	<b>Partially supported</b>	<b>Not supported</b>
<i>H1: Information exchange among FSC participants has a positive influence on the sustainability of FSC by reducing PHL</i>			
<i>H2: Incentive alignment among FSC participants has a positive influence on the sustainability of FSC by reducing PHL</i>			
<i>H3: Effective partnerships among FSC participants have a positive influence on the sustainability of FSC by reducing PHL</i>			
<i>H4: An adequate use of technology has a positive influence on the sustainability of FSC by reducing PHL</i>			

#### 4.9 DYNAMIC BETWEEN THE COMPONENTS OF INNOVATIVE COLLABORATION

Various dynamics were found between the components of innovative collaboration. Some of the components influence one another to enhance the sustainability of the food supply chain through the reduction of postharvest losses. A dynamic between *exchanging the right kind of information* and (1) *effective partnerships* and (2) *incentives alignment* was found. Exchanging the right kind of information, communicating personally or exchanging feedback seem to generate a sense of reciprocity, through which FSC participants feel compelled to further engage in collaborative relationships and partnerships. As the partnership evolves, so seems to do the regularity and quality of information exchange, thereby gradually integrating it in the organizational culture of FSC participants. Incentives are often driven by the perceptions, expectations, beliefs, emotions, values and feelings (cognitive & affective factors) of FSC participants, and from the findings it seems that the higher the (right kind of) information exchange, the more these cognitive and affective factors reflect reality.



The mutual recognition of FSC participants of their cultural, economic and organizational differences may in turn stimulate the creation of partnerships through which such differences can be turned into advantages by means of their complementary assets. In this context, an iterative dynamic is also found between *incentives alignment* and *effective partnerships*, as the former seems to stimulate the formation of the latter, while the latter fosters a natural alignment of incentives as FSC become increasingly acquainted with the benefits of their ‘symbiotic’ collaboration.



Finally, a dynamic is also found between *information exchange*, *effective partnerships*, *incentives’ alignment* and *adequate use of technology*. Information exchange seems to be determinant of both, the adoption of technology and its adequate use. In this context, the superficiality or lack of information exchange can limit the PHL reduction potential of information technologies by for example, decreasing the accuracy of inventories or the efficiency of temperature management technologies. Likewise, ‘the right kind’ of information exchange could boost the effectiveness of such technologies, thereby demonstrating the benefits of adequate technology use and stimulating reticent FSC participants to adapt them. Effective partnerships, in particular R&D partnerships, can be identified as catalysts of technology’ transfers between partners through which the recipient partner not only gains access to technology, but also to the knowledge and skills to use it adequately. Likewise, aligning the incentives of the FSC participants, especially by taking into account their mutual cognitive and



affective inefficiencies (as seen in tables 4 & 5) and dealing with them, could increase their mutual understanding of their attitudes and perceptions towards technology. This could not only facilitate the identification of context-specific barriers to technology adoption, but also stimulate effective technology transfers towards the reduction of PHL that can be embraced and integrated in the business culture of FSC participants.

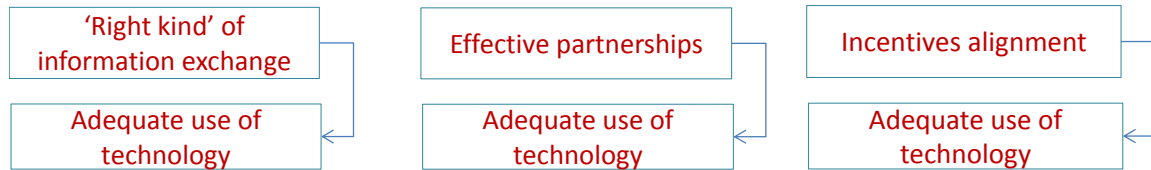


Figure 14 shows the all dynamics between the components of Innovative collaboration and serves as a refinement of the conceptual model.

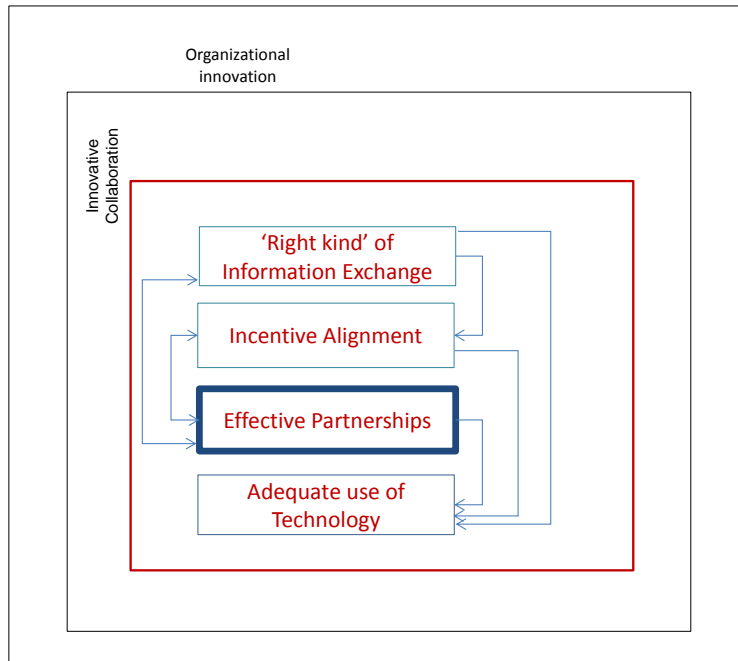


Figure 14: Dynamic between the components of Innovative collaboration

A new dynamic has also been found between sustainable food supply chains and the reduction of postharvest losses. As FSCs become more sustainable, a self-reinforcing feedback seems to amplify the reduction of PHL since positive changes in the behavior of FSC participants achieved through innovative collaboration tend to become embedded in their organizational culture. Organizational innovation is in turn a function of the organizational culture of FSC participants, through which innovative collaboration towards the reduction of postharvest losses is further stimulated. Figure 15 shows the refined conceptual model with the dynamics between the different concepts.

