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Food Loss and Waste in the avocado chain
Kenya - Europe

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Food Loss and Waste in the Avocado Supply chain Kenya - Europe

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Introduction

In front of you is the report "Food Loss and Waste in the avocado supply chain". This report was written by Ramon Wagenaar, Henk de Glopper and Diederik Houben, students at the Business Administration & Agri-Food Business department. The research was done for HAS University of Applied Sciences with the aim of reducing Food loss and Waste for Kenya's avocado supply chain. The research is meant for involved supply chain partners and stakeholders. We worked on the research from August 2022 to January 2023.

During the study, we were able to receive guidance and relevant preliminary research from our client Peter Bouma. Rolf Kerkhof Mogot war our mentor from the HAS, we would like to thank them for this. We would also like to thank Claudy Claus for providing feedback on the accompanying plan of approach and the draft version of the report. Finally, we would like to thank all companies and interviewees for their openness and willingness for interviews.

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25 January 2023, 's-Hertogenbosch

Summary

Avocado consumption in Europe has been increasing for several years in a row. As a result, worldwide avocado production has also increased. Countries that now mainly produce avocados are Mexico, Peru, Chile and New Zealand. Countries like Peru and Chile fully committed to developing avocado plantations 20 years ago. Because of this these countries trade very professionally in the world market.

Because of fertile soils and the possibility of growing avocados in Kenya, the current supply chain in Kenya is being investigated. What the supply chain should meet and how the ideal supply chain should be set up. Finally, it indicates by which strategy the ideal supply chain can be achieved.

This study showed that the supply chain in Kenya is not efficiently organized and that avocado production is mainly done by smallholders. These smallholders need income from growing other crops in addition to the income from avocados. This means that the grower does not have a full focus on growing avocados.

Due to the small quantities produced by different growers, transport costs per kilogram are relatively high and there are many differences in the quality of avocados. Growers are also focused on making as much money as possible. This means that growers market their avocados to the market that pays best and to which they have access.

Because many growers have joined cooperatives, the cooperatives can start supporting growers. To keep costs down, however, growers must have a minimum of 24 trees. If a grower has a minimum of 24 trees, the grower can also specialize in growing avocados. For later links in the supply chain, it is important in the ideal supply chain that the grower keeps cultivation records.

The cooperative must ensure that supply and demand for Kenyan avocados increases proportionately. To make processes efficient, the cooperative must divide the various growers into different regions. Using these regions, costs in the supply chain can be kept low.

For importers, it is important to import homogeneous quality avocados. For this, the exporter needs to invest in a machine that assesses the avocado on internal and external qualities. By importing homogeneous quality avocados, the importer has to incur fewer costs to ripen all avocados exactly right before packaging them for European retail.

In order for the entire supply chain to function ideally, there must be communication. This communication must take place between each link but most importantly, information must be shared with the entire supply chain. With the help of information sharing throughout the supply chain, each link knows faster and better what to expect. This allows each link to respond faster to what is to come.

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Glossary

EU: The European Union consists of 27 countries/member states that have common trade policies (What is the European Union?, 2022).

FLW: Food Loss and Waste (FLW) consists of two parts. Food loss refers to food lost or reduced in quality and value during the process in the supply chain (UN Environment Programme, 2021). Food waste includes products that are fit for human consumption but are wasted by exceeding the expiry date or are discarded. One reason for this may be excess supply. Food waste occurs mainly at retail (Eu-Fusions, 2013).

KPI: A KPI stands for Key Performance Indicator. KPIs ensure that the performance of operational processes can be mapped. A KPI is a goal towards which to work.

Delivery obligation: delivery obligation arises from an agreement between two parties. Here, the selling party has an agreement with the buying party to at least fulfil the delivery obligation.

Switch: This is an organization that adds value to a product.

Supply chain: A supply chain is a collaboration between different links. Each link adds value to the supply chain, creating a product at the end of the supply chain that is sold to consumers

Ideal supply chain: The ideal supply chain is one in which there is as little FLW as possible and in which the margins of the different links in the supply chain are shared on the basis of risk.

Supply chain models: Various supply chain models exist. Supply chain models are models on which different links in a supply chain successfully cooperate with each other. Different supply chain models can be applied to each supply chain.

Smallholders: Smallholders are small growers who own between 1 and 10 hectares of land. These growers often grow multiple crops, but often have a main branch of one crop. Smallholders account for between 50% and 80% of total food production worldwide. (Dutch Research Council, 2020)

Out grower scheme: An outgrower scheme is a system that allows unorganized smallholders to interact with international buyers. When using out grower schemes, an agreement is drawn up. Through the agreement, the buying party has a constant supply with usually pre-agreed prices. The selling party receives technical expertise and financial support.

Nucleus estate and smallholder (NES): In a NES model, the nucleus of a plantation is managed and administered by a single organization. Surrounding that nucleus are smallholders where management choices are implemented. In this way, the central organization benefits from scale and smallholders benefit from technical knowledge.

GlobalGAP: This is an international standard that focuses on food safety, the environment and staff safety (Qassurance, 2023).

Cultivation supervisor: This is a person who supports the grower in growing. In doing so, the grower advises the grower on what is good for his product. The cultivation supervisor advises the grower on choice of variety, method of cultivation and how best to store the product. For the grower, the cultivation supervisor is a person with whom good discussions can be held.

Controlled atmosphere container (CA): Controlled atmosphere containers (CA containers) are containers used to transport perishable products. This is done by regulating carbon dioxide, oxygen and nitrogen levels in the container. This ensures that the ripening of perishable product is delayed (Paerez, 2019).

1. Introduction

This chapter deals with the background and reasons for this report. It provides general information about the country of Kenya and what FLW consists of. It then describes the rationale, objective, problem statement and research questions. At the end of the introduction, the demarcation and reading guide follow.

1.1 Background

Kenya is a very developing country. Agriculture provides a major source of income. The second major source of income for Kenya is the tourism sector. In Kenya, it has long been possible to pay via mobile phone. This makes Kenya fairly modern. The legal tender in Kenya is the Kenyan Shilling.

Kenya is located on the African continent and, as shown in Figure 1, has Ethiopia, Somalia, Tanzania, Uganda and South Sudan as neighbours. In addition, Kenya borders the Indian Ocean and Lake Victoria.

Kenya covers almost 600,000 square kilometres and has a variety of landscapes. There are mountain areas, high plains, desert areas and savannahs. In the north-east, savannahs are predominant. Near the high plains near Lake Victoria and Mount Elgon are the fertile areas for growing crops (roundtrip, 2022). There are two rainy seasons in the year. From March to May The long rainy season and from mid-October to mid-December is the short rainy season (monkey, 2022).

In 1888, the British arrived in Kenya. In 1920, the British colonized part of Kenya. The British built a railway line from Nairobi to the port of Mombasa. This created the opportunity to export products abroad (tour, 2022). In 1963, Kenya regained its independence.

Figure 1: Figure Kenya

It is interesting for Kenya to export fruit and vegetables. This is because of the fertile agricultural land and the prices paid for the fruits and vegetables that are exported. For avocados, exports on average pay three times more than on the domestic market. In addition, Kenya can differentiate it in time when they deliver compared to competitors.

1.2 Waste in the fruit and vegetable sector

In the fruit and vegetable sector, wastage is high. On average, these wastages are at 30% across the sector. Often, these wastages mainly take place at the end of the supply chain. In Kenya, this is different so far. In Kenya, a lot of wastage already takes place at the growers. This has several causes. These causes include lack of knowledge, many smallholders and small production quantities. In this, however, many developments are being made. Smallholders have started working together in a cooperative to better market their avocados. In addition, smallholders want to expand production.

Food waste comes in two different ways. If a product is not consumed for too long it will rot This is a food waste. If the supply chain does not work optimally and this decreases the edible mass this is food waste. Figure 2 shows a sketch for clarification using an apple as a starting point.

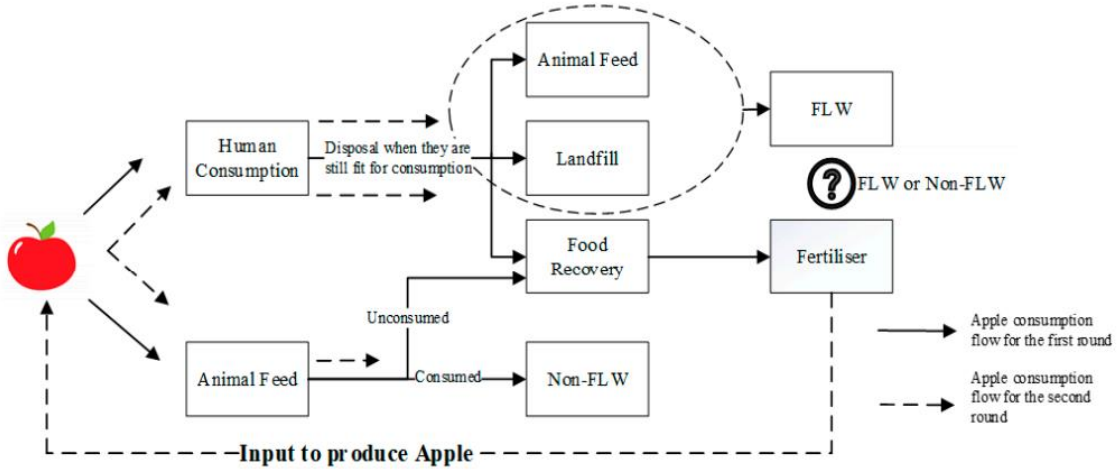

Figure 2: When is there FLW (Luo, Lennon Olsen, & Liu, 2021)

In addition, FLW consists of two different categories. As shown in Figure 3, there is avoidable FLW and unavoidable FLW. Unavoidable FLW is directly linked to the supply chain, avocados are directly lost in this process. Avoidable FLW is not lost by using the product for other purposes such as feed. To find out how much FLW is avoidable, avoidable FLW was assumed to occur when the cost of avoiding FLW exceeds the yields of the avocado (Luo, Lennon Olsen, & Liu, 2021). Indeed, when costs are lower, an avocado can still be processed into other products such as avocado oil. This report discusses avoidable FLW and opportunities for using residual streams.

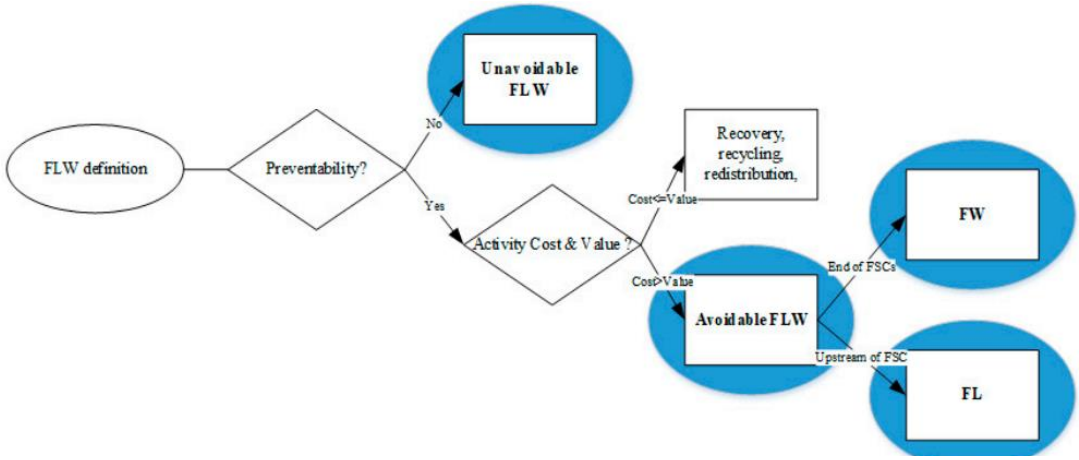

Figure 3: (un)avoidable FLW (Luo, Lennon Olsen, & Liu, 2021)

FLW has both social, economic and environmental impact. By using food more efficiently, global hunger can be reduced. Indirect stakeholders are concerned with developing more efficient supply chains. For direct stakeholders, it is more complicated. This is because supply chains are mainly driven by cost/revenue optimization rather than optimizing as little FLW as possible (Luo, Lennon Olsen, & Liu, 2021). Environmental impact can be divided into two categories. Upstream and downstream wastes. Upstream wastes describe the non-utilization of land and water. Downstream wastages deal with the generation of greenhouse gases by discarding avocados. To reduce environmental impact, it is important to improve harvesting and transport services in the supply chain. (Snel, Broeze, Kremer, & Osena, 2021).

1.3 Reason

Kenya is a major producer of avocados. Yet many of the avocados consumed in the EU come from other countries. This is due to the quality of avocados produced in Kenya. The avocado cooperatives consist mainly of smallholders. These smallholders often have outdated plantations and so do older varieties of avocado trees. Because of the old, smallholder varieties, the cooperatives face different oil densities in the avocados. The different avocados transported together to Europe create an uneven ripening process. This results in FLW. In addition, cooperatives and growers do not always know how to find the right marketing channels for the avocados. Kenya faces overproduction of avocados. Growers also lack knowledge on how to properly harvest and store avocados (Ayumi, 2022).

Avocado plantations are still popular in Kenya. More modern plantations are being developed on a large scale. These plantations have younger varieties and a more homogeneous oil density. Despite this change, smallholders remain important, this is because smallholders supply 70% of the world's food. (Helvoirt, 2022) As avocado exports from Kenya are still in their infancy, but have potential to grow, it is important to analyse this export supply chain (Rabobank, 2020).

Problems arise when the supply chain is not optimally set up. Transit times are lengthy and affect product shelf life. African exporters rely on small-scale avocado growers. These growers, or smallholders, cannot always provide exporters with a homogeneous product and it is difficult for growers to comply with the required certificates. Avocados from different growers are exported, mixed in one container. This does not improve the homogeneity of the product and makes ripening in Europe difficult (Business, 2022). This report is therefore written to find out how the avocado supply chain currently works, where the bottlenecks are and how info streams should run to develop a supply chain where the different partners work well together.

1.4 Objective

The objective of the study is to use qualitative research to shape the optimal avocado supply chain through the right alignment of supply chain partners to thus reduce FLW. For this, it is necessary to find out how the avocado supply chain currently runs and where FLW takes place. An ideal supply chain is then described in which FLW occurs as little as possible. It also describes what information the different partners in the supply chain need to function properly.

1.5 Main question

The main question is as follows: "How can the avocado supply chain from harvesting in Kenya to ripening in the European Union be designed with the least possible FLW?"

1.6 Sub-questions

To arrive at a proper answer to the main question, sub-questions have been drawn up. The sub-questions are listed below.

1. What are the market conditions within which the avocado supply chain operates?
2. Where in the avocado supply chain does FLW currently take place?
3. What preconditions do the supply chain partners set for avocado?
4. Which processes are essential in the avocado supply chain?
5. What is needed to reduce FLW in the supply chain?
6. How can the supply chain best be shaped?

1.7 Reading guide

The report begins with background information on Kenya and the Kenya market. It then describes the rationale, objective, main question and sub-questions. Chapter 2 presents the theoretical framework. This describes various models used in the report. Chapter 3 deals with how information was collected. To take stock of how the avocado market is developing, is written in Chapter 4. This chapter also provides a comparison with Kenya's largest competitor.

Chapter 5 describes the current avocado supply chain between Kenya and Europe. This chapter discusses which the links are in the avocado supply chain, what the links do and where in the supply chain there are bottlenecks. Chapter 6 looks at the conditions that allow the supply chain to emerge. Both EU and Kenyan regulations are discussed. It also describes the specifications of a European retailer. The quality requirements in the avocado supply chain are explored in Chapter 7.
Starting in chapter 8, it explores options for efficient supply chain classification. Chapter 9 then deals with Supply chain Management. This chapter gives examples of current supply chains along with the requirements that links must meet.

The analysis takes place in Chapter 10. This chapter presents options for the bottlenecks that emerged from Chapter 5. Chapter 11 gives a description of the ideal supply chain. It describes the requirements and what each link in the supply chain needs to do to make the ideal supply chain work. Chapter 12 explains how the data flow and which link must have access to the database. The KPIs for the ideal supply chain are described in Chapter 13. The KPIs make the supply chain's performance measurable.

2. Theoretical framework

This chapter discusses the relevant models used during the study. The function of the models with respective relevance to the study is explained.

2.1 Process flowchart

Several processes play a role in the avocado supply chain. These processes can be described using a process flow diagram. This diagram highlights the successive steps that work towards a certain goal or end product. Also, through this diagram, KPIs emerge that secure the processes.

2.2 SWOT analysis and confrontation matrix

A SWOT analysis stands for strengths, weaknesses, opportunities and threats. A SWOT analysis involves identifying the internal and external factors at a company. During the research, a SWOT analysis was made for the avocado supply chain from Kenya to Europe. This allows strengths and weaknesses in the supply chain and its relationship with external factors to be identified. (KVK, 2022)

By creating a confrontation matrix, the key issues of the SWOT analysis are weighed against each other. The confrontation matrix used during the study compared the main strengths and weaknesses of the avocado supply chain with the main opportunities and threats from external factors. The effect each strength and weakness has on each opportunity and threat is indicated by very promising: ++, neutral: 0 and very threatening --. (KVK, 2022)

2.3 Direct and indirect drivers behind FLW.

Below, the direct and indirect drivers for FLW are shown in Figure 4. Direct factors include the technical aspects of the supply chain. Indirect aspects are about how the supply chain is governed. (Sanne Stroosnijder, 2022)

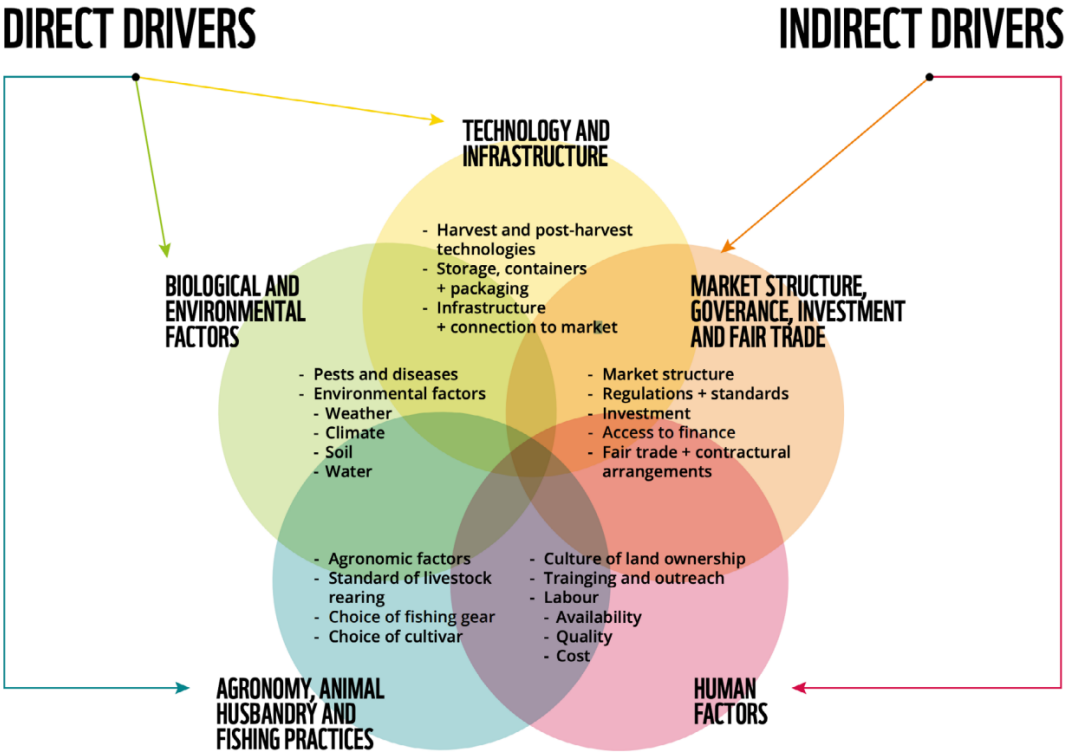

Figure 4: Direct and indirect aspects where waste occurs according to WUR.

3. Research methodology

To answer the main question, qualitative research was used during this study. To provide structure, the research was divided into different phases. This chapter describes the phases of the research and the research methods used. For this research, outcomes and information have been described based on the exchange rate of 19 January 2023. The exchange rate is expressed in US dollars (Exchange rate, 2023).

3.1 Phase 1 Preparation

In preparation for the study and to establish what the purpose of the study was, a Plan of Action was written. The Plan of Approach gave the research team structure to begin the study.
In the preparation phase, several interviews were held on the following topics:

- Supply chain design
- FLW in the avocado supply chain
- Smallholders
- Cultures in Africa

These interviews mainly provided background information on how work is currently being done and what aspects the project team need to consider. In addition to the field research, desk research was carried out. The desk research was conducted to find out more information about Kenya and to broadly analyse the avocado supply chain.

3.2 Phase 2 Orientation

For the study, it was important to describe the current avocado market. For this purpose, desk research was conducted on world production and then on Kenya's biggest competitor. In addition, through field research and desk research, how the European market has developed in recent years has been described. This generated an answer to the first sub-question: **"What are the market conditions in which the avocado supply chain operates?"**
The second sub-question: **"Where in the avocado supply chain does FLW currently take place?"** To answer this question, research was conducted for each link. From desk research, only general figures could be found. It was then decided to conduct field research to find out the necessary information. During the field research, it was also not sufficiently possible to investigate in which places FLW is currently taking place. As a result, it was decided not to conduct further research into the figures on the amount of FLW in the current avocado supply chain. As a result, however, more research was done on the reason for FLW.
The avocado supply chain faces several conditions that the supply chain must meet. These conditions were investigated through desk research and field research. These conditions answer sub-question three: "**What preconditions do the supply chain partners set for the avocado?"**
The fourth sub-question: **"Which processes are essential in the avocado supply chain?"** In answering this sub-question, desk research was used to investigate which processes are essential to the avocado supply chain. In addition to desk research, field research was used to find out whether other aspects are essential for the avocado supply chain.

3.3 Phase 3 Research

In the research phase, opportunities were sought that would allow the supply chain to function better. This included sub-question five: "**What is needed to reduce FLW in the supply chain?"** The aim of this question was to investigate how the supply chain could be better designed so that FLW can be reduced. For this purpose, desk research was applied. This desk research shows where there are opportunities for improving the supply chain. In addition, the research phase investigated supply chain models that already work well. This also showed what the various links in a well-cooperating supply chain should comply with.

3.4 Phase 4 Analysis

In the analysis phase, an analysis was made based on the orientation phase and the research phase. This described various options by which the bottlenecks could be solved. Sub-question six: **"How can the supply chain best be designed?"** is answered here.
The scope of the study runs from harvest to importer. Because it is important to deliver a good quality avocado to the exporter, it was chosen to describe during this phase what the grower should do and what the grower should comply with.
European retail is also outside the scope. Nevertheless, the new supply chain describes a KPI that European retail must meet. This KPI is important to offer a high-quality product to consumers in the supermarket.

3.5 Phase 5 Conclusion

The concluding phase concludes how the ideal supply chain should be set up. It also indicates how the supply chain should interact with each other and what should be expected from each link.

4. Current Market Conditions

This chapter describes which countries export avocados. It then discusses avocado production in Kenya. For developments in Kenya, it is interesting to analyse Kenya's biggest competitor. It also describes how the European market has developed in recent years.

4.1 Avocado Exporting Countries

Figure 5 shows exports from three different avocado producing countries (Tridge, 2022). In it, it is clearly noticeable that Mexico is a very big player in the world market. In 2020, Mexico harvested 2,294,000 tonnes (Agroberichten Buitenland, 2021). Most of these exports went to the Americas. Mexico additionally supplies Canada. Figure 5 shows that most avocados are imported by the Americas, followed by the European market. In 2020, Peru supplied 247,000 tonnes, Mexico 79,000 tonnes and Colombia 75,000 tonnes. Kenya exported 49,000 tonnes in 2020. To grow the export quantities as large as Peru, it is important to understand this market.

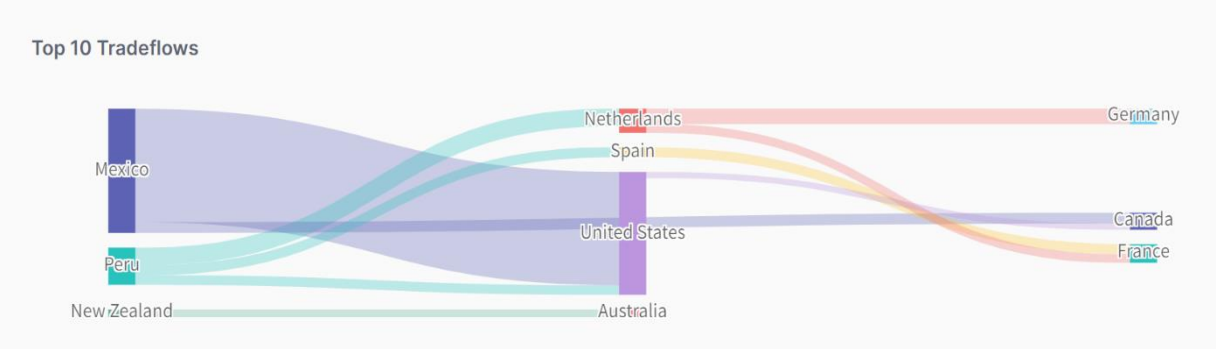

Figure 5: Trade flows of avocado producing countries

4.2 Kenya

In Kenya, avocados are mainly grown by smallholders. These smallholders have between 5 and 400 avocado trees (Chairman, Nandi Avocado Farmers Co-operative Society Ltd, 2022). Most of the smallholders are affiliated to cooperatives. The quantity of avocados sold by each cooperative in Kenya for export quality varies. This is between 4,000kgs and 200,000kgs annually (Chairman, Nandi Avocado Farmers Co-operative Society Ltd, 2022). Because of the many different growers and cooperatives, there is a lot of difference between the quality of avocados. The differences in quality make it more difficult to export a full container of the same uniform quality.