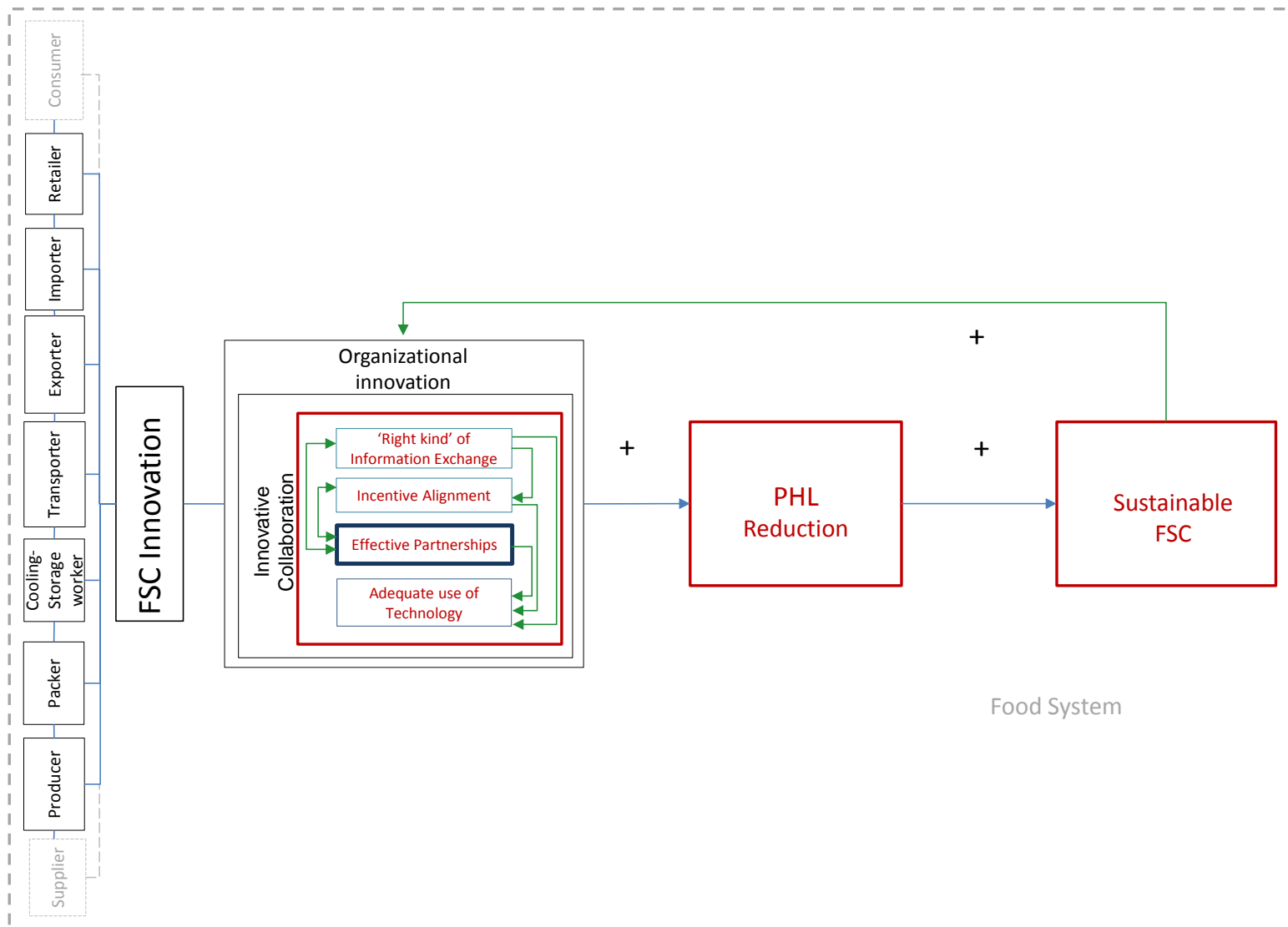


Figure 15: Refined conceptual framework. Dynamics between Sustainable Food Supply Chains (FSC), Postharvest losses (PHL) and Innovative Collaboration. The green arrows represent the new dynamics found during this research. The box of *effective partnerships* is delineated in bold to represent its position as backbone of Innovative collaboration



## 5. DISCUSSION

This chapter reflects on the findings and methods of the research and on its theoretical and practical contributions.

### 5.1 DISCUSSIONS ON THE CASE STUDIES

The case studies show that *Effective partnerships* are the backbone of *Innovative collaboration*, functioning as catalysts of trust, communication, cooperation and innovation along FSCs in addition to contributing to reduce organizational inefficiencies. Some of the partnerships found during this research are cooperative of nature (such as R&D partnerships), described by Ziggers and Trienekens (1999) as coordinating systems in which participants have common objectives and complementary contributions. However, still many of them meet Ziggers & Trienekens (1999) description of transactional partnerships (such as partnerships between buyers and suppliers), characterized by interdependent, yet individualistic participants within a regulatory system, focusing on their own objectives and on the efficiency of their economic transactions. Notwithstanding, many of these transactional partnerships are gradually being pulled towards more cooperative systems, as FSC participants become increasingly aware of the potential benefits of long-term collaboration.

Effective partnerships were found to generate a positive feedback loop, through which the creation of new partnerships is stimulated. However, in some cases, partnerships also lead to learning races between FSC participants. This is in line with the findings of Cao & Zhang (2011) on supply chain collaboration in which FSC participants tend to engage in learning races in order to internalize others' resources and skills that could improve their individual performance. Such internalization of resources and skills was found to be asymmetric in nature, whereby small producers seem to obtain less economic and social benefits than other FSC participants. This is in line with Khanna, Gulati & Nohria (1998)'s assertion that the benefits acquired by a partner from a partnership are likely to be proportional to the relative bargaining power of the partners involved. On the other hand, effective partnerships, R&D partnerships in particular, were found to increase the symmetry in the reaping of benefits along the food supply chain. In this regard, according to Khanna, Gulati & Nohria (1998), as the reaping of benefits approaches a symmetric distribution along the FSC, the incentives to engage in learning races decrease. Consequently, R&D partnerships may also have the potential to compensate the need for learning races and contribute to an increase in collaborative relationships with more symmetric benefits' reaping.

The alignment of incentives was found to align individual goals with business priorities, align companies' goals with FSC' priorities, align perceptions of quality among the FSC participants and increase the understanding of FSC participants regarding their cultural differences. However, also major misalignments were found, especially in the drivers underlying selling and buying behaviours between producers and buyers. Here, it was found that producers focus on the quantities they sell while buyers give priority to quality, but also that producers often buy more than needed in order to protect small consumers from losing profit. This practice however, could shift the postharvest losses to the front-end of the FSC, thereby also increasing the extent of their environmental impact. In line with this, Kader (2004) asserts that this misalignment between producers and other FSC participants may not be completely counterproductive since it could help palliate the effects brought about by buyers in developed countries overemphasizing quality

based on appearance. Aligning incentives between FSC participants is sometimes hindered by individualistic behaviours. According to Simatupang and Sridhadan (2002) individualistic behaviors often arise due to companies “[...] *lacking the means to compel others to adjust their policies and priorities to align with the overall profit*” (p.18), thereby leading to an asymmetric distribution of costs and benefits. To this regard, they recommend to implement productive behavior-based incentives and payment rewards proportional to performance as start measures towards a long term equitable compensation.

The adoption of technologies among FSC participants, especially by small and medium producers, is sometimes limited by their perception of high costs and high efforts. This is in line with Patterson, Grimm & Corsi (2003) s’ assertion that the degree of technology adoption is positively correlated with the size of an organization. This slower pace of technology adaptation by small producers, especially in the view of scientific or supply chain-wide recommendations to do so, has been studied by scholars already since the 80’s. According to Hildebrand (1981) it makes no difference to a small producer how a third party views any specific technology since, “*if he, himself, does not feel it to be appropriate, he is not going to be motivated to accept it*”(p. 377). This statement seems to be as valid in the current agricultural environment as it was more than 30 years ago, especially in contexts in which the operational levels of a supply chain are remotely steered by investors without agricultural backgrounds, as seen in the Mexican case.

In the case of Mexico, the lack of expertise in transatlantic shipping seems to be a major organizational inefficiency leading to postharvest losses. For the Colombian FSC it could be argued in this respect that, the transatlantic shipping expertise of the country is purely a contextual asset and not a merit of the avocado FSC as such, as it stems mainly from the endeavors of other industries. Within this line of thought, Mexico’s lack of transatlantic shipping expertise could be considered as a contextual disadvantage and not as an organizational inefficiency of the avocado FSC. This contextual disadvantage differs from other found organizational inefficiencies such as, the lack of documents proving ownership of land, in that the latter has a direct relevance to the agricultural sector while the former is relevant for virtually every export industry. Following this, and in order to obtain a more precise analysis in future research, all identified organizational inefficiencies could be further specified into *Country-specific organizational inefficiencies*, *Agricultural-specific organizational inefficiencies* and *Avocado supply chain-specific organizational inefficiencies*.

The two case studies show that although several barriers and drivers, complex dynamics, and contextual factors influence established and new FSC participants in different ways, as Hockerts & Wüstenhagen (2010) assert, the sustainable transformation of an industry is brought about by the interaction of both, incumbents and entrants, rather than by their solitary endeavors. Herein, examples of horizontal and vertical collaboration show that the avocado industry is recognizing the importance of collective action and the interrelatedness of their business decisions. However, the findings also show that, out of these collaborative endeavors only very few are directed towards the reduction of postharvest losses, and that the interests of the global avocado industry aren’t yet aligned with those of European governments increasingly putting the reduction of food losses & waste high on their agendas. The avocado industry seems rather highly driven by economic incentives fueled by high market prices and the recent upsurge in avocado demand. High prices and demand have been in turn incentivizing large amounts of new producers to join

the industry, thereby increasing the risk to the avocado industry of presenting features of a *cobweb phenomenon*. Akerman (1957) asserts that a cobweb phenomenon occurs when the increased demand for a product (that has an inherent time-lag between planting and harvesting, such as avocados), leads producers to expand their production, in the expectation that current prices will continue and that their own production plans will not affect the market; this results then in a saturation of the market and subsequent collapse of prices years later, when the trees bear fruit and are harvested. As Simons (2014) observes, cobweb phenomena are caused by FSC participants with misaligned incentives, putting their own, short term interests above the long-term interests of the whole FSC or the whole food system.

Likewise, other discrepancies between demand and supply could occur due to disturbances affecting the food system, such as unusual weather or changes in consumers' preferences (Akerman, 1957). In this context, with European consumers increasingly demanding sustainably produced products, such a disturbance could occur, as explained by Maloni & Brown (2006), due to consumer criticisms of perceived low social or environmental standards of the industry, *which "can be extremely detrimental to corporate profitability and market share"*(p.35). In this respect, latent problems were found in the Mexican case in which the avocado industry is considered a cause of deforestation and perturbation of natural habitats in the country.