Avocado production has increased in recent years. Avocado production was 264,000 tonnes in 2019 and 322,600 tonnes in 2020 (FAO, 2022). One of the reasons for the increased production is more research into proper production methods. This is improving the quality of avocados and increasing yields. The increase in quality and yield is in line with rising demand for avocados for the export market. This market offers higher prices than the domestic market, making export more interesting. Avocado production is expected to increase by 1,500 hectares through 2025 (van Rijswick, 2020). Figure 6 shows where Kenya's avocados are exported to. The EU has the largest export share.

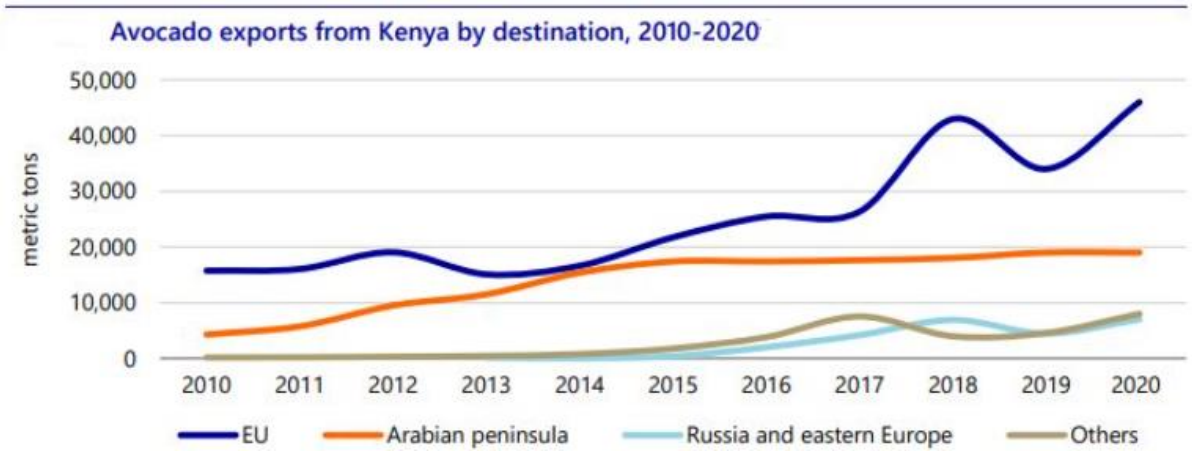

Figure 6: Avocado exports from Kenya

4.3 Biggest competitor Peru

Peru exported 525,000 tonnes of avocados in 2021. This is an increase of 28% compared to 2020 (FAO, 2022). The value of exports also increased, rising 38% to $1.05 billion. Most of these avocados went to the Netherlands, the Americas, Spain and Chile. In 2021, the Netherlands imported 180 thousand tonnes from Peru (Freshplaza, 2022). Because 74% of avocados are exported between May and August, the export seasons match the market of Mexico where fewer avocados are exported during those seasons. Kenya's biggest competitor is Peru because of a simultaneous harvest season. What is striking is that Peru has put a lot of effort into professionalising avocado cultivation since 2000. In 20 years, Peru has quadrupled its exports (AGF, 2021). Quadrupling exports was only achieved with the help of the passionate growers who wanted to do future-oriented business.

Major growers in Peru are fully integrated into the supply chain (International, 2022). These growers grow, sort, package and export avocados themselves. What is striking about these growers is that they divide their plantations into different zones. This eliminates the need to harvest all avocado trees at the same time. This gives the advantage that there is not a very big peak at one moment, but a somewhat constant supply of avocados during a certain time. Of course, in the peak season, from May to August, there is a peak. During this peak, 74% of total avocado exports are exported (Elgon, 2022).

The advantage for these large growers, is that these growers themselves sort, pack and sell avocados. As a result, they control many links in the supply chain themselves. As a result, the growers have more influence on the market. This means that growers generally get a better price for their avocados (P.Bower, 2021). Avocado plantations at a grower's premises can be 4,000 hectares in Peru. Prohass is the cooperative that many growers are members of in Peru. 60% of avocados grown by growers in Peru come from Prohass growers (P.Bower, 2021).
Peru grows mainly two types of avocados: Hass, 95% for export, and Fuerte, mainly for local consumption. The total area under avocado cultivation was 51,241 hectares, of which 31,145 were certified for export by 2020. Peru produced 672,200 tonnes of avocados at 2020 (FAO, 2022).

The average expected yield per hectare is 14 to 17 tonnes. The regions of La Libertad and Lima account for more than 40% of total avocado cultivation (AGF, 2021). Most avocado cultivation is situated along the desert coast. Larger

producers use water from the Andes through federal water canals. The water is then accurately administered using a combination of drip irrigation, sensors and irrigation software (AGF, 2021).
Key statistics relating to the 2020 avocado market in Kenya and Peru are shown in Table 1 below.

Table 1: Comparison of Kenya and Peru

2020	Kenya	Peru
Production (tonnes)	322.600	672.200
Export value (Million $)	127	755
Area under avocados (ha)	24.447	51.241
Avocado exports to the EU (tonnes)	49.000	247.000

4.3.1 Ocean freight in competing countries

In addition to sea freight prices from Kenya, sea freight from competing countries such as South Africa and Peru was examined. The reason to look at these countries is that they are direct competitors to Kenya because they supply avocados in the same months. Appendix I, sea freight costs, shows the prices per container for sea freight. *Please note; these are contract prices for normal twenty-foot containers so not for refrigerated containers and for companies transporting at least 500 twenty-foot containers per year* (UNCTAD, 2022).

From Appendix I, it can be observed that from 2018 to 2021, prices for maritime shipping increased significantly. This was due to COVID-19 and the disruption in the Suez Canal. In fact, the increase in the transport price from Asia to Europe is over 84% (UNCTAD, 2022).
Appendix I shows that, on average, sea freight between Africa and Europe is cheaper than sea freight between South America and Europe. The difference between them is $325.15. The big advantage for Peru is that they grow and export in huge quantities. As a result, a ship also goes from Peru to Europe at least once a week.

4.4 European market

The size of the European avocado market has increased in recent years. As shown in Figure 7, avocado imports into Europe have increased from 456,000 tonnes to 700,000 tonnes in five years. This represents a growth of 12% per year

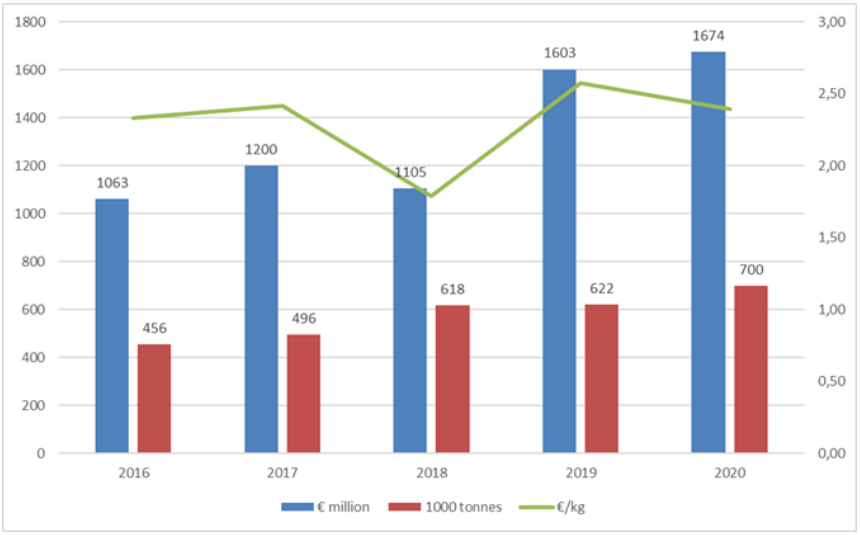

Figure 7: Avocado imports Europe

on average. Per person, an average of 1.5kg of avocado per year is consumed in Europe (van Rijwick, 2022). The avocado is expected to be the most traded tropical fruit after bananas by 2030 (CBI, The European market potential for avocados, 2021).

Figure 8 shows the average avocado consumption of different countries in Europe. 62% of imported avocados in the EU are imported by the Netherlands (House, 2020). In the Netherlands, many of the avocados are ripened and packaged for retail customers in the EU. The Netherlands has good logistics facilities due to its strategic location in Europe, including the large port of Rotterdam.

	Consumption in tonnes	Population (2020)	Consumption per capita
Netherlands	23.243	17,4	1,34 – 2,41
Belgium	13.165	11,5	1,14
Denmark	16.374	5,8	2,81
Finland	7.746	5,5	1,41
France	144.015	67,3	2,14
Germany	104.452	83,2	1,26
Italy	26.840	59,6	0,45
Norway	14.833	5,4	2,76
Poland	18.826	38	0,5
Spain	114.599	47,3	1,61 - 2,44
Sweden	21.566	10,3	2,09
Switzerland	18.836	8,6	2,19

Figure 8: Average consumption by country, population in millions

4.5 Sub-conclusion

There is large-scale avocado production in the world. Major producing countries are Mexico and Chile. Avocados exported to Europe generally come from Peru. From the comparison between Peru and Kenya, it is noticeable that Peru is very specialized in growing avocados. With the EU market still growing every year, this market is of interest to Kenya.

5. FLW in today's avocado supply chain

This chapter describes the current avocado supply chain. It starts from harvesting in Kenya from local growers and ends at the quality assessment upon arrival at the importer in Europe. This makes it clear which links in the supply chain there are and which supply chain partners are located where in the supply chain. This chapter also describes the opportunities and threats for avocado cultivation in Kenya. Finally, the bottlenecks in the current supply chain are described.

5.1 Links in the avocado supply chain

Figure 9 shows the links of the current avocado supply chain. Below is a description of how each link in the supply chain works in the current supply chain.

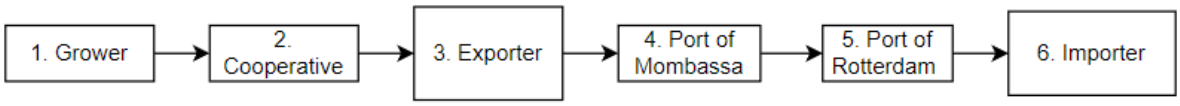

Figure 9: Schematic representation of current avocado supply chain

5.1.1 The grower

Avocado growers in Kenya grow other vegetables and/or fruits besides avocados. The number of avocado trees varies from grower to grower. Among growers who proportionally grow more avocado trees than other crops, it can be observed that these are more concerned with growing avocados more and more. One reason for this is that among these growers, avocados are the largest source of income and so there is more focus on that fruit (Expert, 2022).

During harvesting, the tree is shaken in some cases, causing the avocados to fall to the ground. The avocados are then collected and placed on a rug. In other cases, the avocados are cut from the tree by an employee. The worker puts them in a large bag. When the bag is full, the worker takes it to the collection point in the field. At this place, the avocados are placed on a rug or put in a cart. The avocados in the cart are driven to a place near the grower and placed on a rug. The avocados on the rug remain there until the exporter comes to collect the avocados.

Growers are generally paid according to the quantity of avocados delivered. Due to the lack of knowledge about avocado cultivation, avocados which are of inadequate quality are regularly delivered to customers. Moreover, growers are very price sensitive. This leads growers to harvest when the price is high (Expert, 2022).

5.1.2 Cooperative

Many smallholders are united in cooperatives. These cooperatives help growers market avocados. The aim of the cooperatives is to sell the avocados at the best possible price. This is because this allows the highest possible price to be paid to the grower. The advantage of the cooperative is that the grower receives money for his product and the money is paid quickly. This quick payment is an important aspect for growers to join a cooperative. In Nandi County, consideration is currently being given to expanding the cooperative's service. In this, the cooperative will support the grower in improving cultivation methods. The aim is for the grower to provide better quality avocados (Chairman, Nandi Avocado Farmers Co-operative Society Ltd, 2022).

5.1.3 Exporter

Transportation of avocados from the grower to the exporter is generally by open-body cars. The cars may be arranged by either the cooperative or the exporter. The avocados are then put in crates to avoid damage. Once the avocados arrive at the exporter, the avocados are refrigerated. For larger growers, the avocados are transported in refrigerated cars so the avocados arrive at the exporter chilled. As soon as there is room at the exporter's premises to sort the batch of avocados, they are sorted. Sorting is carried out by hand. The sorting process looks for defects that are visible. If defects are too large, the avocado is removed from the lot and given another final destination. In addition to sorting for defects, it is important to look at the size of the avocados (International, 2022).

The exporter is responsible for selling the avocados. For this, the exporter must prepare several documents. The paragraph on preconditions discusses this in more detail. The exporter must also order a container, arrange for transport and make sure there is space for the container on a ship. The exporter can also outsource these operations to a carrier.

In the supply chain, the exporter is the link with the most power. This is because the exporter determines which quality of avocados he selects. The quality grade into which the avocado falls is determined by the amount of demand. For this reason, when there is excess supply, good-quality avocados are processed into avocado oil. This causes unnecessary food loss (Chairman, Nandi Avocado Farmers Co-operative Society Ltd, 2022).

5.1.4 Port of Mombasa

Once the container of avocados arrives at the port of Mombasa, the container has to be taken off the truck. Once the ship is ready, the container can be loaded. When loaded, the ship sails to Salalah port. In Salalah, the container is transferred to a ship that will sail towards Europe (Executive, 2022).

5.1.5 Port of Rotterdam

At the port of Rotterdam, the ship arrives. This is also where the container is then taken off the ship. Once a truck comes to pick up the container, the container is driven to the importer (Executive, 2022).

5.1.6 Importer

Once the container arrives at the importer, the settings of the container and the temperature recorder are read. The avocados are then inspected. This involves paying attention to the quality and size of the avocados. These are important data for the importer. They tell the importer what quality the batch of avocados is. It also enables the importer to know how long the batch of avocados needs to be ripened and whether the batch needs to be sold quickly (Fresh2You, 2022).

After the inspection on arrival, the avocados always have to acclimatise first. As a result, the avocados are first stored in cold storage for several days. As soon as the avocados need to be ripened, the avocados are taken to the ripening cells. In these cells, depending on how the avocados ripen, the avocados remain for several days (Quality Manager, 2022).

5.2 SWOT analysis avocado exports Kenya

The Kenyan export avocado market has been analysed to identify opportunities in the market and threats that need to be contained. The SWOT analysis can be found in figure 10. A confrontation matrix emerged from this SWOT analysis, which can be found in figure 11 (CBI, Opportunities and challenges of East African avocado exports to Europe, 2022)

Strengths • Increasing investment in Mombasa port and surrounding infrastructure. • Kenya consistently supplies the same size avocados during the delivery season, unlike competitor Peru. • A large proportion of avocados in Kenya are organic.	**Weaknesses** • High shipping costs compared to South America and South Africa. • No direct shipping route to Rotterdam and thus long cut-off time. • Consolidation centres cannot be found everywhere in Kenya. • Control agencies such as Kenya Plant Health Inspectorate Service (KEPHIS) and Kenya Revenue Authority (KRA) do not work on weekends and public holidays. This is a risk for short shelf-life products. • Poor quality seedlings result in poor quality avocados with low yields. (Exporters F. , 2023) • Limited amount of Hass variety seedlings. • Little knowledge regarding growing, harvesting and transporting avocados results in lower quality fruit. • Poor infrastructure in remote areas cause relatively high transport costs, this also does not ensure an efficient cold supply chain. • Growers have little capital to invest in new developments. • Torrential rains and extreme drought cause fluctuation in yields.
Opportunities • Direct fleet from Mombasa to Rotterdam due to growth of other sectors (such as flowers) • Training farmers so that the amount of knowledge about growing avocados is increased.	**Threats** • Risk of environmental tax in future reduces consumption of avocados from countries like Kenya • A growing demand for certification and traceability. • Kenya exports avocados at the same time as Peru and South Africa. Once Peru starts exporting, avocado demand from Kenya drops because the reputation of Kenyan avocados is not as good.

Figure 10: SWOT analysis

5.2.1 Confrontation matrix

		Strengths			Weakness		
		More investments in infrastructure	Constant dimensions of avocados	Mostly organic avocados	Higher transport costs	Inferior quality seedlings	Long cut-off time to the European market
Opportunities	Opportunity for a direct route from Mombasa to Rotterdam	+/+	0	0	+	0	+/+
	Build up avocado knowledge among farmers	0	0	0	0	+	0
	The growing of other crops among avocados	+	0	0	0	0	0
Threats	More demand for closely grown avocados	0	0	0	-	-	-
	Meer demand for certification	0	0	0	0	0	0
	Competitive export countries	0	+	+	-/-	-	-/-

Figure 11: Confrontation matrix

5.2.2 Opportunities

Avocados have a limited shelf life. The transport time from Kenya to Rotterdam makes avocados less fresh and more at risk of passing their shelf life. The current transport routes are shown in, see Appendix II, sea freight routes. Because there is no direct route from Kenya to Rotterdam, the avocados are more at risk of being delayed or missing the transhipment moment (van der Hulst, Rikken, & Finlayson, 2021).

As the flower sector in Kenya increasingly uses sea freight, the opportunity arises to realise a direct sea freight from Mombasa to Rotterdam. This can shorten the transport time, reducing the amount of food loss.

With increasing investment in Kenya's port of Mombasa and surrounding infrastructure, the avocado supply chain is more streamlined and there is less wastage. If a direct shipping route from Kenya to Rotterdam is created, the better quality avocados can also be delivered even fresher.

5.2.3 Threats

Peru is Kenya's biggest competitor as shown in, see Appendix III, avocado seasons. They export more avocados and are generally of better quality. Kenya's advantage is that its avocados are of similar size during the season as opposed to Peru's avocados, which get bigger as the season progresses.

Because transport costs from Kenya are $3100 more expensive for a twenty-foot container (TEU) than from Central/South America, Peru has a competitive advantage. Because sea freight usually takes 35 days from Kenya and 15-20 days from Peru, avocados from Peru are of better quality and have a longer shelf life. (Foreign, 2021)

5.3 External stakeholders

Besides the links in the supply chain, the avocado supply chain also needs links outside the supply chain. The links outside the supply chain are external stakeholders. These external stakeholders are important for the avocado supply chain to function. The external stakeholders include machine manufacturers, avocado tree suppliers, government agencies, banks, software companies, cultivation consultants and competitors.
External stakeholders are relevant for the following points:

- Suppling quality trees so that the grower can then harvest good avocados.
- Supplying machinery anywhere in the supply chain. These include sorting machines, cold stores, forklifts and tractors.
- Make it possible to export and import products. This is where papers are checked and issued. Rules are made, knowledge is shared, conduct investigations.
- Enable international financial transactions.
- Design software programmes that allow various information to be stored in an orderly manner.
- Help growers grow avocados.
- Perform inspections.

5.4 Bottlenecks current supply chain

Now that the links in the current supply chain have been described, the main bottlenecks in the supply chain can be identified. This section identifies the main bottlenecks causing FLW in the supply chain.

5.4.1 Time lapse current supply chain

When the cooperative is of small size, the avocados are stored on a rug in the shade. The avocados are consolidated at the cooperative itself. In larger cooperatives, the exporter collects the avocados the same day after harvesting. Via open or closed trucks, the avocados are transported in crates to warehouses for further processing (Chairman, Mt. Kenya Avocado Growers Cooperative, 2022).

Avocados are processed within one day of receipt at the exporter's premises. If there is sufficient volume for a container, they go to the port the same day of processing. The ship that takes the avocados from the port in Mombasa to the port of Rotterdam sails only once a week (Executive, 2022). Depending on this, the avocados in the container have to wait one or several days at the port of Mombasa. When the container of avocados is loaded onto the ship, they are about 35 days in transit. This depends on transloading at the port of Salalah (Oman), here every shipping company makes a stopover. When transhipment does not connect, the containers have to wait at Salalah port until the next connection (Executive, 2022). In the best case scenario, the transit time from grower to importer is 33 days, in the worst case about 45 days. Figure 12 shows the sequence of the supply chain with the number of days the avocados have to wait.

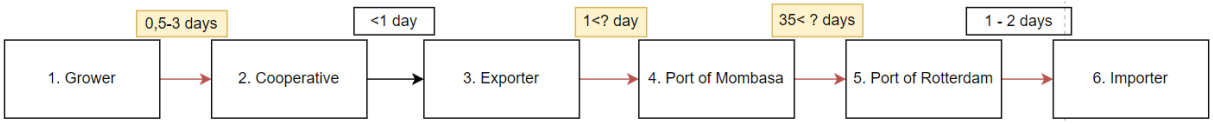

Figure 12: Time course in the current avocado chain

5.4.2 Process flow diagram current supply chain

The current supply chain is described using the process flow diagram in, see Appendix IV, process flow diagram. The process flow diagram describes the entire supply chain from the intention to harvest until the product is fully ripened at the importer's premises (Chairman, Nandi Avocado Farmers Co-operative Society Ltd, 2022).

The cooperative itself organises the harvest teams. These can be locals from the village, for example. These people have the experience and are trained in grading the quality of avocados when harvesting. The cooperative pays for this activity through its earning model. The cooperatives' earning model consists of a percentage of sales. The avocados are taken directly to the exporter.

The exporter measures the dry matter content at growers after request from the cooperative as shown in Figure 13. The meeting takes place when the grower has indicated to the cooperative that the avocados are ready for harvest (Chairman, Nandi Avocado Farmers Co-operative Society Ltd, 2022). Growers do this purely by colour, while the colour of Hass avocados gives little or no indication of the fruit's ripeness (Tesfay, 2015). When the dry matter content is measured and is lower than 20%, no harvest is carried out. Nor is a follow-up measurement scheduled at that time to measure ripeness again. Also, testing for dry matter content is only done during "off-season", from December to February. No measurement is done during the harvest season because the assumption is that most avocados are ripe at that time (Executive, 2022). During measurement, the exporter and the cooperative do not differentiate the dry matter level for the Fuerte or Hass variety while the Hass avocado needs a higher dry matter level at harvest time.

Transporting the avocados to the exporter can be by pick-up truck where the product is loaded loose in the bin. It can also go by smaller truck where the product is stacked in 20 kg crates and the smaller truck is refrigerated, see Figure 14. The truck can carry about three tonnes of avocados. Loosely stacked avocados get crowded with each other and are not cooled efficiently. The growers are at most six hours from the exporter when the avocados arrive at the exporter they are cooled to 20°C overnight. Cooling the avocados to 12°C will preserve them longer (Executive, 2022).

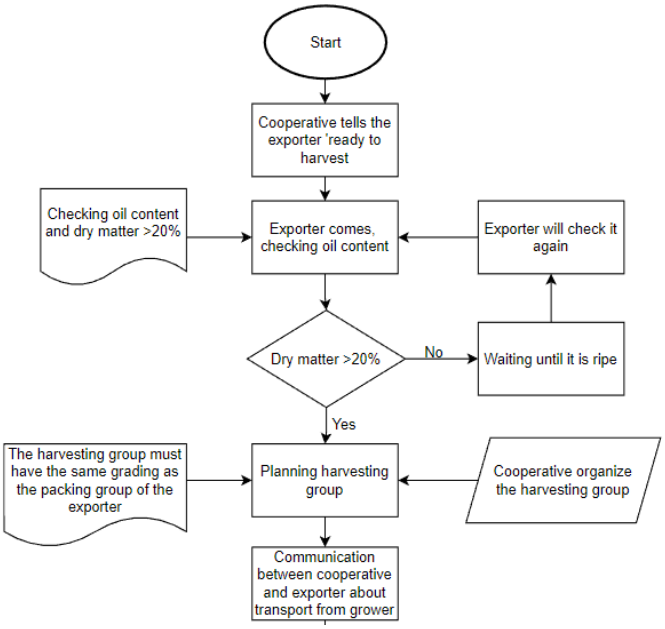

Figure 13:13 Process flow diagram part 1

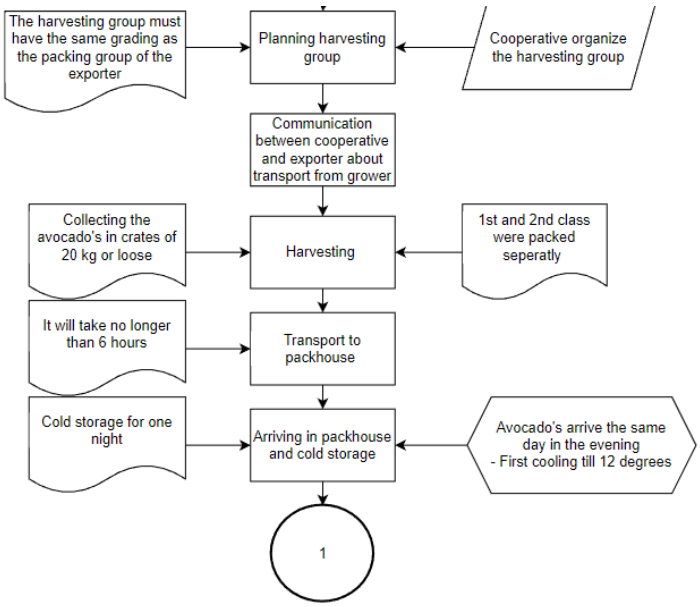

Figure 14: Process flow diagram part 2

The avocados are inspected and sorted during harvest in the same way as at the exporter's packing station. The avocados arrive at the packing station sorted into 1e , 2e class and "not usable" avocados. This is because the cooperative has a contract based on volume with the exporter. The exporter determines the final quality and purpose of the avocado. The avocados can be destined for avocado oil or for export. The different purposes determine the price the cooperative receives (Executive, 2022).

Avocados that come from a grower who does not have a GlobalGAP certificate cannot be used for export, as this is a requirement of retail. The avocados that do have a GlobalGAP certificate are sorted by weight, see figure 15. Weight is not always the fairest way of sorting because weight does not fully equal size and therefore uniformity. The exporter packs most avocados in 4 kg cardboard boxes. However, the European importer wants 10kg plastic crates. This is because the 10kg crates allow more air to pass through. In addition, more avocados can fit into a container due to the size of the crates. After the avocados are packed, they are cooled at 12°C while the optimal cooling temperature is 6°C (Executive, 2022).

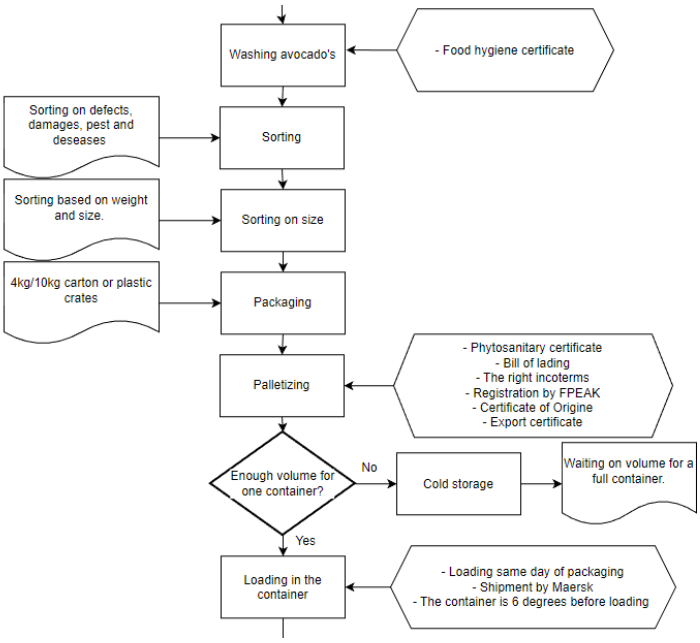

Figure 15: Process flow diagram part 3

When the container arrives at the port of Mombasa, it takes about a day before it is loaded onto the ship, see Figure 16. A ship sails to Rotterdam once a week. If harvest planning, processing and therefore transit time deviates, the avocados may miss the planned route. As a result, shelf life deteriorates.
The ship does not sail directly to Rotterdam, but first sails to the port of Salalah. Here, the container is transferred to a ship that sails further to the port of Rotterdam. This also happens once a week. If the cargo is delayed, the container has to wait at this port. As a result, the total transit time is about between 35 and 40 days (Executive, 2022).

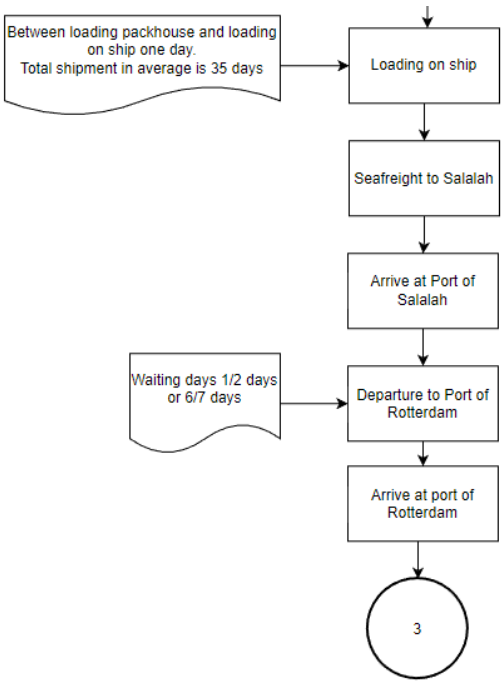

Figure 16: Process flow diagram part 4

Below, the Avocado supply chain in Kenya is shown schematically in Figure 17.
Because not all avocados are of the same quality, avocados go to different markets. Both internationally and regionally. The interpretation of the supply chain is shown below schematically with the corresponding pay out prices per unit (Africa, 2018).

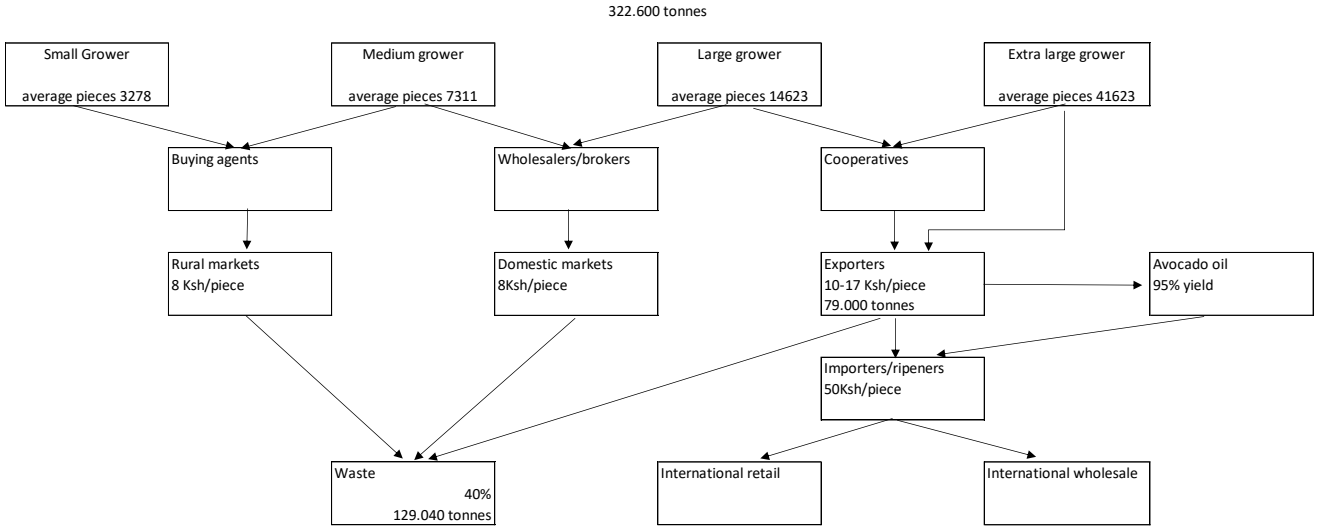

Figure 4: Traditional supply chain Avocados Kenya 2020 (freshela exporters, 2022)

5.4.3 Bottlenecks in the avocado supply chain listed

The following shows where bottlenecks occur in the supply chain. These bottlenecks stem from the previous supply chain descriptions.

- There is little knowledge among growers about growing and harvesting avocados.
- The grower will harvest when prices are high.
- No cultivation records are kept.
- Growers are often not certified.
- Farmer's storage creates FLW. This is because the avocados are stored here without adding value to the avocado. In addition, the avocados are not cooled immediately after harvest this can cause the avocado to lose quality.
- Small volumes make transport expensive.
- Due to poor infrastructure in rural areas, it is difficult and costly to transport avocados. This also creates FLW (Dashboard, 2022).
- Because of the sorting process, FLW arises. Only the avocados that meet the customer requirements can be delivered. The other avocados have to be sold in another market. This may be to the domestic market or the avocado oil market (van der Hulst, Rikken, & Finlayson, 2021).
- At the exporter, the avocados wait until they are loaded for transport.
- At the port of Mombasa, the container has to wait before it can be loaded onto the ship.
- There is no direct connection between Mombasa and Rotterdam.
- FLW is created when avocados are sold from importer to retail. This FLW arises because of the prognosis by retail. This is because retailers always want avocados on their shelves. For this, they set a forecast. From this forecast, the quantity of avocados needed is matured. But because the forecast regularly exceeds sales, too many avocados are ripened.
- Communication between links is not sufficient.

5.5 Sub-conclusion

The current links in the avocado supply chain consist of a grower, cooperative, exporter, the port of Mombasa, the port of Rotterdam and the importer. Each link tries to do its job well but does not know what the next link wants for product. From the SWOT and the confrontation matrix, opportunities include the possibility of future transport by ship directly from Mombasa to Rotterdam. A negative aspect is that Peru is the biggest competitor. The bottlenecks of the current supply chain provide insight into the aspects where improvements can take place.

6. Preconditions

Both the EU and Kenya have different rules for importing and exporting fruit and vegetables. In the EU, this is about food safety rules and how products must be transported. There are also rules about what imported products have to comply with and what taxes have to be paid. Exporting from Kenya to the EU also means complying with rules. These rules require an exporter to register with various organisations. These organisations can then assist the exporter in enabling exports. To make clear agreements between the seller and the buyer, Incoterms are used. Finally, importers draw up rules on what avocados must comply with and under what conditions the avocados must be transported.

6.1 EU rules

To grow, market and package fruit and vegetables, several rules have been established in the EU. These state that traceability of food intended for consumption is mandatory. If products are grown, traded or packaged in the Netherlands and are unsafe, this must be reported to the Dutch Food and Consumer Product Safety Authority (Kamervankoophandel, 2022).

Importing fruit and vegetables into the EU must follow certain rules. It is important to know these rules so that imports can proceed as quickly as possible. Avocados may be treated against fungi and pests in the country of origin. A small amount of these may remain on the product. These are called residues. In the EU, there are regulations on maximum residue levels. Some countries in the EU have even stricter requirements regarding residues (Kamervankoophandel, 2022).

To import products from outside the EU, into the EU, a phytosanitary certificate is required. This certificate must be created in the country of origin. The certificate is valid for a certain quantity. Think of a container. The container must then be sealed. The phytosanitary certificate ensures control of insects that should not be exported (Kamervankoophandel, 2022).

During transport of avocados, a Bill of Lading should always be used. The Bill of Lading is an important document in the transport of goods. The form should contain the following information:

- Who loaded the cargo.
- Where was the cargo loaded.
- When was the cargo loaded.
- What product was loaded.
- How much product was loaded.
- Who was the carrier.
- Who was the addressee.

The Bill of Lading is also used as legal evidence. It states how much product has been loaded. The driver can check this during loading. After loading, the driver must sign the Bill of Lading. With this, the driver indicates that the consignment note matches the load. Should there subsequently be a difference between the loaded and unloaded product during unloading, the driver is responsible for this (e-bookkeeping, 2023).

6.2 Product requirements from the EU

There are three different classes in the avocado market. These are the "extra" class, class 1 and class 2.
The requirements to be met by the **extra-class** avocado are explained below:

- The product must be intact.
- The product must be clean.
- It should be free of insects.
- It should be free of damage.
- It should be free of external moisture.
- The stalk should be no more than 10 mm.
- It must withstand transport and handling.

The difference in weight per avocados in a lot may not exceed 5%. If it exceeds 5%, the lot immediately becomes class 1. No more than 0.5% of the lot may consist of class 2.

The following describes when an avocado may be considered under **class 1** avocado:

- Slight defects in shape.
- Slight colour variations.
- Slight skin abnormalities.
- The stalk may be slightly damaged.

A lot of class one avocados may consist of up to 10% of class two avocados. No more than 1% of the lot may consist of avocados not meeting class two.

The following describes when an avocado may be considered under **class 2** avocado:

- The quality, shelf life and presentation should still be sufficient.
- Defects in form will be accepted.
- Defects in colour will be accepted.
- Defects on the skin should not exceed 6cm2.
- The stalk may be damaged.
- In no case should the defects affect the flesh.

A maximum of 2% of the lot may be rotting. Up to 10% of the lot may not consist of class 1 or class 2 avocados.

There are also different rules for packing avocados. The contents of the packaging must all look the same. This means that the avocados have the same origin, are of the same variety, the quality is the same, the colour of the avocado should be the same and the size should be the same. In addition, it is important to package the avocados in a way that they cannot be damaged. Packaging should be suitable for packing avocados and free of foreign materials (Unit, 2019). During transport, the packages should be transported on pallets that have undergone ISPM treatment (NVWA, 2023).

6.3 Import duties

The import duty depends on the country of origin of the avocado. Kenya is subject to a 9% import duty on sales tax (CoC, 2022). This has to be paid by the importer in the EU. The import duties that Peru's main competitor faces is "Third country customs duty" of 4% and "Sales tax" of 9%. Customs duty is paid to the EU and sales tax applies to the relevant importing country (Tax Office, 2022). Import duty relating to Kenya is paid retrospectively by the importer. Through the body "Fenex", several companies can be found that provide services in import duty administration and logistics transport (Fenex, 2022).

6.4 Regulatory affairs Kenya

Exporters in Kenya have to apply to various agencies before exports can be done. These bodies are:

- Fresh Produce Exporters Association of Kenya (FPEAK).
- Kenya Plant Health Inspectorate Service (KEPHIS).
- AFA Horticultural Crops Directorate.
- Kenya Trade Network Agency.

Besides registering with the various authorities in Kenya, there are other rules that must be complied with. At sites where avocados are processed or packaged for human consumption, a food hygiene certificate is mandatory. This licence is issued by Port Health Services Kenya or by Public Health Officers.
Exporters must register with the Fresh Produce Exporters Association of Kenya before exporting. This is one of the trade associations in Kenya that represents growers, exporters and service providers in the horticulture sector.

A phytosanitary certificate is also required. Before this certificate is given, the avocados to be exported are sampled and tested. This involves determining the maturity and oil content of the avocados. This certificate is issued by Kenya Plant Health Inspectorate Service.

A certificate of origin is mandatory. This document shows where the products were produced and processed. If a product comes from another country, this is stated on the certificate of origin.
Finally, the AFA Horticultural Crops Directorate (HCD) must issue an export certificate. This certificate indicates that the shipment has been cleared for export (infotradekenya, 2022).

The Agriculture and Food Authority in Kenya has a lot of influence on avocado exports. This authority keeps track of how the avocados are growing. If the avocados are not growing well enough or are harvested too early, the authority can intervene. The authority does this to continue supplying the Kenyan market with avocados and so that bad avocados are not exported. This prevents the image of the Kenyan avocado from deteriorating (Muchira, 2022). Since the 2022 season, the government has stipulated that the dry matter content must meet a minimum. This minimum is 24% and applies only to avocado exports to Europe. As a result, Kenya wants to raise its image with avocados (Abendroth, 2022).

6.5 Incoterms

Incoterms are used for importing and exporting goods. Incoterms are drawn up by the International Chamber of Commerce. Incoterms are used to have clear agreements between buyer and seller about which organisation is responsible for the products and where. To keep Incoterms up to date, they are revised every ten years (Hoebink, 2022). The exporting party may receive better transport rates than the importer. This is because the exporter handles more volume than one individual importer. European avocado importers therefore often let the exporter arrange everything. The Incoterms used for this are DDP and DPU, see Appendix V, Incoterms.

6.6 Specifications importer

Besides regulations of the importing and exporting country, the importer also sets requirements for the product. These requirements are checked one by one by the importer's inspectors on arrival at the importer. It is important that the inspectors do this so that the importer knows what quality products are arriving. Below are the specifications of the importer.

Specification
- The variety of avocado should be Hass.
- The lot should have a homogeneous green colour.
- Dry matter should be at least 22%.
- There should be a maximum of 1 week between harvesting and shipping.
- Packaging is on a pallet, avocados should be from one grower.

Class 1
- Defects should not exceed 3%.
- Multiple defects may add up to a maximum of 5%.
- The defects should not affect the flesh.
- The stem should be mould-free and attached to the fruit.
- The stem should be only 3mm.
- One size per pallet.

Size
- It is important that the avocados in a box are uniform. The avocados should all be the same size, colour and quality. Figure 18 shows which weight belongs to which size (Unit, 2019).

Size code	*Weight range (g)*
4	781 to 1220
6	576 to 780
8	456 to 576
10	364 to 462
12	300 to 371
14	258 to 313
16	227 to 274
18	203 to 243
20	184 to 217
22	165 to 196
24	151 to 175
26	144 to 157
28	134 to 147
30	123 to 137
S*	Less than 123

* The difference between the smallest and largest fruit within a package should not be more than 25 g.

Figure 5: weight classes of avocados

Temperature

- It is important that avocados are chilled back as soon as possible. Harvesting and then cooling should take place on the same day.
- It is important not to refrigerate the avocados back too quickly.
- Avocados should be refrigerated at 6°C to 7°C.
- A temperature recorder should be placed in the container during transport of the avocados.
- Beware of refrigeration damage to the product.

Container settings

- Temperature 6°C.
- Controlled atmosphere 4% O_2 and 6% CO_2 .
- Humidity between 85% and 95%
- Ventilation off
- The air system must be kept clean.
- There should be cardboard in front of the last pallets. This means the air has to go up through the avocados and cannot go up through the back near the doors.

Packaging and pallets

- Packaging must meet hygiene, ventilation and sturdiness standards.
- Each package must contain the requested weight on arrival.
- Each pallet should have a sticker on it showing the number of crates on the pallet.
- There must be a label on each crate

Labels should include the following information:
According to UNECE (Unit, 2019).

- Product
- Breed
- Origin
- Size
- Class
- Net weight
- Lot code
- Address details exporter

According to GlobalGAP (GlobalGAP, 2020)

- Packer code

According to the importer

- Address details importer

Certification

- The grower must have the GlobalGAP certificate
- A pesticide residue analysis must be present
- Packaging centres must comply with BRC (British Retail Consortium) requirements.

From the specifications above, it is easy to see that importers supplying supermarkets have stricter rules than European regulations. The specifications also address how the container should be set. This is in the specifications because avocados are sensitive to cold fluctuations and also cannot withstand cooling back too quickly (P.Bower, 2021).

6.7 Sub-conclusion

Avocados have to meet all kinds of preconditions before they can be exported and imported. It is important that these conditions are known to each link. Before being allowed to export, the exporter must have completed the necessary paperwork. In addition, the exporter must meet the condition. It is notable that the importer's specifications are even stricter than the requirements from government agencies.

7. Quality requirements

This chapter identifies the quality requirements of the avocado supply chain. These requirements constitute important activities in the supply chain, on which the final result, continuity in quality and the future within the supply chain depend.

7.1 Grow

It is important that growers grow avocados that are in demand. The most commonly used avocado variety for export is the Hass avocado. This avocado falls under the Darkskin avocados. For the grower, it is important to grow this variety because the export market generally pays higher prices. For this, however, the grower should mainly focus on growing class 1 avocados. Only for these class 1 avocados is the higher price paid.

7.2 Harvesting

The time of harvesting determines the quality of the avocado. This is because once the avocado is harvested, the quality can only decrease. Before harvesting the avocado, it is important to determine the nitrogen level and calcium content. The nitrogen level should be below 1% and fall even further. The calcium level should be at least 0.05%. The lower the calcium content the faster the avocado starts ripening and the more ethylene is developed (P.Bower, 2021). The dry matter content is also an important factor on which to base when the avocado is harvested. The dry matter content should be at least 24% for the Hass avocado (foodsafetyafrica, 2022).

During harvesting, it is important to handle the avocados carefully otherwise damage will occur. After harvesting, the avocados should be carefully placed in a bag/tray. Then the avocados should be refrigerated as soon as possible. If refrigeration is not possible, the avocados should at least be removed from the heat (P.Bower, 2021).

The harvest moment is also important for the avocado plant itself. The harvest moment also indirectly affects the future of the plant, grower and stakeholders further down the supply chain. As explained earlier, the Kenyan people are mainly price-focused when it comes to avocados. If there is a delay in harvesting because the grower finds the market price too low, for example, this will affect the flowering of the next avocado. The next flower for the avocado will bloom later and the avocado will also be ready to harvest later. The market is too volatide and in addition, the price may be low at harvest time and high again when the product is in the European market.

7.3 Storage and sorting

At the sorting centre, it is important that avocados are stored away from sunlight and heat.
Whenever possible, the avocado should be refrigerated. When the avocados are delivered hot to the exporter, it is important to know which customer the avocados are for. Different customers have different requirements.

While sorting the avocado, care must be taken otherwise the avocados will be damaged. During sorting, the product is visually inspected for defects. The avocados are then weighed individually. The products with the same weight class are then packed together in a 4kg or 10kg crate. Sorting by weight takes place so that the customer receives the same size avocados. It is important to take care of the product during all processes.

7.4 Inspection and maturation

At the importer, when the container arrives, the settings are read out. It is very important that during transport of the avocados, the settings of the container are set correctly. This is because the container must be shipped under "controlled atmosphere". The temperature recorder placed in the container during loading is also read out.

The container is then unloaded and the batch is inspected. During this inspection, work is done according to fixed protocols. The lot is inspected for hardness, dry matter, appearance, internal quality and sizing (Quality Manager, 2022). After inspection, the avocados are placed in a cold store where they can acclimatise. After 3 to 4 days, another inspection is carried out. This inspection determines the treatment in the ripening cells. After a few days in the ripening cell, the avocados are inspected again. The ripe avocados go to the packing department and the unripe avocados go back into the ripening cell and are thus further ripened. After ripening, it is important to bring the ripening of the avocado back to rest. For this, the avocados must be cooled again to 6°C.

7.5 Sub-conclusion

From harvest onwards, the avocado cannot be improved. The quality of the avocado can only be maintained. While growing, it is therefore important to grow the right variety. Before harvesting, it is important to check the avocado for nitrogen and calcium levels. During harvesting, care should be taken when handling the avocado. The exporter takes care of cooling the avocados. After harvesting, this cooling process should be started as soon as possible. The importer must inspect the avocados on entry. From this inspection, a ripening schedule is made.

8. Distribution options

Chapter 8 discusses the different ways in which distribution can be designed. The options for getting avocados to their destination are described for each link in the supply chain. It also describes how long the transport takes.

8.1 Grower to exporter

The way the avocado supply chain is organised depends on the way Kenyan growers are organised. 70% of avocados in the country are produced by smallholders. The smallholders may be linked to an outgrower scheme with cooperatives. An outgrower scheme allows smallholders to supply avocados to cooperatives. Besides supplying avocados, the smallholders receive knowledge and growth opportunities in return. The cooperatives thus provide room for professionalisation and are thus the tool for Kenyan farmers to sell their avocados to the export market (Wolter, 2022). The cooperatives primarily serve as marketers to exporters. The cooperatives enable smallholders to be able to export their avocados and thus receive a higher price for their produce (Kahuro, 2021).

After harvesting avocados, it is important to get the avocados to the exporter as soon as possible where the avocados are refrigerated. The cooperative controls the cultivation and harvesting moment. From the time of harvesting, there are two different options. In smaller cooperatives where fewer growers are affiliated, avocados are collected on tarpaulins and placed in the shade. This is done to collect enough avocados to fill a car that can go to the exporter. The avocados can lie on the tarpaulins for up to three days before being transported to exporter (Manager P. , 2023). In the case of larger cooperatives, avocados are collected immediately after harvest and then transported to exporter. As a result, avocados ripen less quickly and are of higher quality for export.

8.2 Exporter

At the warehouse, avocados are checked for quality, sorted, washed, waxed, cooled and packed. Most avocados are packed in 4kg or 10kg plastic crates or 4kg cardboard boxes. It is important that avocados are packed in clean crates that are free of insects and other debris. The 4kg crates are stacked on pallets. A full pallet then holds 264 crates. Twenty pallets go into one container (Manager P. , 2023).

When the avocados are ready for export, they are loaded into CA containers. These CA containers bring the avocados into a controlled atmosphere. This stops the avocados from further ripening. After this, the containers are transported to the port of Mombasa.

8.3 Exporter to port Mombasa

Transport from the warehouses to Mombasa port can be done in two ways, transport on the road and by rail. Transport by road takes about 8-10 hours and costs $1000 from Nairobi. Transport costs are generally more expensive partly because of the last mile that still has to be done by road transport, partly due to government support, rail transport rates have remained low (Maritime Business & Economic Consultants, 2019).

With the renewal of the rail network in Kenya and the opening of the Standard Gaige Railway SGR in May 2017, there are more opportunities for train transport. If the government continues to support this mode of transport through

subsidies, cargo can be transported to Mombasa port in a more environmentally friendly way. It will also reduce the risk of delays or accidents during transport (Commerce, 2023).
In 2021, 445,962 Twenty Equivalent Unit (TEU's) were transported through the SGR. This was a 57% import share and 4% export share. The reason for this difference is mainly due to landings of empty containers (Observatory, 2022).

8.4 Port of Mombasa to Europe

Sea freight from Kenya passes from the port of Mombasa in Kenya via the port of Salalah or Jeddah on to Rotterdam. Due to this stopover, cargo is stationary at the port of Salalah for between 3 and 7 days. The different routes from Kenya and the corresponding shipping line are shown, see Appendix II, sea freight routes.