Following this, the results exemplify that, as Kaipia et al., (2013) and Timmermans et al., (2014) assert, reducing postharvest losses requires a focus on multiple parallel issues at the same time, and an approach that includes the behavioral, organizational, technological and contextual complexities to which global food supply chains are subject, at micro, meso and macro levels. Table 1 showed the impacts brought about by microlevel, mesolevel and macrolevel causes of postharvest losses on respectively, the individual enterprise, the food supply chain and the food system. This research focused on the mesolevel causes of postharvest losses, in particular those related to the lack of the components of innovative collaboration (information exchange, incentives alignment, effective partnerships and adequate use of technology). However, in line with Timmermans et al., (2014), the findings show that causes of postharvest losses at all levels are interconnected, for example due to regulatory frameworks, policies and contextual assets or disadvantages of the country (macrolevel) affecting the development of industries, the incentives they use, the information they exchange and their capacity to offer training, monitoring or legal rights to FSC participants (mesolevel), thereby influencing individuals behaviours and actions (microlevel).

The aim of this research was to explore the role of innovative collaboration in reducing the organizational inefficiencies that lead to postharvest losses along food supply chains and thereby contribute to their sustainability. For this, a conceptual model based on existing theory was developed linking the concepts of *Innovative collaboration*, *Postharvest losses* and *Food supply chains*. Using the findings of this research, the conceptual model has been refined by including new dynamics between the different concepts, while the hypotheses were refined, thereby generating new ones for further research. Further research could be designed to measure the strength of the dynamics between these concepts and the feedback mechanisms between them in a quantitative manner. Therein, the findings of this research on the drivers and barriers underlying such processes could be included. In this context, a further study of self-reinforcing

feedbacks within the FSC is of special interest since depending on the dynamics they reinforce, they have both, the potential to accelerate sustainability adoption and the potential to stagnate it.

## 5.2 DISCUSSIONS ON THE RESEARCH DESIGN

The principles of qualitative research state that the sample size should follow the concept of saturation (Glaser & Strauss, 2009). Saturation occurs when no new data, categories, themes or explanations emerge as the study progresses; the sample size needed to reach the saturation point varies according to the complexity of the research question (Marshall, 1996): “*An appropriate sample size for a qualitative study is one that adequately answers the research question*” (p:523). The number of interviews in this research seems large enough to obtain significant results regarding the role of innovative collaboration within the food supply chain, thereby obtaining an adequate answer to the research question. In this context, the results contribute to the existing theory in various ways.

First, this research develops the concept of innovative collaboration by grouping recurrent concepts from literature on innovation and sustainability that separately have been found to contribute to the sustainability of food supply chains, but that hitherto have not been jointly studied and applied to the specific problem of postharvest losses. Consequently, this research builds on Soosay, Hyland & Ferrer (2008), who mention the concept of innovative collaboration in the context of continuous innovation in the management of supply chains, but don't further develop or describe the concept, and on Fearne & Hughes, 1999; Lambert & Cooper, 2000; Simatupang & Sridharan, 2002; Pibernik et al., 2011; Barratt, 2004; Soosay, Hyland & Ferrer, 2008; Kaipia et al., 2013; Timmermans et al., 2014 and WRI, 2016, who study one or more of the components of innovative collaboration (information exchange, incentives' alignment, effective partnerships or adequate use of technology), but don't explore the dynamics between them. In doing so, this research contributes to the innovation and sustainability literature by investigating postharvest losses and the sustainability of FSC from a new perspective, exploring the dynamics between relevant concepts in the existing literature and their potential contribution to the sustainability of FSC through the reduction of PHL.

Second, this research contributes to existing theory on organizational innovation and postharvest losses by categorizing the organizational inefficiencies that lead to postharvest losses according to their underlying causes; herein, corporate governance inefficiencies, cognitive & affective inefficiencies and tangible inefficiencies were identified. In doing so, this research contributes to point out the direction of needed interventions to reduce postharvest losses, thereby having also practical implications for managers of companies along FSCs, for policy-makers and for practitioners in general working towards the sustainability of global FSCs. Third, this research serves to deepen the understanding on the perceived barriers and drivers of FSC participants to use innovative collaboration in order to reduce postharvest losses within global agrifood supply chains. Whereas most of previous research on the reduction of postharvest losses focuses on postharvest technologies (Barratt, 2004), this research highlights the importance of addressing organizational inefficiencies and exploring the perceptions and behavior of FSC participants, which according to Kader (2004) are key determinants of change towards the reduction of postharvest losses.

The semi-structured interviews provided several insights that enriched the findings of this research. However not all FSC participants were proportionally represented in the interviews sample, for which an additional number of interviews might have been needed if findings were to be generalized to each group of FSC participants. Most interviewees within the FSC were producers/exporters and importers, especially due to the fact that these are more easily accessible (through contact information in websites or mutual referral) than for example transporters, which generally don't limit their activities to a single product and are therefore less approachable within avocado networks. This *convenience sample strategy* as coined by Marshall (1996), involves the selection of the most accessible subjects, being therefore less costly to the researcher, in terms of time, effort and money, but also less rigorous, which can negatively influence the quality of data and the construct validity of the research. Furthermore, having only two case studies limits the external validity of the findings, for which the generalizability of this research may be limited to food supply chains that present similar cultural, economic or organizational contexts. The validity of the research can also be influenced by the fact that interviews were held in Dutch and Spanish and then translated into English, since translation is an interpretive act, and meaning may get lost in the translation process (Van Nes, Abma, Jonssen & Deeg, 2010). Therefore, in order to improve the construct and external validity of the research, secondary data from companies' websites and public governmental documents were consulted, and several informal conversations with experts in food systems were held. The internship of 8 months at Wageningen Food & Bio-based research facilitated the contact with experts in postharvest losses with which the findings were discussed and constantly refined. Also, the findings were continually compared to existing literature on innovative collaboration, sustainable food systems and postharvest losses. Finally, when needed, summaries or excerpts of the interviews were shared with interviewees for clarification, and the final thesis was shared with interviewees willing to provide comments or suggestions.