As shown in Figure 23, there is a direct route from Kenya to Genoa (Italy). This transport route costs about the same as the indirect route to Rotterdam (van der Hulst, Rikken, & Finlayson, 2021). However, it does add costs for road transport from Genoa to Rotterdam. The cost per container are between 1626-2169$ if it is a return freight and 2710-3253$ if it is a single trip.
After the container arrives in Genoa after 21 days, the container can pass customs. This takes 2-3 days. Then the drive to the Netherlands takes another 2 days, making the minimum duration of the drive 26 days from Mombasa. So a direct route from Mombasa to Rotterdam would be more favourable in terms of price and trip duration.

Kenya exports more refrigerated containers (CA containers) than it imports. This creates an imbalance whereby empty containers are transported inland. This has negative consequences for the environment and transport costs. To reduce this problem, containers with cardboard from Sweden can be filled at the port of Rotterdam. These containers are then not refrigerated (non-operating reefers NOR). This can save 500-1000 per container.

8.5 Port of Europe to importer

Figure 19 below shows transport from the port of Rotterdam. Orange shows transport by road and green transport by rail. The points shown are places that can be reached within 1 day by rail and by road (Port of Rotterdam, 2022). Reducing the distance between the port of Rotterdam and the importer reduces the likelihood of delays and losses.

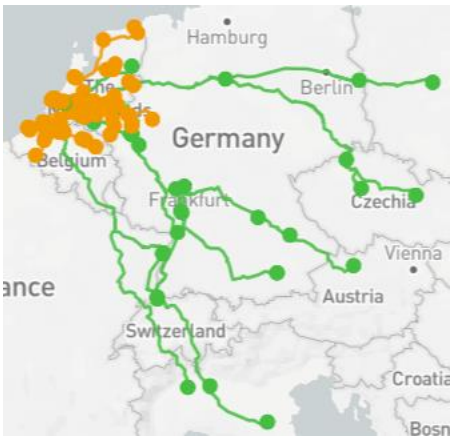

Figure 6: Accessible places from Rotterdam (green rail, orange road transport)

8.6 Sub-conclusion

Avocados are mostly transported after harvest. From the grower to the exporter, this is done with a car. This car can be a pick-up or a conditioned car. The avocados are transported loose or in 20-kg crates. The exporter packs the avocados into 4kg or 10kg crates and stacks them on pallets. The pallets are loaded into a CA container.
Transport from Nairobi to the port of Mombasa can be done either by road or by rail. From the port of Mombasa, there are several options for transporting the container to Rotterdam. The container is then transported by road to the importer.

9. Supply chain management

This chapter discusses the importance of supply chain management. The aim is to track the path from raw materials to consumers. With the help of collecting all kinds of information, the supply chain can be organised more and more efficiently.

9.1 Target

To engage in supply chain management as a supply chain, it is important to have a goal. The whole supply chain must have the same goal in mind. Only when the whole supply chain has the same goal in mind can a supply chain cooperation be successful. It is important to know that a successful supply chain cooperation must take place step by step.

The aim of supply chain cooperation between the grower in Kenya and the importer in Europe is to better match the quality and quantity of avocados. The importer in Europe wants to get good quality avocados in, in the right quantity, at the right time and at an acceptable price. The grower in Kenya wants to get paid as much money as possible for his avocados. It is important to know that when the grower only supplies good avocados, less costs are incurred later in the supply chain. As a result, costs in the supply chain decrease and a better price can be paid to the grower.

It is also important that providing information for each link is tone correct and timely. After all, each supply chain partner needs to know where it needs to be and at what time. It is also important to share the information collected from both the grower and the importer. Through these different information facilities, all supply chain partners know better what is expected and what can be expected. This allows processes to be better managed, resulting in lower costs in the supply chain (Folkerts & Maijers, 2014).

9.2 Efficient design supply chain

Since the agricultural sector mainly works with fresh produce, it is important that processes are aligned. The consequence of mismatched processes is that products remain in one place for longer than necessary. This subsequently means that wastage occurs. To deliver products to consumers, it is important to set up processes efficiently. In the agricultural sector, this is even more important than in other sectors. This is because the agricultural sector is very cost-driven. To make a profit as a company or organisation, there are several options. These are explained below.

- Merge; this involves two companies merging. The two companies combine to form a new company. Mergers often occur when two companies provide the same product or service. By merging with each other, there is no longer competition among each other.
- Takeover; a company takes over another company. This may be the next link in the supply chain, or a competitor. This is also called horizontal or vertical supply chain integration.
- Joint venture; this is a type of cooperation which is used for a project. Two or more companies will work together intensively in a certain field for a certain period of time.
- Strategic cooperation; this involves a partnership between two companies with the aim of obtaining a better price when purchasing goods.

When an organisation chooses any of the above options, it also directly increases its position in the supply chain. By increasing its position in the supply chain, the company or organisation has more power in the supply chain, but quite possible also increases risk (trade, 2022).

9.3 Collaborations

Besides producing efficiently, it is important to know the value of each link in the supply chain. This is because each link in the supply chain exists by adding value to the product. This is both in added value to the product and in service.

Once the redundant links are out of the supply chain, it becomes increasingly important to work intensively with the remaining links. For collaborations within the supply chain, it is then important to have a common goal in mind. Together with the supply chain partners, this goal must be achieved. This therefore requires exceptionally good communication between the different links in the supply chain.

Besides the goal set up together, it is important to establish clear rules. Using these rules, it is possible to hold supply chain partners accountable for their behaviour. This is because the rules define what each supply chain partner can and cannot do and what the supply chain partner is responsible for. It is important to draw up these rules so that each supply chain partner knows what it is responsible for.

When working together within a supply chain, it is important to work with companies or organisations with which there is a good relationship or a good relationship can be built. It is therefore very important to research a suitable company to work with. This is important because confidential information is shared between companies during collaboration. It should be trusted that information about the supply chain also stays within the supply chain (Consultancy.co.uk, 2017).

9.4 Supply chain models

The Nucleus Estate model is one where smallholders benefit from a large avocado grower nearby (expert, 2022). The smallholders operate on their own farms but supply their avocados to the large grower nearby. This gives the big grower more volume to sell. It allows the big grower to invest in a sorting machine and optimise its processes. The smallholders bring their avocados to the big grower where the avocados can be cooled immediately this benefits the quality. Then the avocados can also be sorted, packaged and thereby sold in multiple markets.
Advantages

- Large grower
    - More volume to sell.
    - More volume to process so more use of machines.
    - With more volume, processes can be better designed.
- Smallholder
    - Lower transport costs.
    - Can take advantage of big grower's technology.
    - Better product, so better price.
    - Can take advantage of big grower's knowledge.
    - No investment needed to sort avocados.

To use the nucleus estate model, the smallholders can also unite in a cooperative. In this, the cooperative has contact with the large grower. Here too, the big grower sorts and packs the avocados of the growers who have united in a cooperative.

Another way of working is the example of Royal Lemke's from the Netherlands. In this, the pot plant trading company has changed into the director of the supply chain. Royal Lemke's has started to focus more on a more efficient supply chain. To this end, they started to exchange more information with all supply chain partners. In addition, Royal Lemke's has started to focus on the consumer. The consumer is informed how to take care of the plant. Royal Lemke's also made a clear segmentation on how to approach a market. Subsequently, different formulas were created that

specifically serve a certain market. By approaching different markets in different ways, customer satisfaction increased and sales doubled. By explicitly targeting the different markets, Royal Lemke's became market leader in all markets.

Because Royal Lemke's has focused so much on making money for other links in the supply chain, the supply chain partners are also more satisfied with Royal Lemke's. As a result, trust in the supply chain has increased. In addition, besides more stability and continuity, there is also more fun at the workplaces. The supply chain partners can work together on a supply chain in which high quality products reach consumers through the right channels.

The following steps have been taken at Royal Lemke's to arrive at the supply chain as it is today:

- Setting a goal.
- Selecting right supply chain partners.
- Develop concept.
- Pointing out points for improvement.
- Continuous monitoring of results.
- Keep working step by step.
- Continue to train staff.

The last step continue staff training is a very important aspect to keep improving the results of the supply chain. Indeed, after forming a closed supply chain, it is not that there is less challenge in the work. In fact, after forming a well-cooperating supply chain, even more challenging work may emerge (Folkerts & Maijers, 2014). A closed supply chain is one where systems, people, product flows are in tune with each other (Folkerts & Maijers, 2014).

9.5 Sub-conclusion

From the example above, it can be seen that it is important for a supply chain to work together. To generate an efficient supply chain, it is important to first remove unnecessary links from the supply chain. Here, links are taken over by another link in the supply chain or links disappear completely from the supply chain.
When the supply chain has taken unnecessary links out of the supply chain but sees that the remaining links do add value to the supply chain, supply chain management is adopted. Supply chain management ensures that processes are optimised not only per link but throughout the supply chain. To optimise processes throughout the supply chain, it is important to work together. This cooperation involves information exchange between the links in the supply chain, but also involves rules. Rules ensure that each partner bears responsibility for optimising the supply chain.
It is vital to keep training staff throughout the supply chain. Working together in the supply chain creates a different way of thinking.

10. Opportunities for bottlenecks

Chapter 10 presents options for the bottlenecks shown in Chapter 5. For the various bottlenecks, options are shown that would remove the causes of the bottlenecks. Disadvantages are also shown with the options.

10.1 The grower

Increasing the grower's knowledge level can increase production per tree. Through increased knowledge, the grower knows how to increase production per tree. With increasing knowledge of the grower, the grower can also specialise more in avocado cultivation. With more specialisation, the financial returns of avocado cultivation increase and this reduces the need for the grower to generate other income. If avocado cultivation generates good income, the grower may also start expanding his acreage. By specialising in avocado cultivation and expanding plantations, the cost per kilogram can decreases.
One disadvantage of expanding plantations is the likelihood that large tracts of land will be used in the same way. This is because by expanding the plantations, there will also be a focus on how to get as many avocado trees on a plot as possible. Another drawback is that expanding plantations will lead to an increase in supply. This increase in supply must be able to be sold on the world market.

10.2 Cooperatives

The small size in volumes mean that the cost per kilogram is high. These costs can be reduced by providing growers support that allows more kilograms to be harvested from a tree. Steering can also be done based on location, where growers are located. By linking growers located near each other with each other, the harvest can be collected simultaneously. In addition, the cooperative can set a requirement that the grower must meet as a minimum to be allowed to deliver to the cooperative. By imposing a requirement on the minimum number of trees, avocado cultivation provides a large part of a member grower's income. A disadvantage of the minimum number of trees requirement is that growers with only a few trees are immediately excluded from the cooperative. This prevents these small growers from accessing the export market. As a result, small growers with a few trees are left behind in terms of knowledge and investment. As a result, it actually only makes it harder for small growers to keep developing.

10.3 Transport

During transport of avocados from grower to exporter, the grower must ensure that the avocados are placed in crates weighing no more than 20kgs. Transporting the avocados in crates reduces the risk of damage during transport. The driver has to be mindful of poor roads during transport. It is important for the avocados to at least be out of sunlight during transport. The best solution is to transport the avocados in conditioned cars. In doing so, the car ensures that the avocado is cooled down slightly before it reaches the exporter.

Transport from the exporter to the importer may be by road and possibly rail freight. It then goes to Europe by sea freight. The exporter can choose to send the container by road or rail to the port of Mombasa. Transport by road costs about $1000 and takes between eight and 10 hours. Transport by rail is attractive only when subsidies are given from the government. Indeed, this now costs 950$ including last-mile (Observatory, 2022). Rail transport is more reliable, though. There is less chance of delays, also less chance of accidents.

From the port of Mombasa to Rotterdam, there are several options. The first option is by sea freight from Mombasa to Salalah in Oman or to Jeddah in Saudi Arabia. This involves transferring the container in Salalah or in Jeddah to a larger ship sailing towards Rotterdam. Transferring the container to the other ship causes the container to wait at the port for 3 to 7 days. On average, transport from Mombasa to Rotterdam including transhipment takes 35 days.

Transport from Kenya can also go from the port of Mombasa to the Port of Genoa in Italy. There is a direct connection between these two ports. As a result, avocados arrive in Genoa after 21 days. In Genoa, customs must be taken into account which takes several days. Next, the price for road transport from Genoa to Rotterdam is still around $2706. Via the port of Genoa, the avocados are 4 to 5 days shorter in transit. The downside is that the price is a lot higher than if the container goes from Mombasa via Jeddah or Salalah by sea to Rotterdam.

10.4 Communications

Good communication helps to improve processes. This is because good communication ensures that the product is delivered according to the specification, at the right time and in the right place. This communication between successive links in the supply chain ensures that what is needed can be delivered. Because this communication is mainly between successive links, it is difficult for the entire supply chain to benefit from the information between different links.

Communication can also be more active allowing daily contact between the links. Information to be shared here is the importer's specification with the cooperative and the grower. This allows the growers to focus more on the aspects the avocado needs to meet. In addition, sharing information is important for the exporter and importer when the quality or quantity of the crop is disappointing. A prerequisite for intensive information sharing throughout the supply chain is that the links must be able to trust each other. If links in the supply chain can trust each other, the intensity of cooperation increases. If the trust of links in the supply chain is not good, it is impossible to share correct and complete information within the supply chain.

10.5 Sub-conclusion

Many of the bottlenecks can be solved by good cooperation in the supply chain. Good cooperation in the supply chain ensures that processes are as efficient as possible, reducing costs per kilogram. As a result, yields increase throughout the supply chain.

11. Ideal supply chain description

This section of the report discusses what the ideal avocado supply chain from Kenya to Europe should look like. In an ideal supply chain, the links work closely together. In doing so, the links are not looking to maximise their own profits. Instead, they work to optimise profits throughout the supply chain.

11.1 Requirements

The supply chain must consist of links that are willing and able to cooperate with each other and also build a long-term relationship. Information sharing within the supply chain is necessary to achieve an ideal supply chain. For this, the different links must be able to rely on each other. For this, it is important to have the same standards and values. In addition, goals need to be established towards which the supply chain can work. Links must then also adhere to these goals.

11.2 Grower

It is imperative that growers in Kenya continue to develop avocado cultivation. Investments should be made in larger plantations that will reduce costs for the grower himself but also reduction in costs further down the supply chain. It is important to increase the grower's cultivation knowledge by offering courses or training. For the subsequent links in the supply chain, it is important that the grower shares information. This information consists of:

- When was pruning done?
- What plant protection products did the grower use?
- What is the status of the trees?
- What is the age of the trees?
- What was the season like?
- How many trees does the grower have?
- What is the expectation of the harvest?

During harvesting, growers must distinguish between 1^{e} and 2^{e} class avocados.
For exports to Europe, it is important that the grower is GlobalGAP certified. This certificate is a minimum requirement to supply for European retail. For the grower, it is important to be in contact with the cooperative. Close communication is especially important just before and during harvest. The cooperative then communicates when the grower may harvest. The grower harvests the avocados, immediately sorting them into 1^{e} and 2^{e} class avocados and placing the avocados in clean crates. The cooperative ensures that as soon as the avocados are harvested they are collected immediately. This allows the cold supply chain to start as soon as possible after harvesting.

Because the grower collects a lot of information for later in the supply chain, it is important that the grower also gets something back from the supply chain. An important condition for this is that the grower gets a price for his avocados from which the grower can live and continue to invest. In addition, the grower must receive information from the supply chain. This information is about the quality of his supplied avocados. But the information should also include information about what the other links in the supply chain want. This is information about which trees should the grower plant, is there high demand for avocados from Kenya.
The grower bears much of the risk in the supply chain. There are three years between planting the avocado trees and the first harvestable avocado. This means the grower has to generate income by other means during these three

years. In addition, the grower is dependent on climate, diseases and pests. Diseases and pests can be controlled with the help of plant protection products. For this, however, the grower has to consider the regulations.

11.3 Cooperative

The cooperative is an association of growers. The cooperative must be committed to the grower. This means that the cooperative must support the grower in growing avocados. For this, it is important that the cooperative communicates a lot with the growers. To support the growers, it is necessary to appoint a cultivation supervisor. This cultivation supervisor ensures that the quality of avocados at each grower increases. For the cultivation supervisor to visit growers, it is important that a grower does meet certain requirements.
These requirements should be:

- A grower must have a minimum of 24 avocado trees.
- A grower must be willing to develop further.
- A grower is obliged to sell his avocados to the cooperative.

These requirements are important too:

1. Growers in Kenya need an annual yield of 14068 avocados at a price of $0.1007 each to ensure a liveable income. If production per tree is included as described in the KPI section, a grower needs a minimum of 24 trees. If the grower has fewer trees, he must also grow other crops. As a result, the grower cannot fully focus on growing avocados which can be favourable for the grower (Schouwenburg van, 2018).
2. To be able to sell increasingly better and better avocados as a cooperative.
3. Link available avocados to demand.

Because the crop supervisor visits the growers, the information passed on by the grower can also be checked. If information is missing or if the grower does not know something, the grower can contact the cultivation supervisor directly. The information collected is important for both the cooperative and the next links in the supply chain. Through the information collection, forecasts can be made. These forecasts are about quality, quantity and time of harvest. These forecasts provide information for making choices.

Because the cooperatives consist of different growers, the growers have to be divided into different regions. To divide the different regions, the altitude of the plantations and where the plantations are located must be taken into account. Different heights refers to how far above sea level the grower cultivates. This is because the different altitudes of the plantations affect the time when the avocados can be harvested.

By classifying growers into certain regions, a more homogeneous product can be offered to the exporter. It can be assumed that because of the cultivation supervisor's guidance, the avocados have approximately the same qualities. To determine whether the avocados are ripe, the cultivation supervisor should examine some avocados. In doing so, the cultivation supervisor should examine whether the dry matter content and oil content are at the right value. By developing the regions, it can be assumed that the avocados are equally ready throughout the region.
By having growers in the regions also harvest at the same time, the best possible use can be made of transport. To keep costs as low as possible, it is important that transporters drive to the exporter with a maximum load as much as possible.

11.4 Exporter

The exporter ensures that the avocados are collected from the growers on the day of harvest. The avocados should be collected as soon as possible after harvesting so that they can be refrigerated. Chilling the avocados as soon as possible ensures longer shelf life. Communication about the harvest time as mentioned before is done through the cooperative.

The exporter takes care of processing and packing the avocados. During processing, the 1^{e} class avocados are sorted by defects and then by size and then by weight (Manager E. , 2022). The avocados that belong in the same size and weight grading are packed in the packaging according to customer requirements. For export to Europe, this is 10kg plastic crates. For picking the avocados, a machine must be used where the avocado is checked for internal external defects. In addition, the machine has to measure the dry matter content. By sorting on dry matter content, the exporter is able to export a more homogeneous product. During sorting, sorting must be done according to the regulations from governmental organisations and according to the importer's specifications. The regulations and specifications require the exporter to have food hygiene certificates.

For the exporter, it is important to be in frequent contact with the importer and the cooperatives. This is because the exporter needs to be constantly informed about the quantity and quality of avocados being delivered. With this information, the exporter knows whether the importer's specifications can be met. Indeed, qualities and quantities always depend on the growing season. Communication between exporter and importer on quality and quantity is therefore important.

The exporter needs to match supply and demand. For this, the cooperative's crop forecasts are valuable. This allows the exporter to coordinate a sales programme with the importer. After coordinating this programme, the exporter can plan in terms of personnel and transport. For transport, the exporter can contact shipping companies. Agreements can be made with these parties about when the containers are needed and when they can be loaded on the ship. Contact between the exporter and the transporter should also be maintained during transport. Indeed, as soon as a truck or a ship is faster or delayed, this should be communicated to the importer.

The exporter takes care of preparing all paperwork to enable the export. These papers consist of:

- Certificate of origin.
- Bill of Lading.
- Fruit quality report.
- Registration with FPEAK to export.
- Export certificate.
- Phytosanitary certificate.

Exporter sells avocados under DDP or DPU Incoterms

While transporting avocados from the grower to the exporter, the avocados must be in crates. These crates should weigh a maximum of 20kg. The crates should be loaded in a conditioned vehicle. This allows the avocados to be transported safely and refrigerated from the grower to the exporter. The conditioned vehicle may cool the avocados to 12°C. Care must be taken here to avoid refrigeration damage. This means that during transport, the conditioned vehicle may only cool the avocados back by a few degrees difference at a time.
Transport from the exporter to the port of Mombasa and then at sea to Europe is by containers. While loading the avocados into the container, a temperature recorder must be placed in the container by the exporter. Should anything go wrong with the temperature in the container during transport, the temperature recorder can be read.
The container should be set as follows during transport.

- Temperature 6°C

- Controlled atmosphere 4% O_2 and 6% CO_2
- Humidity between 85% and 95%
- Ventilation off
- Keep the air system free
- There should be cardboard in front of the last pallets. This means the air has to go up through the avocados and cannot go up through the back near the doors.

11.5 Importer

As soon as the avocados arrive at the importer, an inspection has to be done. In this inspection, hardness, dry matter, appearance, internal quality and sizing are tested. The inspection is carried out according to predefined specifications. This allows every inspector to perform the inspection in the same way. From this inspection, the quality of the avocados is determined and a programme is drawn up for when and how the lot should be ripened. It is important to establish this so that the avocados can be packed as soon as they are in demand. Since it takes a few days for the avocados to ripen, it is important to also check the quality of the batch in between.

Before the avocados are packed in consumer packaging, quality control is once again done with the help of a machine. This machine has to check the avocados for internal and external defects. The machine then weighs the avocados after which the avocados can be packed. It is important to weigh the avocados accurately by weight. This weight is important to then pack the avocados in the appropriate packaging.

The importer takes care of ripening the avocados and packs the avocados in consumer packs. The importer must ensure that retail can always sell avocados to consumers. For this, the importer therefore prepares a sales forecast. This forecast shows when and in what quantities avocados should be imported. This programme is discussed with the exporter in Kenya. As a result, the exporter knows at what times of the year a peak in demand can be expected.

From retail, the importer has a delivery obligation of at least 99.7% delivery (Quality Manager, 2022). It means that the importer must be able to switch quickly between retail sales and avocado packing. This requires real-time insight into supermarket sales. Because this will give the importer better and faster insight into avocado sales, the importer can also switch faster.

11.6 European retail

European retail should consist of service-oriented supermarkets. The service-oriented supermarket serves the consumer who wants to buy the avocado. In the supply chain, the supermarkets must make a volume commitment. Through this volume commitment, the supply chain is certain of demand. This certainty allows the supply chain to engage in quality improvements.

11.7 Sub-conclusion

This chapter has described what the ideal supply chain should look like. To arrive at the ideal supply chain, the links in the supply chain must be willing to cooperate a lot. In addition, it is important that each link collects data to continue optimising the ideal supply chain. Important here is that the link members want to enter into a long-term relationship with each other.

12. Data streams

Avocados destined for the international market must meet higher standards than the local market. For example, quality must be better and more uniform, and avocados must be delivered at the right time. The information needed to meet the requirements arises at the end of the supply chain, at the retail point. This is where demand, retailers' packing preferences, quality requirements and promotions arise (Coronado, 2010).

To meet those requirements, measures are taken in the supply chain. The transport condition and operations involved are determined, the route is determined and the alignment of transport in the supply chain is determined. To show the most important requirements, a data flow diagram was drawn up showing the most important requirements and data flows in the supply chain. Consideration was also given to how the supply chain could be classified on the basis of information provision to internal and external stakeholders. The most important thing to emerge is the link between quality and volumes in forecasts. This can ensure less "Food Loss and Waste" in the supply chain and also a lesser degree of risk for each link.

12.1 Understanding databases

As highlighted above, the main info flows within the supply chain will be shared, based on quality, volume, product specification (also customer-related) and laws and regulations. Providing insight into forecasts and actual results adds value to internal stakeholders, reduces risks and ensures long-term relationships. The classification and information flows based on laws and regulations, product and customer specifications and certification provides a basis in the relationship and provision of information because every stakeholder speaks the same "language". The data files are the nodes in which data is shared within the supply chain. Below in Table 2 is the job description and for which stakeholder(s) they are intended. Figure 20 shows how data files are shared in the supply chain. Appendix XII, Data flow diagram also depicts it.

Table 2: Data file including job description

Data file	Job description	Destination stakeholder
Product specifications	This describes the product specifications, quality requirements and other aspects from the laws and regulations both from the EU and also from the Kenyan government. Putting these together provides a clear overview.	European retail and importer
Quality requirements	European retail adds its own quality and customer requirements in addition to specifications according to laws and regulations. The importer now has a clear overview for the final product.	European retail and importer (exporter also via importer)
Sales forecast	European retail issues forecast sales at package level to the importer who translates it into container volumes of gross product.	European retail and importer
Sales programme	The sales programme is the result of the translation at coli to container level. This forecasts, but also during the season, this information is immediately provided to the shipping company and transporters and exporters. This allows reservations to be made for the transport of containers. Also, together with the cooperative(s), the exporter can match the harvest planning accordingly.	Importer, exporter, transporter, shipping company

Transport specifications	Through the sales programme, the transporter and shipping company create a transport schedule with corresponding transport specifications. These transport specifications can be used to adjust the carriers' internal planning to that of the cooperatives, exporters and importers. Each transporter in the supply chain can thus view its share of information.	Cooperatives, Exporters, importers and transporters
Harvest planning	Harvest planning follows from observations made by the field supervisor. The field supervisor makes the harvest programme with the cooperative based on observed quality at individual growers.	Cooperative
Cultivation registration	Cultivation records are kept by the field supervisor and follow from the work done by the grower. Pruning and fertiliser application are examples. These activities affect the quality and volume of avocados per grower and reflect a good stage of the orchard. In addition, this is the basis for certification such as GlobalGAP.	Cooperative
Quality forecast	The quality forecast follows from the cultivation supervisor's observations at the grower's premises. Through the quality forecast, estimates can emerge with the quantity of harvested avocados of suitable quality for export. This can also show the degree of "Maturity or Maturity" of the fruit.	Cooperative
Harvest programme	From the harvesting programme, it will see which grower can be harvested at which time. This is shared with the exporter. In the harvest programme, volumes are forecast and linked to quality forecasts at grower level.	Cooperative and exporter, the importer indirectly through the exporter
Certification	The certification serves to meet the requirements imposed from the EU. The data file certification is the result of crop registration. The certification is shared in the supply chain through the exporter.	Cooperative, exporter and the Importer indirectly through the exporter

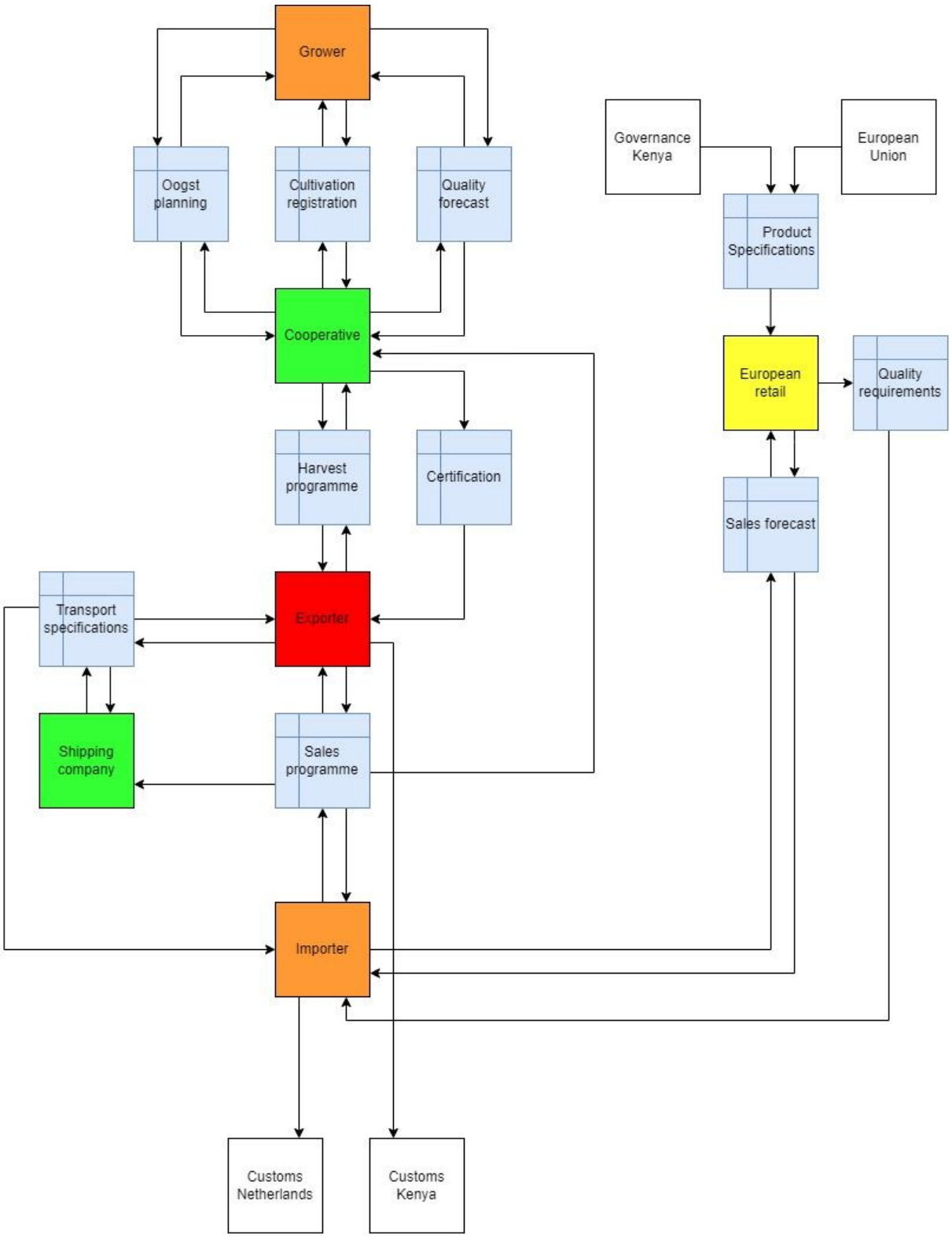

Figure 7: Classification for ICT platform

12.2 European retail

The main topics are: laws and regulations and product specifications from two different continents. These product specifications should be collected publicly in a database and form the basis for cooperation within the supply chain. This is also the basis for European retail to obtain avocados. European retail has its own requirements regarding avocado quality in addition to requirements from government agencies.
European retail has the latest consumer data and is best placed to use it to make a sales forecast. This is on a coli-level basis and not on a container-level basis. This forecast is passed on to the importer.

12.3 Sales programme

The importer who receives the gross product ripens and packages it for European retail. The importer has the ability to translate from coli level to container level. The importer also has insight into transit times because he is in touch with the shipping company. In addition, the importer has insight into the seasonal development of avocados in Kenya. This allows the importer to plan realistic avocado imports from Kenya at container level.

The sales programme is passed on to the exporter. The exporter engages with the cooperative on how to meet the sales programme. The cultivation advisor within the cooperative has knowledge and experience in the area and measure growers' sales based on:

- Varieties of trees.
- Pruning/flowering stages.
- Season progression.
- Geographical location (altitude above sea level).

With these data, the crop supervisor can create a harvest planning together with the cooperative. This harvest planning will include a forecast including the expected harvestable volumes that will be shared with the exporter. The harvest planning will meet European retail requirements by monitoring the dry matter content of avocados. Harvest planning can be adjusted during the season based on adjustments of external factors. Examples include temperature, rainfall and adjustments to product specifications. The crop supervisor and the cooperative translate the harvest planning into a harvest programme and this is fed back to the importer and exporter. As a result, the cooperative removes the risk and uncertainty from the exporter and importer by providing feedback to the importer and exporter. By having a certain safety margin in the volumes, there is insight into what becomes available at the cooperative in question. This gives the importer as well as the exporter time and space to generate volumes of avocados elsewhere when needed.

12.4 Cultivation and harvesting

It is important for the cooperative to collect data on growers' avocado trees. This information consists of the following points:

- Pruning moment.
- Fertiliser donation.
- Protective equipment gift.
- Age of trees.
- Season progression.
- Harvest moment (forecast and actual moment).
- Harvest volumes (forecast and actual moment).

With this, the cooperative also monitors certifications. The above aspects also affect the outcome of avocado quality and harvested volume. The above information is shared in harvest planning, crop registration and quality forecasts. The cooperative translates this into a harvest programme for the exporter and certifications. The exporter can use the harvest programme to populate the database with days, times and location when a car is needed to pick up the avocados from the grower and take them to the exporter's packing station. The relevant transporter can extract this requested information from the data file and gives a feedback via the data file to the exporter. This exporter communicates it back to the cooperative and it sends an automatic SMS message to the respective growers with the specifications of harvest date and transport.

With this planning, the cooperative can schedule harvesters in which places to harvest on which days. Meanwhile, the exporter can collect the volume and estimate whether there is enough volume for a full container. Once these exporter's schedules and forecasts are established, the importer can make forecasts. These forecasts are about when the product will arrive and which customers and product packages can be linked.

12.5 Influence of external stakeholders

Customs is needed to export avocados. Customs sets the requirements about the avocados and this is what the importer and exporter have to act upon. In addition, the people working for Customs are also very important for the avocado supply chain. These bodies take care of carrying out inspections and inspecting whether the right paperwork has been completed and whether it has been filled in properly.

Banks are important for financial transactions within the avocado supply chain. This is because the transactions all go through the banks. The grower is paid according to the quantity of avocados delivered and by quality. The quantity of avocados delivered with the corresponding quality is passed on to the exporter. The cooperative ensures that the grower is paid within two weeks. The cooperative has a 15% margin to pay the costs. This 15% is calculated from the total value of avocados delivered to the exporter. The financial transaction between the importer and the exporter takes place in two steps. First, an amount is paid once the Bill of Lading is received by the importer. The exporter takes care of preparing a Bill of lading. The Bill of lading is sent to the importer as soon as the ship with the container sails away from the port of Mombasa. The rest of the payment is due two weeks after the container arrives at the importer.

European retail must be committed to optimising the entire supply chain. After all, retail is the link that can sell the high-quality product to consumers. It is therefore vital that European retail puts avocados in locations where consumers pass by.

12.6 Sub-conclusion

Data flows in a supply chain are crucial to optimising the supply chain. Data flows allow the links in the supply chain to interact better. This makes processes more efficient. Data sharing creates a lot of communication between the different links in the supply chain.

13. Key Performance Indicators

The ultimate goal is to strive for optimal supply chain performance. To achieve this, each link in the supply chain will have to perform at an operational level. To help with this, KPIs have been drawn up. The KPIs measurably reflect how each of the links is performing to deliver the optimal quality avocados to consumers. This ensures that each of the links retains margin and minimises FLW (fit-professionals, 2022).

13.1 Grower and cooperative

Dry matter: >24% <30%.

The grower is the most important link in the supply chain when it comes to avocado quality. From the time of harvesting, avocados can be preserved as best as possible, but not improved. Dry matter content is the first KPI that matters. Once the dry matter content is above 21%, avocados have reached maturity (Trademap, 2022). After this, they can be harvested for the local market. To compete with other exporting countries such as Peru, it has been decided to set a minimum dry matter content of 24% for the export market. This ensures that the avocados are of better quality. (foodsafetyafrica, 2022)

The dry matter content of harvest-ripe avocados increases as the season progresses. This ensures that avocados ripen earlier after harvest. A dry matter content below 30% ensures that avocados can reach the European market without ripening too early (Appendix XI, specialfruit).

Time between harvesting and cooling: <5 hours on average.

Avocados start ripening only after they are harvested. To stop this process, avocados must be cooled to 5°C as soon as possible. If this is not done quickly enough, the transit time cannot be bridged before the avocados are ripe. Therefore, avocados should be chilled within 5 hours of harvesting. (Kalro, 2018). Table 3 shows the percentage of Ready-To-Eat (RTE) avocados in storage 8°C and 18°C weather (WUR, 2022).

Table 3: Influence of temperature on shelf life of avocados

Percentage of RTE avocados in batch	Shelf life at 8 °C (days)	Shelf life at 18 °C (days)
60%	15	9
70%	10	7
80%	10	5
85%	7	3

Average number of avocados per tree per year (from 4 years): >600 pieces on average

Field supervisors oversee the cultivation of avocados. To measurably map activities such as pruning and nutrient application, they chose to map the number of avocados harvested per year. At least 600 fruits grow annually on avocado trees after performing the appropriate work (exporters f. , 2022). Avocados do not start growing until 3 to 4 years after trees are planted. For new growers, this KPI is not yet applicable (Kalro, 2018).

13.2 Exporter

Lead time from harvest to port Mombasa: <5 days on average.
The lead time from harvesting to leaving the port in Mombasa should not exceed five days. To guard the freshness of avocados, avocados should be exported as soon as possible. This is enough time for harvesting, transportation, packaging consolidation and transportation to the port of Mombasa (Executive, 2022).

13.3 Port

Transit time Mombasa to Rotterdam: <30 days on average
To guarantee the shelf life of avocados to retail, it is important to keep the transit time as short as possible. A transit time of no more than 30 days ensures this (Maersk, 2022).

13.4 Importer

Delivery rate to retail: >99.7%
If the importer can meet a delivery reliability of 99.7%, then the importer can meet retail expectations. This makes the matching of avocado supply and demand important.

Avocado turnover rate: <12 days
If the importer ensures that the avocados are in operation for a maximum of 12 days, then the amount of FLW is minimal. There is then enough to activate the avocados for the ripening process, the ripening process itself and time to sell to the supermarket.

13.5 European retail

Avocado turnover rate: <6 days
Avocados can have a limited shelf life after ripening. Therefore, it is important that avocados are transported to retail immediately after ripening. According to the Hass avocado board quality report, avocados can have a maximum shelf life of between 4 and 7 days (Hass Avocado Board, 2020). For this reason, it is important to sell the avocados within six days.

13.6 Sub-conclusion

To make the supply chain's performance measurable, KPIs have been drawn up. There are KPIs for each link in the supply chain. By first optimising the processes per link, the supply chain can then perform better. The KPIs at the end of the supply chain are mainly about transport speed, while the KPIs at the beginning of the supply chain are about quality assurance.

14. Implementation perspective

This chapter presents the steps through which the ideal supply chain can be achieved. The first step is cooperation, the second step is professionalisation and the third and final step is continuous improvement. The steps are shown in this order because the ideal supply chain has to be shaped step by step. This can be seen in Figure 21.

14.1 Collaboration

To arrive at the ideal supply chain, the links in the supply chain must meet the requirement set out in the section "Ideal supply chain description". After all, if links are not willing to cooperate intensively for the long term and share data with each other, the supply chain will never become an ideal supply chain. During cooperation, processes between links are first improved and the goals of each link are discussed. The first step to be taken is to understand what links in the supply chain know. Next, each link in the supply chain must know what the added value of each link is.

After this, the cooperative must divide its growers into regions according to the 'Ideal Supply chain Description' chapter and ensure that a GlobalGAP certificate is obtained for each region. The certificate helps growers to grow products responsibly. Growing products responsibly involves crop registration. It is important that the cooperative supports the grower in keeping cultivation records.

To ensure the ideal supply chain can last, there is a requirement for the importer and European retail. The quality of avocados fluctuates annually due to external factors such as the weather. As a result, fewer avocados may be sourced from a country such as Kenya if the quality there is lower. Avocados are then sourced from countries with a similar harvesting season such as Peru. This creates surpluses and ultimately food loss in Kenya. It is therefore important that European retailers and importers stick to the target sales volume, even if the avocados are of poorer quality due to external factors.

14.2 Professionalisation

Once there are good collaborations between links, the supply chain can be professionalised. During this professionalisation, the links working together start helping each other to improve processes.
In the ideal supply chain, this means that the cooperative helps the grower to professionalise. The cooperative ensures that the grower keeps his own cultivation records and that the grower grows avocados responsibly. The cooperative will deal with predicting the quality and quantity of avocados yet to be harvested. The cooperative will also ensure that growers are individually certified.

Collaborations between the cooperative and the exporter are intensified. Communication between these links will increase through contact, when avocados are harvested. Between the cooperative, the exporter and the importer, there is going to be information exchange on sales forecast, expected quality and expected supply.

The cooperative has good cooperation with the exporter. The cooperative knows in what quantities avocados will be harvested. The cooperative shares this information with the exporter. This information allows the exporter to contact the importer about expectations of quality and quantity.

14.3 Continuous improvement

To permanently improve the chain, the data collected must be shared. The sharing of these data must be clear from the grower to the importer. Data must also be clear from the importer to the cooperative. Through this data, the ideal chain becomes measurable. KPIs can be linked to the data. Through the KPIs, the chain can steer itself more towards continuous improvement.

All links in the supply chain must continue to actively participate in the supply chain. This means that communication must take place with all links. This communication should include information about satisfaction with the different links and what future expectations are. Future expectations are about the challenges the supply chain faces, but also about market opportunities.

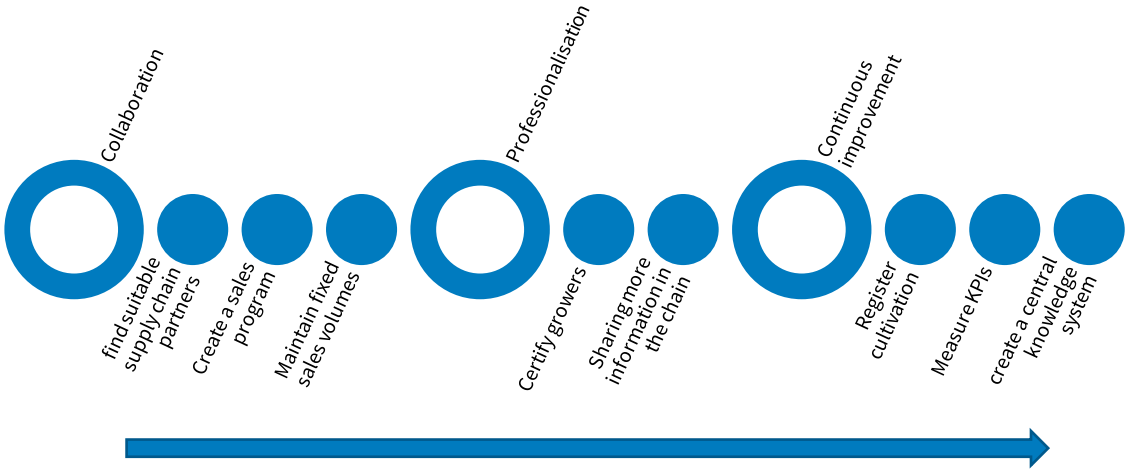

Figure 8: Chronological sequence to arrive at the ideal supply chain

Conclusion

The purpose of this study is to answer the previously posed main question. This main question is formulated as follows "How can the supply chain of avocados from harvesting in Kenya to the ripening process in the European Union be set up with as little FLW as possible?"

To answer the main question, the market conditions in which the current supply chain operates were first looked into. From this, it can be concluded that demand for avocados in the EU has been rising for several years in a row. Peru has been committed to developing avocado plantations for years. As a result, Peru is now a large and professional player in the global avocado market.

To reduce FLW in the avocado supply chain, the supply chain where FLW takes place and what kind of FLW takes place was researched. FLW mainly takes place at the beginning of the supply chain. In Kenya, 70% of avocados are produced by smallholders. The smallholders lack knowledge and financial resources to grow avocados properly. This is how FLW is created. In addition, there is a lack of communication in the supply chain. The expectations of European retail are not known by all the links in the supply chain, which means that not all expectations are met.

The main starting point for the entire supply chain is to ensure that avocados meet the expectations of European consumers. To meet this, each requirement KPIs. For the grower, a dry matter content between 24% and 30% is important. This ensures the avocado is of the right quality to compete with other countries without being ripe during transport. After harvesting, it is important to chill the avocados within 5 hours so that the avocados do not ripen too quickly during transport. From the time of cooling, it is important that the avocado reaches the supermarket as soon as possible. Therefore, the total transit time until ripening should not exceed 35 days. From the moment of ripening, avocados are prepared for retail.

To grow avocados for export to Europe, it is important to know that the Hass avocado is mainly used for this purpose. This is because European retailers want to offer these avocados to their customers. At the grower, it is important that the Hass avocados are grown in the best possible way. As soon as the avocado is harvested, the cold supply chain must be set in motion as soon as possible. The faster the avocado is chilled, the longer it will stay good. The avocados are sorted at the exporter's premises. During processing processes, it is important to handle the avocado calmly. The avocado may suffer damage during the processing process, causing the quality to deteriorate. At the importer, the quality of the avocados received is measured after which the avocados are stored and ripened when necessary.

Reducing FLW in the supply chain is certainly possible. However, this requires all links in the supply chain to cooperate. To achieve this, supply chain partners must work together towards an optimal supply chain result. Links in a supply chain can only work together if they share the same goals. To work together, these links exchange all kinds of information. This information is shared not only with the next link in the supply chain but with several links in the supply chain.

Finally, the answer to the main question: the most ideal supply chain consists of the following links: grower, cooperative, exporter, importer and European retailer. This means that in the ideal supply chain, the same links as in the current supply chain would be used. However, it is very important here that growers become more professional. In addition, the cooperative must work intensively with the growers. The cooperative must ensure that data is collected on the amount of expected harvest, on product quality and cultivation records. Through these data, the next links can prepare for what is to come in terms of product. In addition, machines that can assess avocados for internal and external quality should be used during sorting. Through this machine, the quality exported can be increased and a more homogeneous product can be exported.

Recommendations

Based on the conclusion, the ideal supply chain is shaped by cooperation. Cooperation involves sharing data. The study referred to a flowchart describing the data needed at each link in the supply chain. Cooperation requires openness and willingness in the supply chain from all parties involved. If all links in the supply chain are willing to share data, the flowchart can be used to create a knowledge system. It is therefore wise to prepare a study on the feasibility of a knowledge system for the avocado supply chain from Kenya to Europe after the completion of this study.

To determine the quality of avocados at the beginning of the supply chain, more research is needed into an objective and non-destructive way to measure avocado quality. By taking measurements in this way, it is possible to better manage the harvesting moment.

Because not all financial flows were sorted out, this could not fully result an opinion or classification. As a result, this issue is necessary to be determined in follow-up studies. The appendices can be used for this purpose. To determine the financial flows in follow-up studies, plans can be made on how to help growers financially with the application of fertilisers and pesticides and maintaining certifications.

When the supply chain is improved and dry matter content is seen more as a core value within the supply chain, it is important that the government is better involved in supply chain cooperation. This is important so that exports in the supply chain are no longer hampered by Kenya's laws and regulations. The supply chain can demonstrate in the future that the dry matter contents are in order for export. The government can also be a sparring partner in the form of transport. After all, transit days have not yet been curtailed and there is increasing controversy in transporting by air.

Discussion

The aim of the study was to find a way to reduce FLW as much as possible in the avocado supply chain with the optimal alignment of supply chain partners. However, shaping the supply chain involved a number of constraints. During the study, in-depth interviews were conducted with the most important players in the supply chain in the Netherlands and in Kenya. It was not possible to visit Kenya during the study. For this reason, it was more difficult to speak to each link in the supply chain. Partly because of this, the study lacks financial data.

Transport costs were gathered from sources published annually by Kenyan agencies. Partly because the use of infrastructure has changed significantly in recent years due to stricter environmental requirements for the flower sector and renewal of infrastructure change the use. As a result, data regarding choice of the best transport can change rapidly. For this reason, it is important to keep an eye on the following reports annually. The "Annual Transport Observatory report of the Northern Corridor Transit and Transport Coordination Authority" and "Annual review of maritime transport". Both reports are published annually, the sources can be found in the bibliography.

During the study, it was particularly important to investigate postharvest losses. Any opportunities for improving cultivation and breeding were not investigated for this reason. It is therefore possible that there are still gains to be made there.

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Appendix I Sea freight costs

Table 3.2 Contract freight rates, inter-regional, 2018–2021, $ per 40-foot container (FEU) (July rates)

From	To	2018	2019	2020	2021	2020/19	2020/18	2021/2020	2021/2018
Africa	Africa	1 812	1 849	1 924	2 013	4.1%	6.2%	4.6%	11.09%
	Asia	748	750	775	664	3.2%	3.6%	-14.3%	-11.19%
	Europe	1 431	1 643	1 747	1 487	6.3%	22.1%	-14.8%	3.96%
	South America	2 010	1 860	1 979	1616	6.4%	-1.5%	-18.3%	-19.59%
Asia	Africa	1 800	1 927	2 112	2 733	9.6%	17.4%	29.4%	51.89%
	Asia	737	747	821	1 194	9.8%	11.4%	45.5%	62.00%
	Europe	1 782	1 847	1 916	3 285	3.8%	7.5%	71.4%	84.39%
	North America	2 426	2 603	2 711	3 820	4.1%	11.8%	40.9%	57.48%
	Oceania	1 770	1 790	1 850	2 800	3.4%	4.6%	51.3%	58.24%
	South America	2 290	2 075	2 230	3 589	7.5%	-2.6%	61.0%	56.74%
Europe	Africa	1 595	1 650	1 858	1 727	12.6%	16.5%	-7.1%	8.23%
	Asia	967	870	1 004	1 225	15.4%	3.8%	22.0%	26.61%
	Europe	804	881	976	1 077	10.7%	21.3%	10.3%	33.84%
	North America	1 518	1 742	2 256	2 304	29.5%	48.7%	2.1%	80%
	Oceania	1 996	1 933	2 077	2 319	7.4%	4.1%	11.7%	16.18%
	South America	1 019	1 302	1 376	1 465	5.6%	35.0%	6.5%	43.79%
North America	Africa	2 890	3 112	2 981	2 639	-4.2%	3.2%	-11.5%	-8.66%
	Asia	1 009	1 111	1 269	1 385	14.2%	25.8%	9.17%	37.29%
	Europe	858	1 109	1 323	1 053	19.3%	54.2%	-20.4%	22.75%
	North America	1 534	1 429	1 584	1 362	10.8%	3.2%	-14.0%	-11.22%
	Oceania	2 538	2 634	2 996	2 475	13.8%	18.1%	-17.4%	-2.47%
	South America	1 254	1 318	1 486	1 064	12.7%	18.5%	-28.4%	-15.15%
South America	Africa	1 778	1 951	2 000	2 187	2.5%	12.5%	9.3%	22.99%
	Asia	1 623	1 963	1 802	1 841	-8.2%	11.0%	2.2%	13.42%
	Europe	1 313	1 977	1 961	1 767	-0.8%	49.3%	-9.9%	34.52%
	North America	1 521	1 882	1 745	1 969	-7.3%	14.7%	12.9%	29.50%
	South America	1 349	1 699	1 539	1 243	-9.4%	14.1%	-19.2%	-7.84%

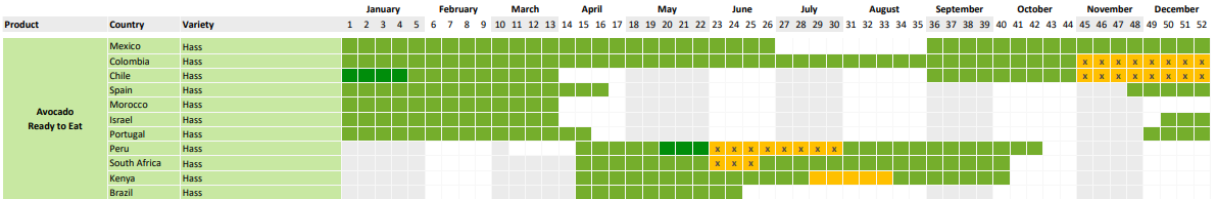
Source: UNCTAD, based on data provided by Transporeon/TIM Consult Market Intelligence data, www.transporeon.com.