The selected components of innovative collaboration are also subject to limitations. Although information exchange, incentives' alignment, effective partnerships and adequate use of technology were found to be very recurrent concepts in relevant literature, these are by no means exhaustive and might be in need of being supplemented in further research in order to generate a more detailed conceptualization of innovative collaboration. This selection of components however, served to shed light into the complexity and dynamism that underly individual and collective behaviours towards the reduction of postharvest losses along food supply chains. Another limitation of this research is that it involves many different concepts which by themselves could be the single focus of a research question. Using these concepts was necessary in order to generate an optimal conceptual framework that was able to cover the main complexities of the topic of this research. By doing so, however, these concepts were only partially explored for which further research is necessary in order to explore them in further depth. Notwithstanding the limited generalizability of the findings, the conceptual model can be used as an analytical tool for further research, thereby allowing for a further refinement by including new dynamics between the concepts, other components of the food system (such as government agencies), or by applying it to different case studies.





## 6. CONCLUSION

The main research question of this study was: *How does innovative collaboration influence the sustainability of global food supply chains through the reduction of postharvest losses?* In order to answer this question, first the sub-questions are answered.

*Sub question 1: How do participants in global food supply chains interact with each other and which organizational inefficiencies limiting the reduction of postharvest losses can be identified therein?*

The exploratory case study shows that FSC participants interact through both, horizontal collaboration driven by competition, and vertical collaboration driven by the inherent need in FSCs of getting a product from the field to the consumer. Horizontal collaboration is considered to be strategically advantageous, as FSC participants get to exchange the kind of information that is beneficial for the whole supply chain and whose exchange does not entail a competitive disadvantage for any FSC participant. Vertical collaboration is considered to be functionally essential as it leads to, (a) cost savings from increased efficiency due to recurrent procedures that become habitual, (b) reduced transactional friction due to regular communication, (c) increased alignment of the organizational culture, and (d) increased risk-taking attitudes towards innovation due to risk-sharing practices between FSC participants; all of which have the potential to contribute to the reduction of postharvest losses. However, collaborating vertically is done with caution in order to avoid exchanging information that potentially increases the competitive advantage of others at expenses of the own.

Inter-personal interactions seem to be very important in paving the way towards more formal and long-term relationships. As relationships evolve, organizational inefficiencies are gradually removed from the food supply chain due to positive behaviours becoming embedded in the organizational culture of FSC participants. Three main types of organizational inefficiencies were found: (1) Corporate governance inefficiencies, which are flaws in, the processes, corporate structures and managerial mechanisms underlying the coordination of activities along the food supply chain, thereby leading to postharvest losses, (2) cognitive & affective inefficiencies, which are perceptions, expectations, beliefs, emotions, values, behaviours and feelings of FSC participants leading to postharvest losses along the food supply chain, and (3) tangible inefficiencies, which are infrastructural or operational flaws in the production, in the use of resources or in the handling of the product leading to postharvest losses along the food supply chain. A complete list of the organizational inefficiencies found in this research is showed in Table 5 and Table 6. Most of the found organizational inefficiencies in both cases studies are of the corporate governance category, suggesting that the well-functioning of the FSC is highly dependent on the enabling environment created by the food system in which the FSC exists.

*Sub-question 2: What are the main drivers and barriers of FSC participants to engage in innovative collaboration to reduce postharvest losses within global food supply chains?*

Most of the barriers of FSC participants to engage in innovative collaboration seem to relate to the cognitive & affective, and the corporate governance inefficiencies. In this regard, barriers relating to cognitive & affective inefficiencies stem from, feelings (such as lack of trust and lack

of interest), from behaviours (such as resistance to change, reluctance to share information and opportunistic behaviour) and from perceptions, beliefs or values (such as differences in working culture and opinions). Barriers relating to corporate governance inefficiencies stem from inappropriate corporate structures (that allow asymmetries in the extents of power of FSC participants) and from inappropriate managerial mechanisms (that lead to compartmentalized reaping of benefits). The drivers of innovative collaboration seem to have a more tangible nature. In this context, FSC participants are driven to engage in collaborative innovation due to the prospect of potential operational improvements (resulting from increased FSC' efficiency, costs savings and smoother logistics) and increased access to resources (such as information, knowledge and technologies). FSC participants perceive that through innovative collaboration, the working staff could become empowered as the exchange of ideas is encouraged and people get culturally integrated, therefore also enhancing the stability of relationships. A complete list of barriers and drivers of innovative collaboration is showed in Table 7.

These findings suggest that FSC participants might refrain from engaging in innovative collaboration due to barriers influencing not only the FSC, but the food system as a whole. They perceive these barriers as institutional, governmental and behavioral flaws, which in their view reduce the appeal and potential benefits of engaging in innovative collaboration to reduce postharvest losses. On the other hand, FSC participants feel encouraged to engage in innovative collaboration to reduce postharvest losses due to the prospect of more individual and tangible benefits. For example, from a producer perspective, the driver *increased stability of the relationship* is perceived in relation to a more steady demand that decreases the risk of losing product due to sudden changes in contracts. In this context, increasing the understanding on how FSC participants perceive barriers to innovative collaboration, and translating them into more operational terms could lead FSC participants to perceive them as problems they too can do something about.