Note: The data set provides regional averages for forty-foot container dry cargo freight, as negotiated for routes where rates were available for at least five shippers and at least 500 TEU per year on port-pair basis.
Rates are "gate-in gate-out", i.e., including terminal handling charges and all charges and surcharges of ocean transport. Not included are pre- and on-carriage as much as classical administrative services of forwarders (customs clearance, booking and invoice control fees, etc.).
The average is unweighted, based on representative main ports.

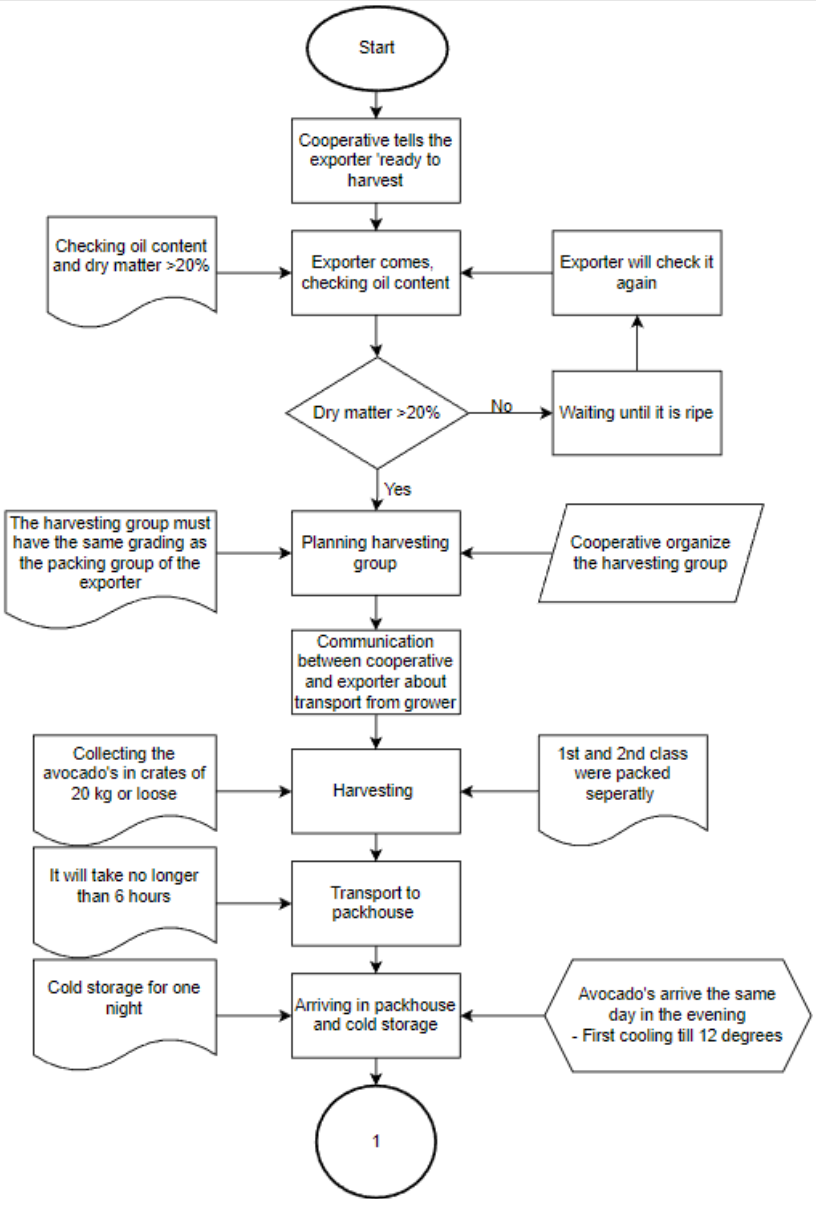
Appendix II Sea freight routes

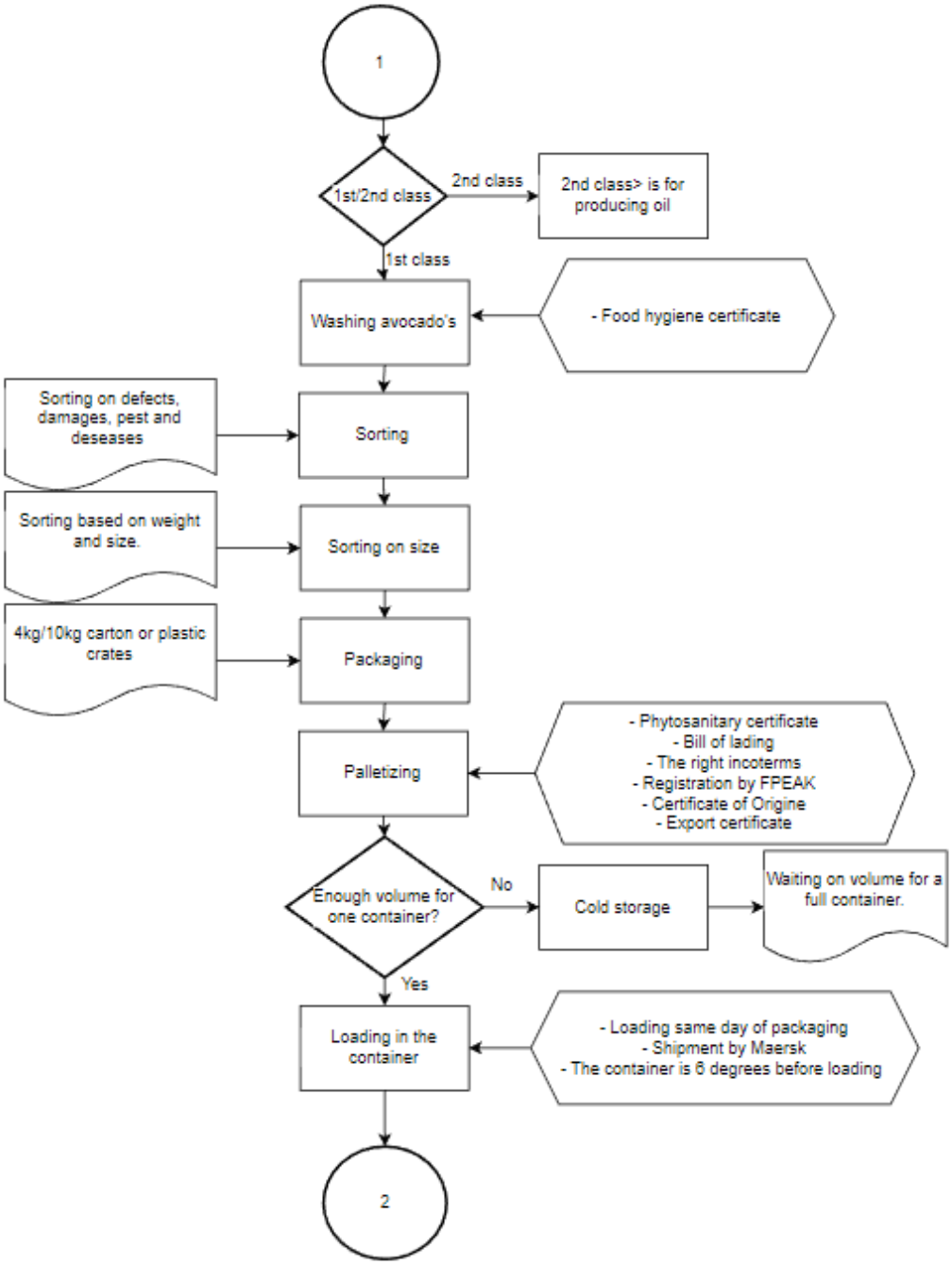
Best option sea freight routes						
shipping line	**destination**	**trans shipping**	**travel days**			**remarks**
			ideal schedule	**realistic schedule**	**disaster schedule**	
CMA	Rotterdam	Jeddah	28	35	35	• Weekly sailing to Rotterdam • Frequently miss connections or have blank sailings • Mombasa port is the cause of some delays
	Marseille	Jeddah	25	32	32	
	Genoa	Jeddah	22	29	29	
Maersk	Rotterdam	Salalah & Algeciras	24*	31	38	• Weekly sailing • Dedicated berth in Mombasa for Maersk
	London Gateway	Salalah	28-29*	35	42	
MSC	Rotterdam	King Abdullah Port	24-28	31-35	42	• Not weekly sailing
Messina	Genoa	Direct	21	21	31	A sailing every 10 days

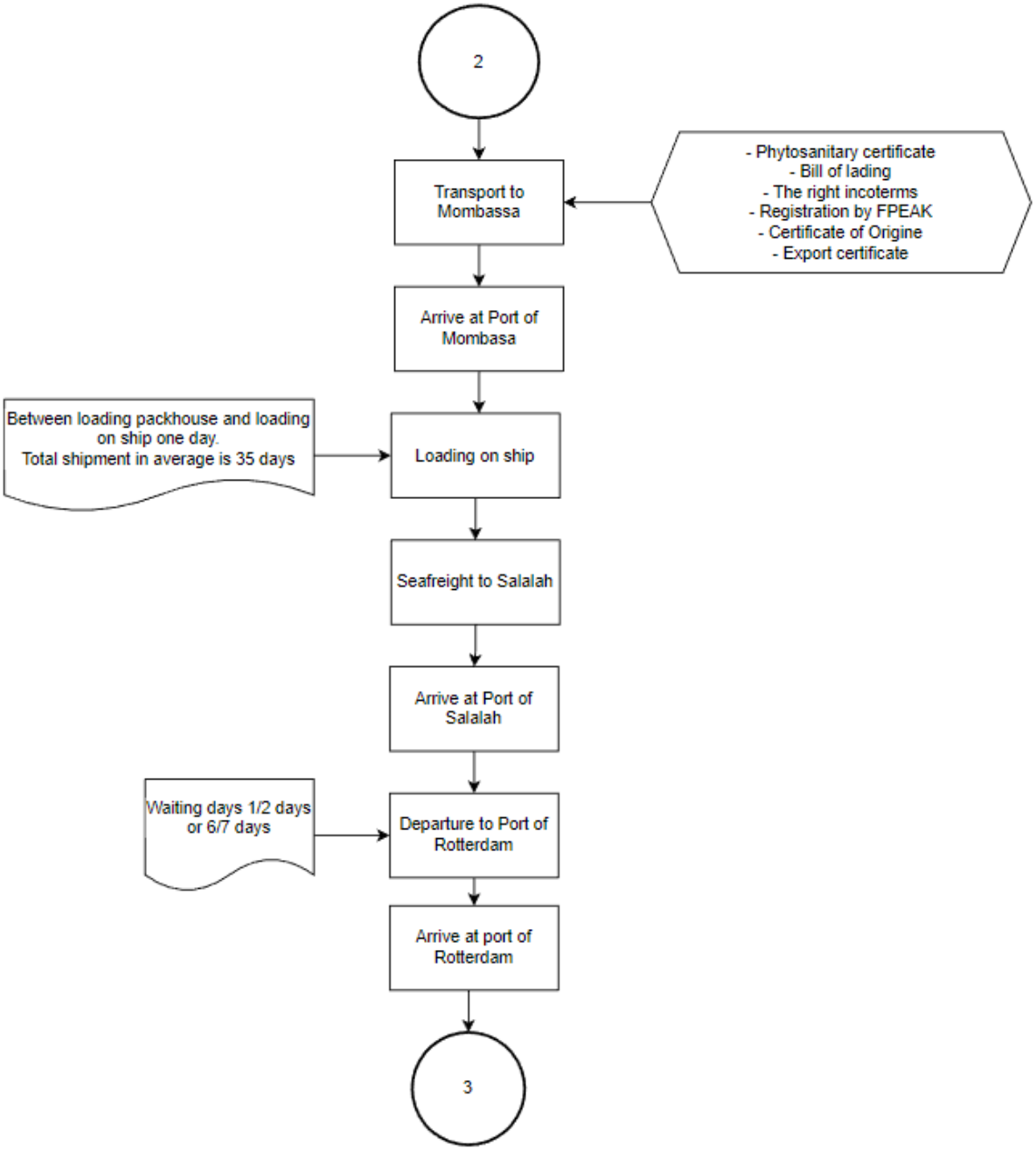
Appendix III Avocado seasons

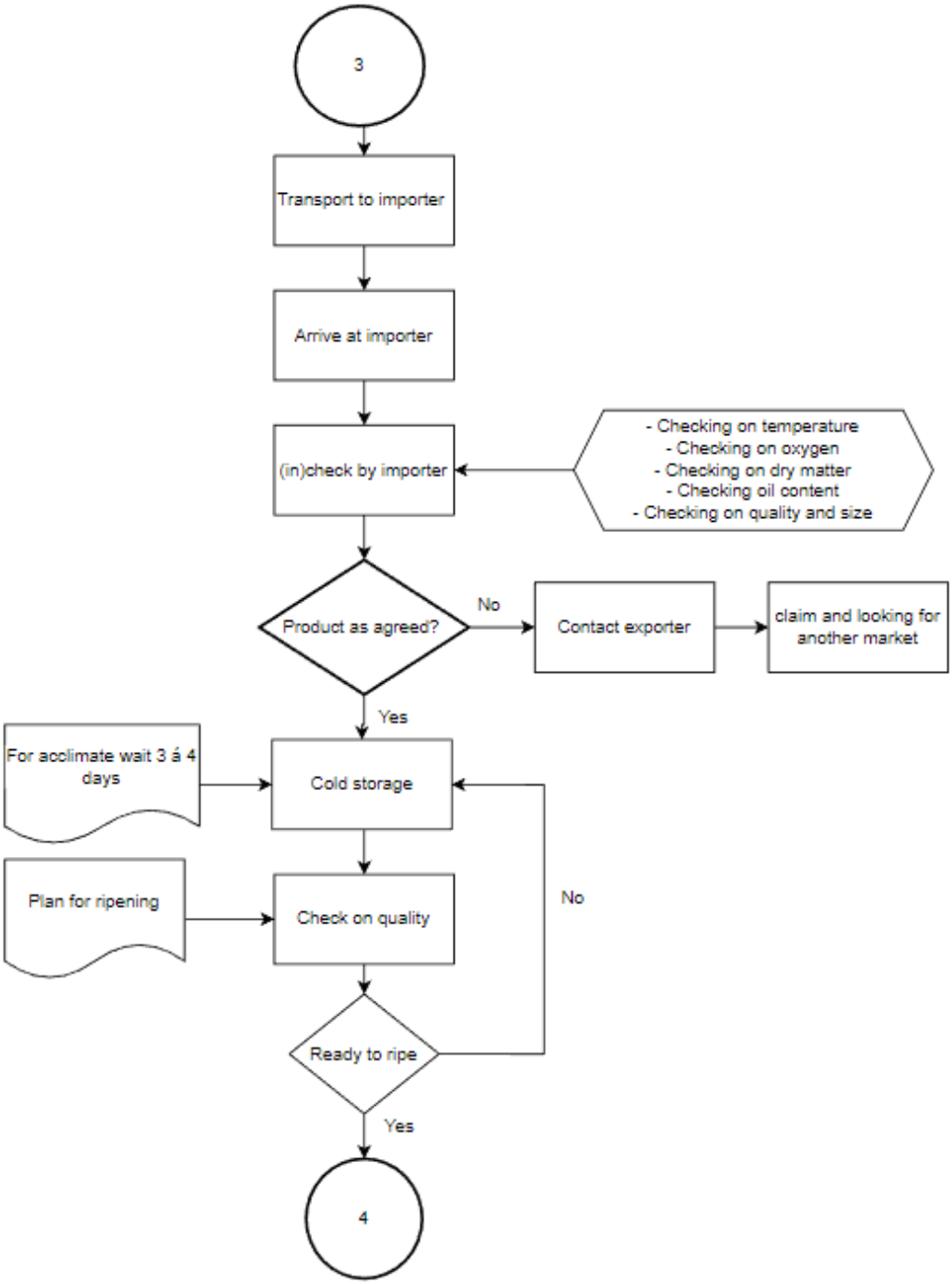


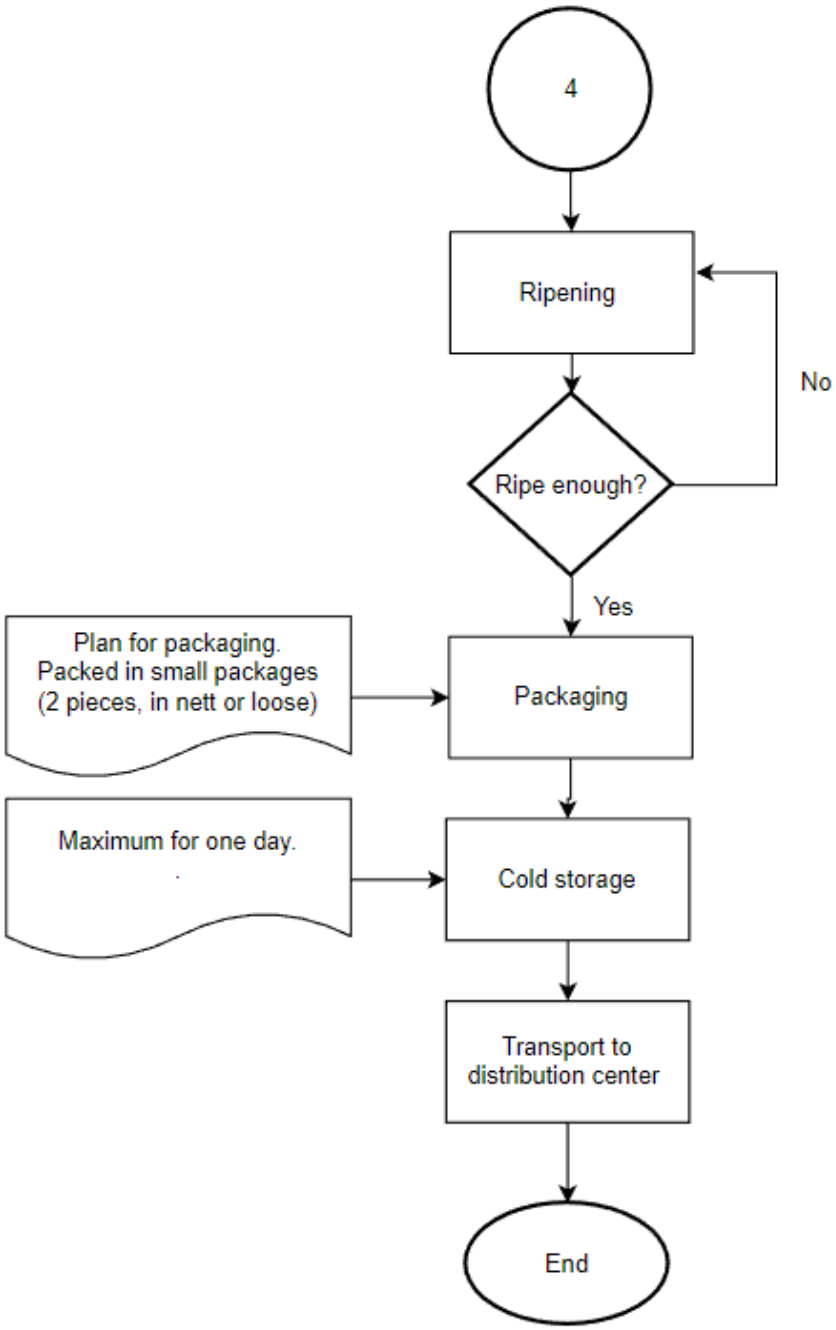
Appendix IV Process flowchart



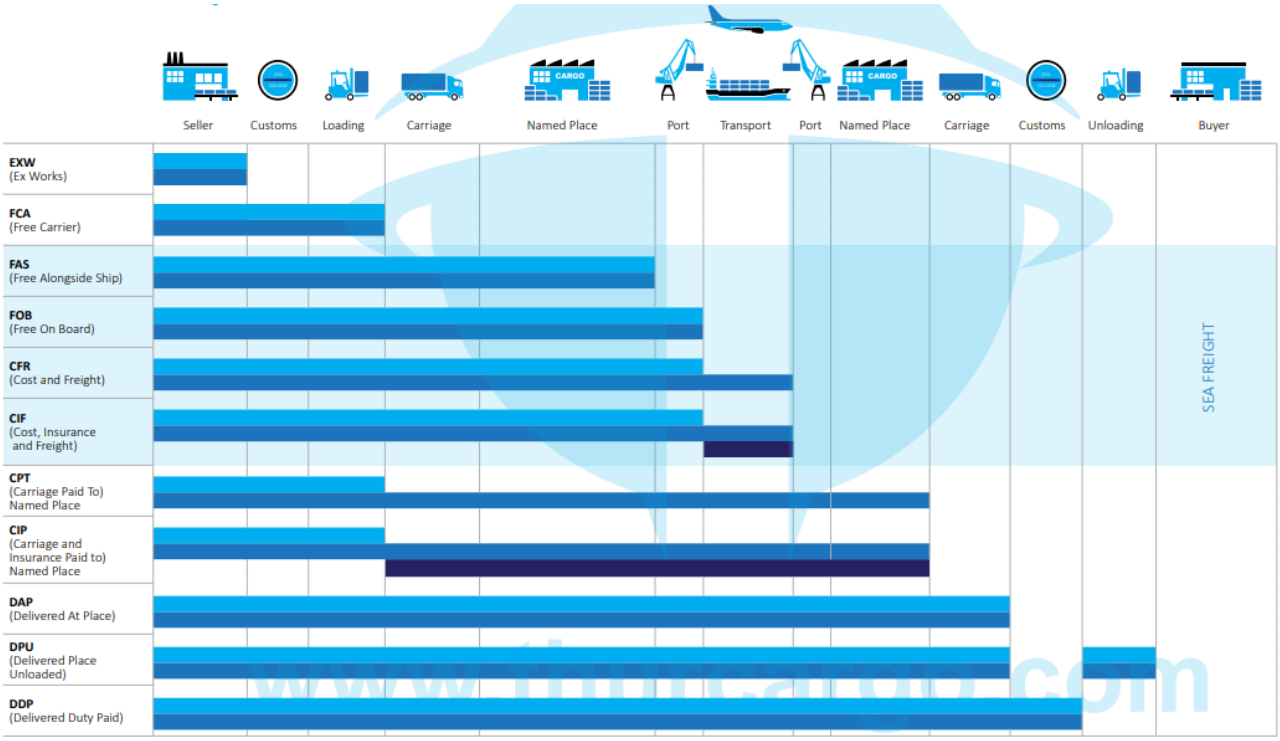

1
1st/2nd class
2nd class
2nd class> is for producing oil
1st class
Washing avocado's
- Food hygiene certificate
Sorting on defects, damages, pest and deseases
Sorting
Sorting based on weight and size.
Sorting on size
4kg/10kg carton or plastic crates
Packaging
Palletizing
- Phytosanitary certificate
- Bill of lading
- The right incoterms
- Registration by FPEAK
- Certificate of Origine
- Export certificate
Enough volume for one container?
No
Cold storage
Waiting on volume for a full container.
Yes
Loading in the container
- Loading same day of packaging
- Shipment by Maersk
- The container is 6 degrees before loading
2


2
Transport to Mombassa
- Phytosanitary certificate
- Bill of lading
- The right incoterms
- Registration by FPEAK
- Certificate of Origine
- Export certificate
Arrive at Port of Mombasa
Between loading packhouse and loading on ship one day.
Total shipment in average is 35 days
Loading on ship
Seafreight to Salalah
Arrive at Port of Salalah
Waiting days 1/2 days or 6/7 days
Departure to Port of Rotterdam
Arrive at port of Rotterdam
3


3
Transport to importer
Arrive at importer
(in)check by importer
- Checking on temperature
- Checking on oxygen
- Checking on dry matter
- Checking oil content
- Checking on quality and size
Product as agreed?
No
Contact exporter
claim and looking for another market
Yes
For acclimate wait 3 á 4 days
Cold storage
Plan for ripening
Check on quality
No
Ready to ripe
Yes
4


4
Ripening
No
Ripe enough?
Yes
Plan for packaging.
Packed in small packages
(2 pieces, in nett or loose)
Packaging
Maximum for one day.
Cold storage
Transport to
distribution center
End

Appendix V Incoterms



- EXW; this stands for ex works. This means that the buyer bears all risks for transport and customs. The buyer must collect the products from the seller.
- FCA; FCA stands for Free carrier. Again, the buyer has to collect the products from the seller. The seller only has to load the truck. If the container cannot be loaded at the seller's premises, it can be agreed that the seller will take the products to an agreed place where the container can be loaded.
- FAS; Free Alongside Ship. Here, the seller must deliver the goods at the agreed port of shipment. Here, the goods must be delivered on the quay next to the departing ship. These Incoterms already clearly show that the selling party is responsible for the products for longer.
- FOB; Free on board. This Incoterms is mainly used for bulk transport and therefore not for container transport. The selling party is responsible for the product until it is loaded. From the moment the products are loaded on the ship, the buyer bears responsibility over the products.
- CFR: This stands for cost and freight. Here, the seller is responsible for the products until loading. However, the seller has to pay the cost of unloading the ship at its destination.
- CIF; Cost insurance and freight. Here it is important to agree in which port the products are to be unloaded. The selling party bears the costs for unloading at the destination port. The buyer bears the costs for customs clearance and import taxes. The difference between CIF and CFR is that the seller is obliged to take out goods transport insurance for the buyer. The risk of sea transport does lie with the buyer.
- CPT; carriage paid to. The risk of loss and damage passes from seller to buyer as soon as the seller hands over the products to the carrier. Transport costs shall be borne by the seller.
- CIP: Carriage and insurance paid to. The risk of loss or damage passes from seller to buyer as soon as the goods are handed over to the carrier. The seller arranges and pays for the carriage to the agreed destination. The seller also pays the cost of unloading the goods. It is an obligation for the seller to take out goods transport insurance.