*Sub-question 3: How do information exchange, incentive alignment, effective partnerships and adequate use of technology contribute to the reduction of postharvest losses along global food supply chains?*

Each of the components of innovative collaboration (information exchange, incentive alignment, effective partnerships and adequate use of technology) was found to contribute in different degrees to the reduction of postharvest losses, not only individually, but also through the interrelated dynamics that take place between them. However only H3: *Effective partnerships among FSC participants have a positive influence on the sustainability of FSC by reducing PHL*, was fully supported by the findings. H1, H2 and H4 were only partially supported and therefore refined for future research. Effective partnerships were found to be the backbone of innovative collaboration, and the largest contributor to the reduction of postharvest losses within the framework of this study.

Table 10 shows a summary of the findings regarding the individual contributions by each component of innovative collaboration to the reduction of postharvest losses along FSC chains.

**Table 10: Summary of findings on the contributions of information exchange, incentives alignment, effective partnerships and adequate use of technologies to the reduction of postharvest losses along FSC chains**

	<b>Information exchange</b>	<b>Incentives alignment</b>	<b>Effective partnerships</b>	<b>Adequate use of technology</b>
<b>Contribute to the reduction of postharvest losses by</b>	Reducing uncertainty of demand and supply	Aligning individual goals with business priorities	Offering clear communication channels	Transferring technology and skills
	Improving coordination and planning	Aligning companies' goals with FSC' priorities	Exchanging more detailed information	Increasing quantity of production
	Reducing costs related to uncertainty	Aligning perceptions of quality among the FSC participants	Preparing FSC participants to better cope with environmental threats, unequal competition and international trends	Reducing inadequate handling
	Enhancing overall supply chain performance	Aligning organizational cultures of FSC participants	Strengthening the commercialization in international markets	Improving quality of production and product
	Balancing the knowledge-base of the industry	Understanding and sensitizing mutual cultural differences	Improving logistic processes and work conditions of small producers	Reducing unnecessary use of resources
	Strengthening the market position of the less powerful FSC participants	Incentivizing the establishment of common long term objectives	Decreasing the uncertainty of small producers and amount of unsold product	Facilitating the use of side-streams
	Aligning production with consumer preferences	Facilitating the building of personal and business relationships	Increasing bargaining power of small FSC participants	Improving temperature management
	Improving the management of temperature along the FSC	Increasing the awareness of FSC participants regarding the interconnectedness of their actions	Accelerating the adoption of adequate postharvest practices	Stimulating integration of secluded producers
	Increasing transparency and visibility of the FSC		Facilitating access to technical advice from knowledge institutions, and to financial support from governmental bodies	
	Keeping FSC		Avoiding delays caused	

	participants informed of market trends		by logistical deficiencies	
			Increasing reliability of supply	
			Catalyzing trusts, communication, cooperation and innovation along FSCs	
			Stimulating investments from FSC participants	
			Reducing time of transactions	
			Stimulating capacity building	
			Increasing awareness of FSC participants regarding the importance of improving social and environmental conditions at the back-end of the FSC	
			Increasing the sense of responsibility of FSC participants regarding the quality of the product beyond their own gate	

A more important finding however, is that regarding the dynamics between the components of innovative collaboration (see 4.9), which through their mutual influence enhance their potential to contribute to the reduction of postharvest losses. In this context it was found that, as effective partnerships evolve with increased trust between FSC participants, the information exchange might become smoother and the fear to exchange sensitive information gradually smaller. Through the long term interactions brought about by effective partnerships, FSC participants might be able to turn their cultural, organizational and economic differences into advantages by means of their complementary assets, thereby also aligning their incentives through a more fair distribution of costs and benefits. As incentives become more aligned between FSC participants they might be able to recognize the interconnectedness of their actions and align their objectives accordingly. In this context, suppliers for example, might be driven to improve their handling of the product at the back-end of the FSC by using technologies in more adequate ways, in order to avoid exporting a product that would present damage at the import stage, and would thereby result in postharvest losses.

Engaging in innovative collaboration might not always succeed in addressing the organizational inefficiencies that cause postharvest losses, since many factors have influence on, the FSC participants, the food supply chain and the food system. In this context, an enabling institutional environment that recognizes the importance of reducing postharvest losses to attain sustainable FSCs is essential. Furthermore, the findings show that without an integrated approach to

postharvest losses, interventions could only result in a shift of the stage of the FSC in which postharvest losses take place. Notwithstanding, innovative collaboration was found to contribute positively to the environmental, economic and social dimensions of the FSC by for example, 1) avoiding unnecessary use of valuable resources and its entailed impact on the environment 2) reducing the uncertainty of supply and demand, and stimulating a commercial vision among producers, thereby allowing them to increase profit, and 3) increasing the reliability of contracts between FSC participants, as well as improving the working conditions and learning options of small producers. Consequently, besides having theoretical and practical implications, these findings are also socially relevant, especially in the view of the increasing pressure on the environment caused by current food systems, and the need of increasing the global food supply to meet the needs of a growing population. Through the multiple case study, this research offers insights on how innovative collaboration can contribute to alleviate some of these environmental and social pressures, through the reduction of postharvest losses. In this context, it was also found that, as FSCs become more sustainable due to the PHL reduction achieved through innovative collaboration, a self-reinforcing feedback might amplify the reduction of PHL as positive changes in the behavior of FSC participants become embedded in their organizational culture and stimulate further innovative collaboration.



## 7. ADVICE TO POSTHARVEST NETWORK

Based on the findings of this research the following recommendations are offered to the community of Dutch companies, NGOs, knowledge institutes and governmental organizations that work together under the Postharvest Network, in order to facilitate the prioritization of interventions to reduce postharvest losses in developing and emerging countries.

### ***Recommendation 1: Promote collective action along the food supply chain while highlighting individual benefits of reducing postharvest losses***

Collective action towards mutual objectives can increase the awareness of FSC participants regarding the interrelatedness of their business decisions and stimulate mutual learning. In this context, facilitating the perception of individual benefits to FSC participants, in operational and tangible terms has been found to positively influence their motivation to engage in collaborative endeavors. Likewise, supporting FSC participants in defining their barriers to engage in innovative collaboration (such as exchanging detailed information or communicating effectively) in operational and tangible terms, might stimulate them to take actions to overcome them. Doing so might contribute to closing the gap between strategic objectives and operational actions, thereby reducing the organizational inefficiencies leading to PHL that occur at operational levels (such as inadequate loading and overfilling of boxes or rough handling of product).

### ***Recommendation 2: Stimulate the presence of FSC sustainability ‘champions’ that encourage other FSC participants to reduce postharvest losses***

In the Mexican case, packers were found to act as “champions” guiding FSC participants from harvest to export, having a positive influence on the quality of export avocados thereby contributing to reduce PHL. A FSC sustainability champion could (1) increase the awareness of FSC participants regarding the importance of reducing postharvest losses, (2) identify opportunities to reduce postharvest losses, and (3) implement sustainable thinking among FSC participants by engaging them through effective communication. Hitchcock & Willard (2008) developed an assessment tool that facilitates the choice of sustainability champions within single companies. Table 11 shows an adaptation of this tool to facilitate the choice of sustainability champions to reduce postharvest losses in FSC.

**Table 11: Assessment tool to choose sustainability champions to reduce postharvest losses in food supply chains (Adapted from Hitchcock & Willard, 2008). (The amount of boxes checked with yes is positively correlated with the suitability of the FSC participant to become a champion)**

Food supply chain perspective	Yes	No
1. Can you clearly and specifically describe the relationship between the reduction of postharvest losses and the needs/outcomes of the food supply chain?		
2. Do you have a compelling need or desire to pursue the reduction of postharvest losses?		
3. Would you be able to obtain the support of a critical mass of FSC participants to achieve this change?		
4. Are you able to commit significant resources (time and money) to ensure that the effort will be successful?		
5. Do you accept the idea of investing now in improvements along the food supply chain in order to avoid future postharvest losses?		
6. Are you willing to take some risks and reinvent how the food supply chain operates?		



Personal perspective	Yes	No
1. Do you believe that reducing postharvest losses is an important issue?		
2. Are you willing to dedicate a significant amount of your time talking about the reduction of postharvest losses and ensuring that it is taken seriously?		
3. Are you willing to carry out this task for at least two years until the effort is well established?		
4. Can you take action to ensure that your successor will be equally supportive?		

***Recommendation 3: Stimulate FSC participants to set targets for the specific purpose of reducing postharvest losses***

Setting PHL reduction targets with a clear plan of action could motivate FSC participants to work towards their achievement. The target of the UN Sustainable Development Goal (SDG) of halving food losses and waste along food supply chains per capita can be used as a guide to define targets for each stage of the FSC. This can be complemented by keeping FSC participants informed on the latest developments on standardization, accounting and reporting of postharvest losses. The FSC sustainability champion can support this by disseminating information of these developments and encouraging FSC participants to apply them.

***Recommendation 3: Include consumers in the solutions of postharvest losses***

It was found in this research that connecting producers with consumers is a logical business construct with a very high potential to increase the demand for more sustainably produced products. Including consumers in solutions of postharvest losses can be done by increasing their awareness regarding the extent of postharvest losses that occur before they purchase the product. When measuring postharvest losses becomes standardized, food products could be awarded points based on how well they manage to avoid PHL along the FSC. Also, information can be given to consumers (through a label for example) regarding the amount of time, energy, water and people needed to grow, produce, transport and deliver the product, thereby allowing them to make more informed choices.

***Recommendation 5: Implement FSC participants exchange programmes***

Implement programmes through which FSC participants can learn from the experiences of others, by bringing together (a) FSC participants from developing and developed countries with similar functions within a FSC of a similar product (for example avocado producers from Mexico or Colombia with pear producers from the Netherlands), (b) FSC participants from developing and developed countries with different functions within the FSC of the same product (for example, avocado producers with avocado importers), and (c) FSC participants from developing and developed countries with similar functions within the FSC of the same product (for example packers). Learning from their mutual experience can also contribute to align their organizational cultures and increase their understanding of their differences, thereby being able to use them for the benefit of the whole FSC.

***Recommendation 6: Assist governments in the creation of an enabling environment for innovative collaboration towards sustainability***

FSC participants perceive the lack of institutional and governmental support as an important barrier to engage in innovative collaboration towards the reduction of postharvest losses (such as the lack of deeds and documents proving the ownership of land by small and medium farmers).

Supporting governments in the creation of an enabling environment for innovative collaboration towards sustainability can be done by (a) assisting them in the development of policy instruments that reward innovation in FSCs towards the reduction of postharvest losses, (b) assisting them in bringing about changes in the regulatory framework that limit the sustainability potential of FSCs, and (c) assisting them in embedding sustainability in their vision statements regarding the future of their food systems.



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## ANNEX 1: INTERVIEW QUESTIONS

### TOWARDS SUSTAINABLE FOOD SUPPLY CHAINS THROUGH INNOVATIVE COLLABORATION

#### BACKGROUND

- Can you shortly introduce yourself? Work experience.
- How long have you been with this company/organisation? In what capacities?
- What is your current position and what are your main responsibilities and objectives?
- What are your personal objectives in relation to reducing PHL?
- What are your personal objectives in relation to sustainability?
- What are your company/organisation's objectives in relation to reducing PHL?
- What are your company/organisation's objectives in relation to sustainability?
- How do you work daily towards meeting those objectives? What process do you follow and what inputs do you need?