- DAP; Delivered at place. Under these Incoterms, the selling party is responsible for the products for a long time. The seller arranges and pays for the transport to the agreed destination. The risk of loss and damage is also for the selling party up to the agreed destination. The buying party bears the cost of unloading the goods.
- DPU; Delivered at place unloaded. Under these Incoterms, the selling party is also responsible for unloading the goods. The place of unloading the goods is agreed in advance with the buyer. With this, DPU is the same as DAP. With DPU, the seller alone must also take care of unloading the goods.
- DDP; delivered duty paid. This is the Incoterms where the seller has to arrange, pay for and is responsible for everything until the products arrive at the buyer's doorstep. The buyer is responsible for unloading the freight.

Appendix VI Interview report with "Nandi Avocado Farmers Co-operative Society Ltd."

This company is one of the cooperatives in Kenya located in Nandi province, which brings avocados into Europe through an exporter.

Chairman "Nandi Avocado Farmers Co-operative Society Ltd."
Telephone contacts 2022
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

Purpose of interview:
Mapping the supply chain, cooperation/relationships with exporters as well as growers.

Interview summary:

About the cooperative
The cooperative consists of about 780-900 growers. These growers own avocado trees varying in number, between five and several hundred trees. Besides avocados, the growers also grow other products like, beans, maize, tea, coffee etc. the growers who have around 40-50 trees or more grow only avocados. The cooperative has grown strongly and indirectly exported about 90 tonnes of avocados last season. In the coming season, the cooperative wants to move towards 200 tonnes of avocados. this is about 20 containers on an annual basis.

So far, about 60% is for export, these include the Hass and Fuerte varieties. About 40% is destined for the local market. All growers are located in Nandi province. There are different altitudes in the province. About 80% of the growers are in the "High Hills" and 20% in the "Low Lands". In the Low Lands, are more the varieties Fuerte and are about 1 to 2 months earlier with harvests per bloom of avocados. This is because the avocado blooms several times, as there are also two times to harvest.

An example of a flowering and harvest can be, in September/October flowering is about from May harvesting. A fruit hangs the tree for about half a year from flowering to harvest. There are no clear season of harvest, by numbers there are, but if it is up to the trees themselves they will continuously have a portion of their tree in bloom with a continuous smaller harvest. The harvest itself can be adjusted if the avocados remain on the tree. In fact, flowering only resumes when the avocados that are good are harvested. More avocados are harvested roughly in two periods, between February and April and between July and October.

Prices in season
The local market price of avocados can range from 30-50 shillings per kg. When volume is high, the price can drop back to 20 shillings per kg. The 2^{e} grade is also offered in this market or processed into animal feed and oil. The export market, on the other hand, pays about between 60-80 shillings over the year, this is for the 1^{e} class quality. They are packed in 4 kg cartons or 10 kg plastic crates. In the Off-season, between December and March when there are fewer avocados available, the government imposes requirements on dry matter content. This is because Kenyans are price-oriented. In these months, prices are high and therefore Kenyans want to export. Prices for the export market then are around 120 Shillings. Also at the beginning of the "on-season", from March approximately when more avocados become available, the price is high. Exporters then try to tie up growers as well as cooperatives for the rest of the season. It seems that then the exporters start taking a position in the market. Through the cooperative, growers are often paid within a week.

Threats to avocados
Kenya experiences heavy rains. These occur between March and June and can bring a lot of damage to fruits as well as trees. The flowering trees can also suffer a lot of damage as a result, and all result in a lower harvest. This is mainly because this rainy season also sees a lot of hail. In the month of September, there is a short rainy season. Besides the weather, insects like thrips also have free rein. These can be controlled biologically nowadays by planting lavender, for instance.

Organic?
For many growers, fertilisers and protectants are too expensive, so all different "organic" solutions are being devised (as above) to still get good quality. These avocados are marketed under "organic", in the market. This segment has a bad image due to no homogeneous quality.

Contract with exporter
A contract is signed with the exporter on an annual rather than seasonal basis. The focus of the contract is only on the volumes that the cooperative has available and wants to place them with the exporters who have most customers and can earn the most in good and bad times. The cooperative usually bets on at least two exporters.

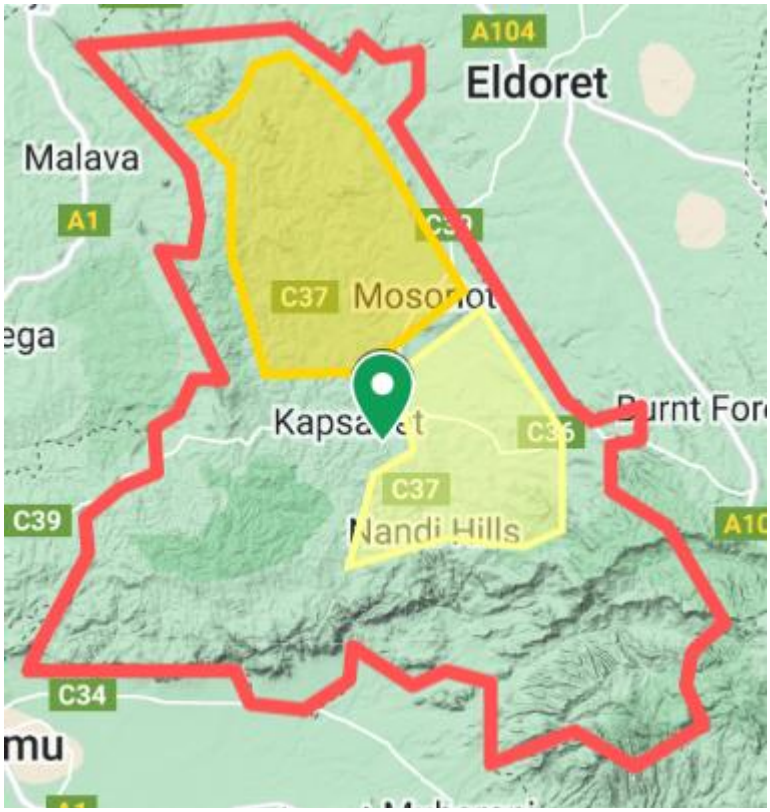
Nandi County, growers and knowledge
Growers often have little knowledge of the market, some cannot read and write and only grow smaller volumes. A cooperative is a godsend for them. In addition, there is little knowledge of tree maintenance and almost nothing is registered. At the cooperative, the pressure for certification is increasing and because of this, it has started training growers. It started in the east of Nandi, because there were tea plantations here; the growers there were already more familiar with European standards.

In the future, the cooperative also wants to use field officers who will guide growers and keep crop records. This idea emerged mainly from certification. It is also often still unknown where the growers are located. What is known is that the grower living furthest from the exporter's packing station is about a six-hour drive away.

Harvesting
The exporter takes many activities in the supply chain off their hands, only the cooperative itself does the harvesting. They do this with "trained, experienced" people, often from local villages who go to the farmers to harvest. This costs about 2 to 3 shillings per kg. In addition, the transport that the exporter arranges from the grower to the packing station also costs about 2 shillings. This means that 5 shillings has to be kept aside for these costs. The cooperative has a percentage gain per kg of avocados. from this percentage, they pay the employees and the above activities, for example. The Food Loss and Waste mainly occurs at harvest (40%), because this is where all avocados are pre-sorted. the 1^{e} class, 2^{e} class and others go to the exporter in separate crates. These no longer see the local market because this is too large a volume at a time to sell directly on the local market.

Avocado tree
The avocado trees are grafted with a local variety. after about a year, this is done. Nowadays, many are already grafted with the Hass and Fuerte varieties. This is good for the economy and development. The "nursery" takes about two years total. Then after year 3 to 4, the avocado trees start fruiting and with sufficient fertilisers and protection, the tree is mature after about 7 years and harvest volumes of about 200 kg per tree or more are achieved. Everything depends very much on the fertiliser and protective agent supply. Bees are often used for pollination and, as a result, growers often still have a close income from honey. The trees can pollinate each other through insects. The trees can live for about 30 years. After about 20 years, production goes down.

Growers of Nandi Avocado Farmers' Co-operative Society Ltd:



Most growers are located in the eastern part of Nandi County. These growers are more advanced in terms of certification. This is because these growers also have many tea plantations. To the north are the largest growers of the Nandi Avocado Farmers Co-operative Society Ltd.

Appendix VII interview Elgon

The Mount Elgon company mainly specialises in roses in Kenya, among other things. In addition, the company now also has a farm for avocados. The company's cold supply chain and high degree of sociality are strengths of the company. For example, the company is able to chill roses within 20 minutes of harvest and avocados within two hours.

Owner Mount Elgon
Visit to Elgon's booth at IFTF2022 on 9 November 2023
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

Purpose of interview:
Map the supply chain, what place does the exporter occupy, what is the contact like, intercept the bottlenecks both in communication and in the activities performed by the exporter.

Interview summary:

About the exporter
Mount Elgon Orchards (Elgon Avocados) is located in a high rainfall area and has one of the best soil types in the world, resulting in premium quality and consistent fruit production.

Avocados were grown on the farm until the 1980s, and in 2016 we decided to return to avocado cultivation. Since then, Hass avocados with drip irrigation have been planted and a small acreage of Fuerte avocados. Plans are to continue this expansion to 200 to 500 hectares over the next five years. For this, the company has about 1,500 people working and 120 hectares of avocado trees so far. Cold stores have been strategically built in the plantation so that avocados are cooled as quickly as possible. Packaging is done at a central location.

Processing and image
Elgon has an Aweta machine in grading with dry matter meter, machine is in Kenya, after which residual streams are processed on site. Poor-quality product in the Netherlands is processed into guacamole and oil. Elgon mainly serves the classification towards full-service, wholesalers.

The Elgon company found that organic avocados are undervalued on the European market. Farmers who do not use protection agents or fertilisers have a much lower quality and buyers therefore assign a much lower value to them. Organic is not directly the aim, but a more sustainable way. This is partly due to the strict European regulations that make it difficult for organic farmers. European regulations impose stringent requirements. Including no insects. While for tomato sauce (example) there may be an allowed percentage of insects. But for avocados and flowers, it is zero.

Appendix VIII Interview Farm Produce International

Owner Farm Produce International
"Experiential import and export of avocados, among others"
Avocado supply chain Kenya
Date: 13/10/2022
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

Target
Supply chain mapping of avocado between Kenya and the Netherlands/Europe. When possible also some data on volumes etc to get more of a picture of what we are talking about.

The avocado supply chain

Roadmap links:
According to Chris, it is important to first map the supply chain during the investigation. This would then involve mapping the amount of FLW per step in the supply chain. After this, the amount of risk per link in the supply chain should be investigated. Which link carries risk with transport and packaging? Make your own overview of the transport and shelf life of avocados from tree to consumer.
Everyone has value addition in the end, cultivation is the most important here. The logistics supply chain is also important to 4-5 ships leave in Peru and spend 4 weeks on the road. In Kenya, it goes by container in the ship. We can make a comparison with Peru. In the supply chain, product cost and cultivation are the highest cost items.
Another thing to investigate are post-harvest processes. So applying a coating to the crops. Natures pride works with Apeel for the coating. The further from the source this is done, the better the shelf life.
Specialfruit can help us map the supply chain. Kenya is less good at tracing trade. The old pallets should be packed first and this is not always done.

Peru
Harvested on Monday
Packed on Tuesday
Wednesday Thursday loaded and shipped
Out of port within a week (2 sailings per week)
3 to 4 weeks en route to NL.
500/600 containers per week from Peru

Kenya
Monday harvest
Tuesday Nairobi
Wednesday Thursday packed
Thursday Collect fruit and fill container.
Friday Saturday Transport Mombasa
Transport collection + departure from port is 1.5 weeks.

Import

Most importers in the Netherlands work with a weekly price. For example, $10 per box. Whether the importer buys ripened avocados depends on the importer. At the largest in Europe, 90% of sales go out the door ripened. Westfalia is a big importer that does hard exports (unripened). The outlet for this is Eastern Europe. The mature market yields more.

Trends are now reaching 54% of the market in Sweden. Each buyer buys 4.7kg of avocados. Germany is at 39% with 3.9kg. Penetration and consumption is ramping up, this is promising.

The importer then wants a 10% margin on clearance charges, for example. Here, the grower picks up the transport costs up to the gate in Rotterdam. This applies Peru. AAA growers does this in Kenya itself.

Exports and competition

Chris' data can be used to analyse where avocados are imported from. Farmers in Peru have an area of up to 2,000 HA. This creates differences in export sales.

Peru is one of the largest producers, this is because avocados grow along the coast from northern Peru to the south. Large irrigation projects have been funded from the government to grow avocado farms from the Andes. Large-scale cultivation ensures consistent quality. The small farmers ensure lack of homogeneous quality.

Avocados are a tricky product because it needs to be ripened. If the fruit is not grown correctly. The container must have an equal dry mass to ripen properly.

Market Kenya

In Kenya, there is a lack of professionalisation. The small market is not suitable for Europe because the scale is too small to make a homogeneous product. Coffee, mango cultivation and sugar snaps, however, can be grown on a small scale.

In Kenya, a farmer gets e.g. 20 cents per kilo, because of the number of links, the farmer in Kenya has little power and hence little margin.

There are different sizes of avocados. So, for example, 20'ers or 10'ers that fit into 4 kg boxes. Kenya exports more small sizes 26-32, this fruit is worth less. 16-22 is worth the most. If a tree does not get the right nutrition, avocados will not grow to 16-22.

Production for domestic consumption can be found online, this will be around 14%.

Maturation

Ethylene provides maturation

Ripening depends on the season. Depending on the dry mass, it is harvested. Between 19-20% is desirable. 19% creates harder fruit so it needs longer heating 5-6 days. At 26-27%, 2-3 days is needed. Then the fruit has hung in the tree longer. Dry matter is tested by dry matter sampling. There is also an avocado tester with which dry matter is measured. It can also be measured by cutting a slice, weighing it and then putting it in the oven. Felix avocado dry matter sampling is a measuring instrument. This costs 5,000 euros.

EU requirements

There are UNESCO European standards for avocado product specifications. These can be found online

Processing

If there are defects in the product, the avocado will be processed. Outlets are:
Guacamole - Spain, slightly higher quality.
Oil - least value happening in Kenya.
Dumping - If temperature rises in a container causing fruit to rot, the product may not meet specifications, for example.
In Peru, it is immediately cooled back down. This does not happen in Kenya

In conclusion

Chris thinks there is potential for a Kenyan avocado. Kenyan smallholders are more for the middle east. They need to add value and meet EU requirements. To meet the requirements, scaling up will have to take place. Kenyan avocados already have a typical 'tasty' flavour due to the soil it grows on. There is still room for more differentiation. Once Peru gets loose June July Kenya cannot compete. Kenya wants to deliver fruit as soon and early as possible so they don't have to compete with Peru at that time. The dry mass of avocados increases as it hangs on the tree longer. Spain too short of water for avocado to grow
Questions for Special fruit could include the following.
How long is the stock, how long is the warehouse at special fruit, how do they work what is important how does the process work, longer in stock faster from you etc.?

Appendix IX Interview - supply chain organisation

Board member Fresh2You
"Ex-ripener- Experience expert in importing and exporting bananas and ripening avocados"
Banana supply chain design compared to avocado supply chain
Date: 13/10/2022
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

Started with his father, then to De Groot and since 2013 for himself where bananas were ripened. Sells 1 million kilograms of bananas a week.

Target
Analyse the banana supply chain and compare it with the avocado supply chain. Where can the avocado supply chain learn from banana imports?

1. What are the successive links in the banana supply chain from harvest?

Grower/exporter, transport, importer/ripener, retail

2. How does the process of ripening bananas work?

Bananas need 7 days in the ripening cell to ripen. These 7 days are fairly standard.
You add ethylene to the banana this converts sugars and this ripens the banana itself and then you start chilling
A box imported contains three weeks of harvest. Yet these bananas are equally ripe after the ripening process.

3. Which KPIs (Key Performance Indicator) are important in the banana supply chain (colour of bananas, when to harvest, how long to ripen, etc.)?

The banana has six colour scales. They are therefore sorted on these.

4. How is transport in the supply chain? Everything by container, by ship?

Transporting bananas can be done in two ways. Bananas can be shipped by container or conventionally by ship. With conventional, the bananas are put in the hold of ship. The risk here is that if there is a bad batch among the good ones, there is a chance that the quality of the good ones will also deteriorate. The advantage of shipping by container is that when the quality is bad only the container that is bad.

5. Do you have many different breeds of bananas or is origin more important, how does this work?

In bananas, there is 1 variety. This is the variety Cavendish. Here, however, there is now a problem with a fungus. This fungus is now being sprayed a lot, but this has been a danger to the banana plantation. Because there is 1 variety and a new disease arises, a lot of spraying has to be done against that too. This makes it better to look at more different varieties.

6. Which supply chain partner bears the most risk in banana imports?

The exporter bears most of the risk. This is the owner of the plantation so there is risk in terms of cultivation. The exporter also has to take care of sorting the bananas, which again requires enough people. The exporter is also responsible for the freight to Rotterdam.

7. Which supply chain partner do you think makes the most margin in the supply chain?

The ripener makes the most margin. This is because the ripener is the supply chain director. Even if more bananas are needed, more are imported, if there are enough, they simply buy according to the programme.
Most added value in the banana supply chain is the ripener. Sits at the end of the supply chain, has contact with retail and has to arrange purchasing. Actually the supply chain director. This market is more of a supply market.

8. What requirements does an importer of bananas place on its supply chain and buyers?

In the banana trade, there is talk of three classes. These are premium bananas and 1e and 2e class bananas.

9. What issues play a role in the banana supply chain? What is the supply chain strong in? How is traceability?

Banana traceability is not exactly good. Bananas can be traced back to the grower, day of packing and whether it was packed in the morning or in the afternoon. Tracing should go further so that it is known from which plot the banana comes and at what time it was packed.

Important points to include in the study.
Interests importer are:

- Price and quality matter to the importer.
- The environment and how it gets here does not matter much to the importer.

All customers are spoken to every day. Sometimes they are like friends.
Using an Aweta machine, it is possible to see the avocado for ripeness.
When ripening avocados, a lot of waste occurs during ripening. Because of this, special fruit has agreed with the supplier that the net kilos after ripening are paid out to the supplier. The high wastage is because the ripening process is different for each avocado.
To ripen avocados properly, the oil content is looked at. Ripening avocados is done by increasing the temperature and using fresh air.
In case of errors, the logger is read into the container. It then looks at who is responsible. This is done with the help of a CV.
Can the ripening process be arranged differently? This is tricky as the avocado has very many different qualities.
Hardness comes from temperature and colour comes from the amount of air.
In France and Spain, you can still supply triggered avocados just fine. In a few years, it will only move to ready-to-eat there.
EDEKA Germany ripens its own avocados
Ripening with be started earlier, but you only get orders from buyers a day or a few days in advance. You have to anticipate it yourself, have to start ripening earlier a little push strategy. Self-watch ripening, watch the weather there are other fruits coming on the market.
There is 1 country of origin. Dominican Republic, Colombia, Ecuador, Costa Rica
At the plantation by cable car to a central spot in the plantation, the bananas are placed in a bath and then cleaned. From the bath, the bananas come onto a tray on which all the cones are sprayed so that the bleeding stops. Then it goes to the packer and is packed and then it goes into the container. Each bunch contains 3 colours and these all come in their own bath. The advantage per container is that if it goes wrong that only that container has bad quality.

You could go more towards partnerships. So that you could work towards a more demand-driven market.
Bananas were 1% of retail sales last year and 2% this year.
Another time is coming when people will spend less.
IRI scanning data. To get figures in twice a day.
Relationship baker and AH is actually as it should be.

Citrus from green to colour also needs to ripen for 7 days and especially from very cold to very hot, you need to keep the difference as big as possible

Appendix X Interview Smallholder expert

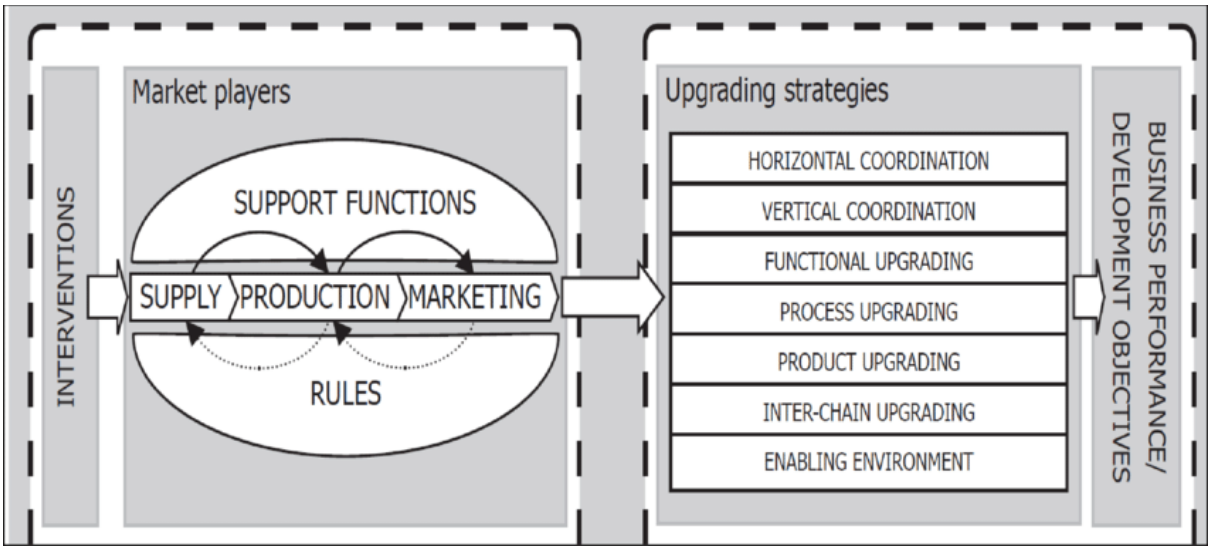
Lecturer HAS University of Applied Sciences, Smallholder expert
Date: 15/09/2022
Date: 06/12/2022
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

1. **In what way can small growers be worked with?**
   Last time it was indicated that the wants need but also indicate the capacity of farmers. Farmers must have something to gain from the smallholder system. After this, investors and companies can also get something out of it.
   It is important to know how a cooperative works. It is important to see in that way how they actually work. That way, a system can be applied.
2. **How can smallholder systems be implemented?**
   There is a reciprocal relationship between importer and producer. The question is how to get large and small farmers to work together to get both larger and small farmers to work together. Investment will be needed to set up some kind of demo farm to show how production can be set up. The willingness to invest is important because the small farmers themselves do not have the resources to finance this. After this, a contract farming model can emerge with which small farmers can work together on a permanent basis. Nucleus estate model can work for this.

   Market demand is not going to drive this project. A relationship between cooperative and large companies is needed to reach small-scale products that way.
   Small-scale farmers are quite locally oriented.
   The farmers' position means they have little bargaining power and little margin left. If a firmer relationship develops, margin and quality can improve.