#### INNOVATIVE COLLABORATION WITHIN THE FOOD SUPPLY CHAIN

##### Information Exchange

- How and with whom do you coordinate your activities? How and to whom do you communicate your results?
- How would you describe your relationship with other companies/organisations along the FSC? Do you have common objectives? How do you choose those objectives? How do you communicate and what kind of information is exchanged?
- Do you give or receive feedback after you sell/buy the product?
- With whom and how often do you communicate with other participants of the FSC?
- What communication channels do you use to communicate to other FSC participants?
- What kind of knowledge do you exchange? (tacit or explicit knowledge)

##### Incentive's alignment

- Do you have shared responsibilities with other participants of the FSC regarding the quality of the final product?
- Do you have shared goals with other participants of the FSC regarding the final product?
- What is your main incentive to meet those goals? Is your performance evaluated in relationship to those goals? Is any kind of compensation linked to meeting those goals?
- Is there a regular assessment of the objectives to meet those goals?
- What is the reach of your responsibilities along the FSC of the product?
- Are there incentives for you to be involved in guaranteeing the quality of the product beyond your own gate?
- When trading with international companies, what kind of differences is more evident? (Very evident (2); More or less evident (1); Non-evident (0).

Economic	Organizational	Cultural

- To what extent do you consider important to align economic, organizational and cultural incentives in order to enhance collaboration? Very important (2); More or less important (1); No important (0).

Economic	Organizational	Cultural

- What are the long-term objectives of your company/organisation regarding the reduction of PHL?
- How does your company/organisation define the quality of the product?

- Does your company/organization follow standardized policies and definitions to set goals and objectives?

### **Effective partnerships**

- How do you solve problems regarding the quality of your product? Do you involve other participants of the FSC in the solution?
- According to you, which participants along FSC play an important role in the reduction of PHL?
- What type of collaboration among FSC participants do you reckon? is it (formal, informal, short or long term)
- What do you consider to be important pre-requisites to engage in partnerships?
- Regarding the different parties that you have contact with regarding the reduction of PHL; how does the partnership function? How do you enhance each' others capabilities? Which procedures are in place to leverage the partnership?
- When you observe partnerships or collaborative arrangements between different participants of the FSC how would you describe them in terms of
  - Knowledge spillovers
  - Learning races between partners
  - Difference in opinions regarding the intended results
  - Flexibility and adaptability
  - Trust between FSC participants
  - Mutual respect
  - Openness and transparency
  - Designation of a qualified representative to manage the partnership
  - Sense of ownership by FSC participants
  - Sense of responsibility beyond own gate

### **Adequate use of technology**

- How are shifts planned, task distributed and instructions given in the field?
- How do you make sure instructions are clearly understood and followed?
- Does your company/organization offer training to handlers?
- Does your company/organization use best handling practices?
- Does your company/organization use quality standards?
- Does your equipment fulfill the needs to produce the expected quality of the product?
- Do you think that the technology at disposition is fully harnessed?
- What do you think can be done better/ differently regarding the use of the available technology?
- What do you think can be done better/ differently in the innovation process of reducing PHL?
- What do you think are key factors to ensure the further success in reducing PHL?
- To what extent do you implement communication technologies in the trade of your product?

### **Closing questions**

- Who do you think I should interview next?
- Would you be willing to be contacted later if clarification of this interview is needed?
- Would you be willing to provide the findings and analysis of this research with comments?

## ANNEX 2: RESULTS FROM SURVEY QUESTION ON INCENTIVES ALIGNMENT

This appendix shows the results from the survey questions

### Question

*When trading with international companies, what kind of differences is more evident? 0=not evident, 1=more or less evident, 2= very evident).*

Response	economic importance	organizational	cultural
1	1	2	2
2	1	2	2
3	1	2	2
4	2	2	1
5	1	2	1
6	2	2	2
7	2	2	1
8	2	1	1
9	1	2	2
10	2	2	2
11	2	2	2
12	2	1	0
13	2	1	2
14	1	2	2
15	2	2	2
16	2	2	1
17	1	2	1
18	2	2	2
19	1	1	2
20	2	2	2
21	1	2	1
22	1	2	2
23	2	2	1
24	2	2	2
25	1	2	2
26	2	2	1
27	1	2	2
28	1	2	2
29	1	2	1
count not evident (=0)	0	0	1
count more or less evident (=1)	14	4	10
count very evident (=2)	15	25	18
<b>count Total</b>	<b>29</b>	<b>29</b>	<b>29</b>
[%] not evident	<b>0%</b>	<b>0%</b>	<b>3%</b>
[%] more or less evident	<b>48%</b>	<b>14%</b>	<b>34%</b>
[%] very evident	<b>52%</b>	<b>86%</b>	<b>62%</b>

**Question**

*To what extent do you consider important to align economic, organizational and cultural incentives in order to enhance collaboration? 0=not important, 1= more or less important, 2=very important.*

Response	economic importance	organizational	cultural
1	1	2	1
2	1	2	1
3	2	2	1
4	2	2	1
5	1	2	1
6	2	2	2
7	2	1	1
8	2	1	1
9	2	2	2
10	2	1	1
11	2	1	1
12	2	1	0
13	2	1	2
14	1	2	2
15	2	2	2
16	2	2	1
17	1	2	1
18	2	2	1
19	1	1	1
20	2	2	1
21	2	2	1
22	1	2	1
23	2	2	1
24	2	2	1
25	1	2	2
26	2	2	1
27	1	1	1
28	1	2	2
29	1	2	1
count not important (=0)	0	0	1
count more or less important (=1)	11	8	21
count very important (=2)	18	21	7
<b>count Total</b>	<b>29</b>	<b>29</b>	<b>29</b>
[%] not important	<b>0%</b>	<b>0%</b>	<b>3%</b>
[%] more or less important	<b>38%</b>	<b>28%</b>	<b>72%</b>
[%] very important	<b>62%</b>	<b>72%</b>	<b>24%</b>

**ANNEX 3: EXCERPT OF CODING TREE**