3. **How can growers be tied to cooperatives?**
   By binding them through collaboration.
   We need to have a view of the farmer and the cooperative. After this, we can look at how much the farmer produces and where the production is marketed. After this, we need to see what the relationship is between producer and cooperative and how it can be strengthened. An example is sharing data such as weather forecasts, with this the producer can deliver the quality delivered and the trust of the producer can be gained. To reach certain information, a university in Kenya can be contacted.

value supply chain upgrading

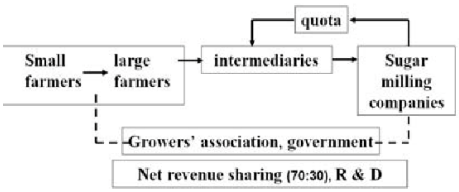


https://www.marketlinks.org/good-practice-center/value-supply chain-wiki/types-upgrading

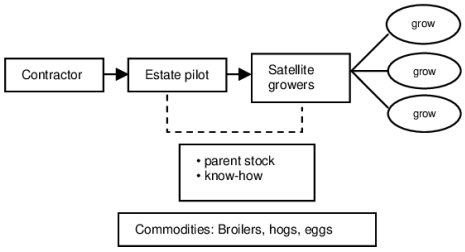
nucleus estate model

Example of contract farming in Thailand

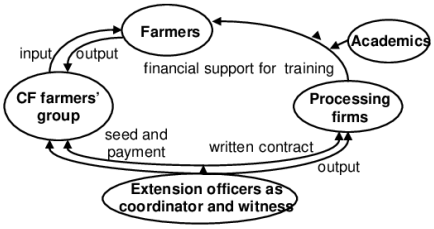
(a) Centralized model: sugar cane



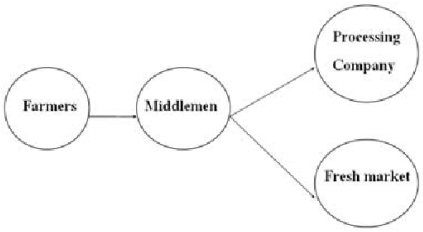
(b) Nucleus estate model: commodities require high technology



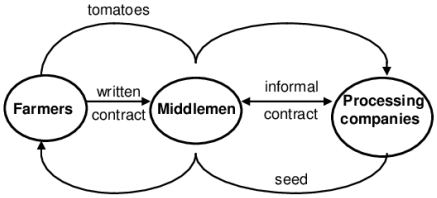
(c) Intermediary and multipartite model



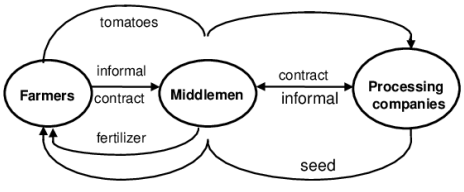
(d) Formal model



(e) Partly Informal model



(f) Informal model



Appendix XI: interview Special Fruit

Quality manager, Senior Purchaser
Date: 08/12/2022
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

Processes:
On arrival at Specialfruit, the avocados are inspected. The avocados are then stocked in the cold store for at least 3 to 4 days. The avocados need these 3 to 4 days to recover after coming out of the container with Controlled atmosphere. In the new soft ripe cells, it is no longer necessary to let the avocados recover first. After unloading, the avocados can be placed directly into soft ripe cells.
When the avocados are in stock, inspections are also carried out. The inspections are done on the basis of specifications drawn up by Specialfruit. Using these specifications, each inspector carries out the inspections in the same way. On the basis of these inspections, the ripening method used for the batch of avocados is determined. A batch of avocados generally consists of 20 pallets on entry. This is the number of pallets that fit into a 40-foot container.

After ripening, the batch of avocados is inspected again. During this inspection, the ripening status of each pallet is determined. Pallets that still have to ripen further go back into a small ripening cell and the avocados that have ripened well enough are packed.

A batch of avocados does not ripen completely evenly. Using the new soft ripe method, it is possible to ripen the batch of avocados more evenly. Behind this method are several measurement sensors that determine what the batch of avocados needs. When the avocados have finished ripening and the market is slightly disappointing, these soft ripe cells can cool the avocados and use controlled atmosphere to stop the respiration again.
The avocados arrive shipped in plastic crates with a capacity of 10kg. A special machine is used to unload these crates. This machine empties the crates automatically. Then a machine looks at the avocados for visual defects. These are black spots, Stem and rot, skin damage, hardness and mould. The good avocados are then packed according to customer requirements. This can be in 4kg cardboard boxes, by twos in flow pack packaging or in a 1kg net.

Specialfruit does not use a coating to keep the avocado longer. This is a conscious choice by Specialfruit. This is because the coating prevents the fruit from breathing. As a result, the very inside of the fruit can rot/deteriorate faster.

Food losses are difficult to determine per lot. This is because the avocados are not ripened evenly during ripening. This separates the unripe avocados from the ripe avocados. This means that the batch becomes even smaller. This makes it difficult to determine how many losses there are from a batch in the end.

Supply chain
There is close contact with suppliers. Information discussed between them includes the quality delivered, but also the supply of produce and picking dates. This is because there are currently strikes that will affect the supply of avocados in 3-4 weeks' time. Imports must now be made from other countries.

For Specialfruit, it is important to know who the grower is, what altitude the orchard is at, what the age of the orchard is, where the grower is located. These are all aspects on which an estimate of the fruit can be made. It is also important to know what pesticides have been sprayed on the avocados.

Specialfruit focuses mainly on long-term relationships. This gives suppliers a reliable buyer. However, the relationship has to work both ways. The market price of avocados can sometimes be higher than Specialfruit pays, but sometimes the market price is lower than Specialfruit pays. At a higher market price, Specialfruit expects the supplier to just keep supplying. At a lower price, Specialfruit also buys products from the grower anyway. This in turn is more favourable for the grower.

It is important that avocado suppliers are GlobalGAP certified. This is a minimum requirement before the products are imported. For avocado traceability, we prefer to work with large exporters/growers. Not because Specialfruit necessarily wants that, but more because it facilitates many processes. For risk diversification, though, it is important to work with different suppliers.

It is important for Kenya to look at market data. This is because Kenya needs to enter the market when there is demand for avocados. This is because now avocados are not bought because the image of Kenyan fruit is less. Whereas when it is avocado season in Kenya, good and tasty avocados can just come from there. To avoid further damaging the Kenyan image, it is also good that the government has intervened to not export avocados for a certain period.

For Kenya to successfully export avocados, it is important for the many different small growers to unite. This will make it possible to jointly appoint a cultivation supervisor. By uniting, a joint packing station can also be looked into. In this way, the avocados can be better delivered according to customers' wishes.

Other information
It is very important to support the grower in Kenya. After all, the basis of a good avocado starts with the grower. When it delivers good avocados, the supply chain must maintain quality. But when poor quality avocado starts from the grower, the too supply chain can only sell poor quality.
Spain and France which generally demand thicker sizes of avocados. The sizes demanded in the Benelux are smaller. For Specialfruit this is always calibre 18. This means 18 fruits in a 4kg pack.
For avocados to ripen well, it is important to receive as homogeneous a product as possible. The more homogeneous the product the less complicated ripening will be.

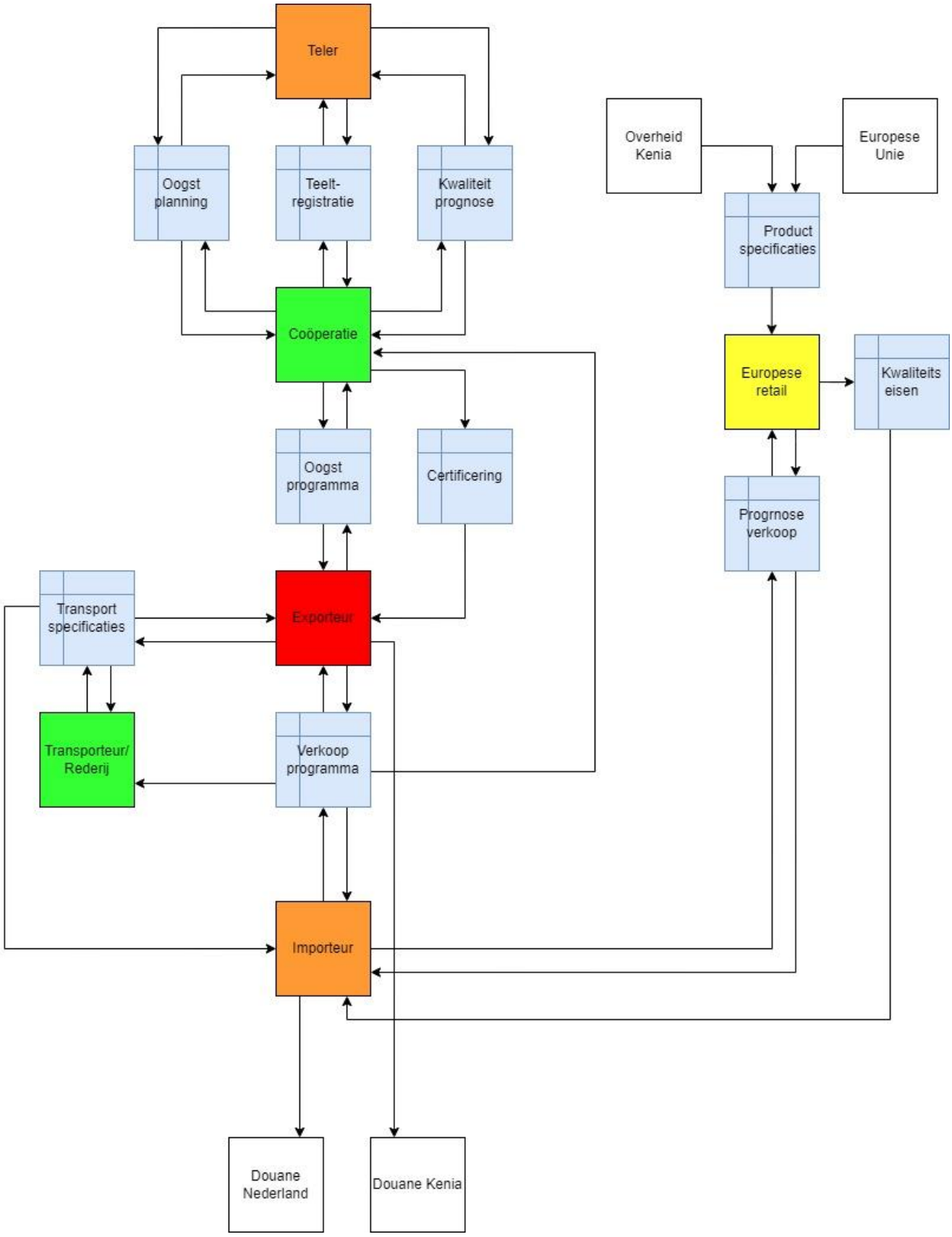
Plums from South Africa are raised in terms of temperature in the container after a certain time. Then the temperature is lowered again. As a result, the plums are triggered. The advantage of this is that the plums continue to ripen. The disadvantage is that on your farm you have visibility of the ripening process in the container this is not possible.
The potential of the Asian market is very big. After all, a huge number of people live there. Regulations in these countries are stricter than in Europe. If batches are rejected, Europeans will still do their best to sell part of the batch. In Asia, rejection is really rejection. The market in Asia is very volatile. Prices can be very high, but can then also drop very quickly.

Peru is a very aggressive player in the market. They want to keep extending their season. They enter the market earlier and also stay in the market longer. As a result, they are crowding out Chile more and more.

The agreed Incoterms are generally DDP or DPU. DDP means that the selling party arranges and is responsible for everything until the produce is unloaded at its destination. For Specialfruit, DPU means that the selling party is responsible for the products until the container is unloaded at the port of generally Rotterdam. With DPU, Specialfruit is responsible for transport from the port to Specialfruit.
Keep in mind that when the avocados are picked, they are only shipped after 7 days.

In Kenya, green skins and darkskins. The Hass avocado falls under the darkskins avocados. The darkskins are generally more expensive avocados. The green skins avocados should not be underestimated. In fact, a good green skin avocado is also very tasty. The Hass avocado from Kenya is available from May to September. For Kenya, it is interesting to focus on the months of August, September and October.

Appendix XII Data flow chart



Appendix XIII Interview report with "KEITT Exporters Kenya"

This exporter purchases avocados from Nandi Avocado Farmers Co-operative Society Ltd. The contact person of the cooperative to the exporter was interviewed from this.

Avocado production manager
Telephone interview on 5 January 2023
Interviewer/Notetaker Henk de Glopper

Purpose of interview:
Map the supply chain, what place does the exporter occupy, what is the contact like, intercept the bottlenecks both in communication and in the activities performed by the exporter.

Interview summary:

About the exporter
The exporter has its own pack houses mainly in Nandi province, in Kenya's capital Nairobi to be precise. The exporter collects the avocados in its own cold stores nearby or adjacent to the pack station. In the process, the exporter processes the avocados, by this it means washing, sorting, packing etc. In this case, the exporter is in contact with the shipping company Maersk for container transport. Besides packing and exporting 1^{e} class quality, KEITT Exporters makes oil from the degraded quality avocado. Animal feed is made from the residual product. this exporter keeps about 100 employees in the low season and 300-500 approximately in the high season.

Sales and certification
KEITT Exporters meet the required certificates such as Organic, BRC, GAP+ and "Rain Forest". The latter certificate means that the product comes from, for example, farmers who responsibly grow their product in conjunction with nature for a more sustainable future. These many certifications allow the exporter to supply the product to many customers, adding value to cooperatives. KEITT Exporters serves customers in Europe, Dubai and the United Arab Emirates. Which countries in Europe were exported to, the exporter could not tell. Export volume varies from a few containers to at least 4-5 containers per week. The larger volumes mean that all degraded grade (<2de class) is processed into oil, as these volumes cannot be sold quickly on the local market and the oil brings in more money.

This exporter is in contact with the cooperative. The cooperative has a contract with this exporter regarding volumes. The contract describes that all avocados are for this exporter. A price has not yet been agreed for this; it depends on the export market. The exporter discusses the approximate volumes needed with the importer prior to the high season and the importer does provide guidelines for a possible price during these months. In the low season, this is not necessary because then avocados are scarce and prices are high. The exporter could not quite tell whether it has a percentage per package or a percentage per kilo margin. Probably it is a percentage per kilo.

Seasonality and cultivation

The high season runs roughly from March to the end of October. This is when most avocados are harvested. The exporter takes avocados of the HASS and Fuerte varieties. In the low season from November to February, avocados are also exported but in much lower numbers. This is because then a much lower level of avocados are good and because of this, especially in these months, checks are made for oil density and dry matter content. This happens about twice, the first time when the cooperative indicates which growers they think are ready for harvest. However, there is no regularity or set procedure/aspects in checking the avocado contents when to check. The exporter could not tell what volumes came in in a season or year on a weekly basis, this is also not tracked. There is also no knowledge what volume comes out on average per harvest.

Supply chain flow - Process flow - Time flow in the supply chain

The exporter carries out various activities from harvesting to container loading for export. For this purpose, it uses sorting machines and employees, among others. The sorting machines are imported, but from which country and brand the exporter could not tell. In addition, it was also difficult to formulate what the average monthly wage of a warehouse/production worker, for example, was. Successive activities are described below:

1. Contact with cooperative where harvest takes place, and exporter arranges transport from grower to cold store exporter.
2. For example, if harvesting takes place on Monday, the product will be in the cold store on Monday evening and will be cooled back to around 20°C overnight. This is done so that before processing, the worst heat is off and the product is cooled back in stages.
3. After cooling back overnight, the product is processed the next morning, (Tuesday morning) this goes through the following steps:
    a. Remove the wrong avocado when it is still between 1^{e} class.
    b. Remove avocados with damage, insect damage or handling
    c. Wash
    d. Sort by weight
    e. Packed in 4 kg cardboard boxes or 10 kg plastic crates and palletised.
4. The largest percentage is packed in 4 kg cardboard boxes. When enough volume is processed for a full container one day, it is loaded immediately. The container is cooled beforehand but the product is not yet fully cooled to 6°C. This happens inside the container. So a full container could be loaded on Tuesday late afternoon or evening, for example. If there is still not enough volume for a full container, the product is stored in a cold store and re-cooled there. It is not known how long the product will remain there.

The exporter does not know what the container length is and there is no record of how many containers are exported per week, for example. The capacity of processing in the warehouse is a maximum of one container per hour. This would be an estimate of about 15-20 tonnes of avocados. In the warehouse, there are several quality managers who randomly check products for oil density and dry matter after and before processing. However, there is no clear procedure in this regard.

Appendix XIV Interview report with "Greefa"

This company builds various machines for processing lines or provides complete processing lines for companies in the AGF, nationally as well as internationally.

Export Manager
Visit to Greefa on 26 October 2022
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

Purpose of interview:
Mapping the supply chain, what experiences does this company have with African countries, especially Kenya? It also discusses the innovations and new technologies at play in the sector today, in the future and what is being applied in Kenya.

Interview summary:

Greefa in Africa
Greefa develops machinery for all over the world and focuses specifically on the fruit sector. The company controls the entire development of processing lines itself. For customers abroad. Greefa sells the sorting machine, and the dealer in Africa does the cleaning, installation etc. This is a partnership where the dealer in Africa has a team specialised in this. Recent avocado processing lines have been sold to the countries Peru, Kenya, Ivory Coast, Uganda and Australia is in the pipeline.

Culture and travel in Kenya
Travelling around Kenya is difficult, even making contact is not obvious. The lesser degree of media and mobility makes it easy if you know someone there. For Western people, it is also safer to have someone drive you around Kenya. Making contacts in Kenya is mostly through other people in the country. Dealing and contact is difficult. There are a lot of requests for avocado processing lines, sometimes by larger local growers themselves. However, the price of the lines remains an issue. The processing lines are made to process at least five tonnes per hour and most growers fall far short of that.

Innovations and Markets Kenya and exports
Determination and power is in Europe. Europe prefers ready-to-eat. This is also becoming an increasing range in different packaging vs unripened avocados on the shelves. Most of the money is now made in Europe is estimated. After all, Europe also has the most risks and therefore a lot of waste, so there is also such a margin for Europe in the supply chain.

The culture in Kenya is mainly price-oriented. As a result, growers, exporters look at market prices, and when the price is high, the country sends the containers to Europe. Due to long transit times, the price can be low before the containers reach Europe. This prevents stakeholders in Kenya from making enough money. The increase in avocado growers is also increasing the local market in Kenya. This is driving down the price of the local market. In addition, quality is also an issue. Many growers in Kenya are considered "Organic", organic, this should sound quite positive in European terms. However, this comes at the expense of the homogeneity of the product and is valued lower in Europe than non-organic avocados because of this image.

Different aspects in cultivation are important for the final result. This could be cultivation analysis, fertiliser analysis, time of picking, protective equipment. This data should be collected to set up a structured supply chain with a homogeneous quality. After all, investments for this country are already very substantial if avocados are processed based on avocado weight. An example of such cooperation to gather data and knowledge is Zespri Kiwi. In some countries, processing lines are also better utilised by processing mangoes as well as avocados on the same lines.

Greefa is looking at using Infra-red to determine internal quality. However, this is difficult because the kernel is in the middle of the fruit. This makes it difficult to measure through the fruit. In addition, the meat content or composition also depends on the variety, origin area and altitude, so the machine would have to be adjusted each time for each variety. Sorting with light sources is also difficult because, as mentioned earlier, you cannot see through the fruit. As a result, opposite sources do not catch the light, for instance, or nothing or too little is reflected.

Payment method when ordering

A "Letter of Credit" is always used when ordering a machine to be exported abroad 30% of the amount for the line or machine is transferred by the customer to Greefa before construction is started. For the transport, the remaining 70% is transferred which comes into Greefa's account when the machine is delivered. This is done through the bank.

Ideal process flow

1. Avocado washing in water
2. Leaf removal through the line
3. Chemical treatment (wax low) on non-organic only
4. Avocado drying
5. Sorting by avocado size, better homogeneity
6. Sorting by colour, ensuring neat homogeneity per package.
7. Sort for control (to "give away" as little weight as possible) by weight
8. Checking for quality in terms of appearance.

The basis of this process flow is to strive for as homogeneous a batch of dry matter and oil density as possible. The basis remains when setting up a line, customer preference and available space.

Analyse quality more easily

Greefa is currently investigating whether the ripeness of the avocado can also be easily seen by X-Ray radiation. This will also allow us to see through the avocado. This will also allow us to see worms in fruit, for example.

Appendix XV Interview report with "Mt. Kenya Avocado Growers Cooperative"

This company is one of the cooperatives in Kenya located in Nandi County, which brings avocados into Europe through an exporter. This coming June 1, the cooperative will be celebrating its one-year anniversary.

Chairman
Telephone contact on 20 December 2022
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

Purpose of interview:
Mapping the supply chain, cooperation/relationships with exporters as well as growers.

Interview summary:

About the cooperative
The cooperative consists of about 50 growers, about half of whom own between 15 and 30 trees. Some growers have only five trees and others have more than 100, for example. Last season, the cooperative collected and marketed about four tonnes of avocados. Next season, the target is about 10 tonnes of avocados. With coffee and tea crops doing less economically in recent years, many growers are switching to avocados.

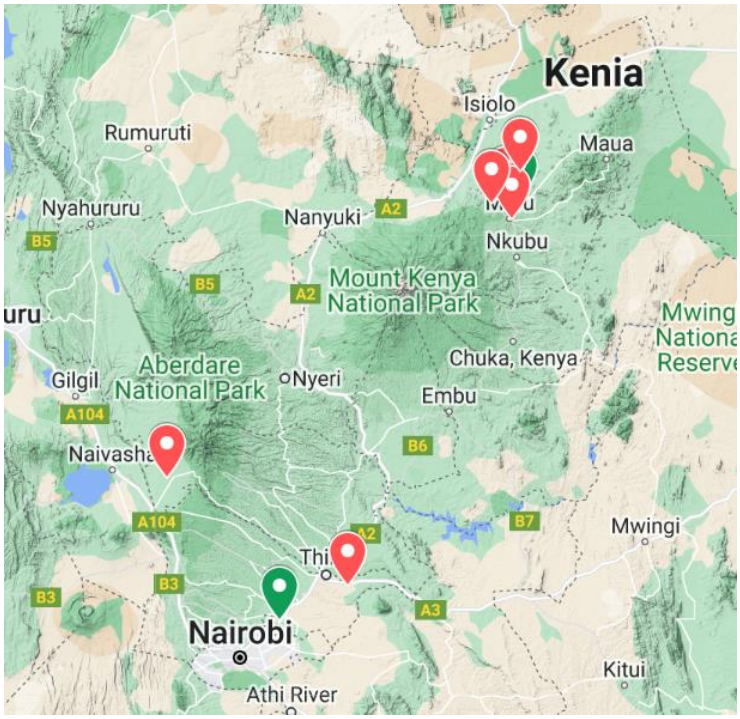
The growers
The growers of the avocado cooperative are growers who also grow other products or keep some livestock. The breakdown in varieties among the growers is about 70% HASS and 30% Fuerte. The growers are located between 1000 and 1800 metres above sea level. This gives differences in times of harvesting. The higher altitude orchards are ready for harvesting later than the lower altitude orchards. This is due to a temperature difference that can reach 9°C. The largest volume of avocados is grown organically, as fertilisers and protection agents are almost too expensive. The cooperative faces a loss of product in waste between harvesting and final packaging for export of the avocados.

Supply chain of custody
The growers collect the harvest at the cooperative itself. This is because with the smaller number of growers, it is not yet profitable enough to transport directly to the exporter with a small quantity. At the cooperative, it is stored for a maximum of three to four days on a tarpaulin in the shade; there is no cold storage available. When enough avocados are collected, they go to the nearest packing station, about 200 km, 5 to 6 hours' drive from the cooperative.

Last seasons, farmers had to pay for transport to the packing station themselves. This entailed more risk. Gathering the avocados, longer non-refrigerated storage and transport can cause lower quality and shelf life. The cooperative is now entering into contracts where the product is owned by the exporter after harvest. This eliminates the risk for growers and avoids additional costs.

In transport, the supply chain is encouraged by the government to start transporting avocados more in crates. However, this is a kind of announcement or advertisement, financially the supply chain is not supported by the government with this. In the supply chain, the cooperative also transports in crates with smaller trucks. this prevents more loss of quality. When the avocado is completely sorted, it is either stored in the warehouse or, if there is sufficient volume, loaded into a container for export. With these two steps, the cold supply chain only starts.

The growers of Mt. Kenya Avocado Growers Cooperative:



The dark green sites are those of the cooperatives and the red sites are those of the growers.

Appendix XVI Interview report with "Q-Point"

This company is an independent consultancy specialising in supply chain management, quality requirements and management, market and business development and food safety. The company has extensive experience in Kenya, among other countries.

Director/Owner Q Point B.V.
Visit on 24 November 2022
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

Purpose of interview:
Present the initial results of the analysed supply chain, describe situation and spar together towards different possibilities for a new supply chain design in the future that is secured.

Interview summary:
In this interview, the supply chain was presented how it had been analysed to date. Mr Jaspers indicated that more research was still needed on the different varieties and that, despite the scope of the research, the final product at European retail also needed to be looked at. In addition, Mr Jasperse recognised the lack of cultivati on guidance, knowledge and coordination and transparency in the supply chain. He also believed it was necessary to analyse the supply chain and establish "success indicators", the Key Performance Indicators we know. He also recognised that the first improvement factors lay with the growers, indicating that guidance from the cooperative is essential. The field supervisors we appointed per area on the basis of altitude fitted in well. Mr Jaspers saw improvements:

- Simple crop registration
    - Pruning moments
    - Harvest moments
    - Volumes in harvest

Persona grower
From the conversation, it emerged that a grower does need to be focused on avocados. for example, it is interesting to find out what the minimum annual income of a grower should be and express this in the number of trees. From this, a minimum number of trees can emerge that the grower must meet to be a member of the cooperative. After all, a lot of time goes into grower supervision, training and certification. In addition, a field officer or supervisor must be able to talk well with the population/ growers. Some growers probably cannot read or write.

Certification and added value
With regard to certification, Mr Jaspers also indicated that this could be done, for example, per area of growers, meaning a certification per area which would then be supervised and guided by the relevant field supervisor. In addition, thought should also be given to how a grower can be encouraged, is the price for export enough? Should a degree of quality tier be added? The exporter and importer benefits from continuous volumes. Therefore, such forecasts are also important.

Appendix XVII Interview report with "Maersk"

Møller-Mærsk Group often named as Maersk, is a Danish international company. It is a conglomerate of companies operating mainly in the transport sector. The company Maersk Line, was the world's largest container shipping company until early 2022. Since 2022, Maersk is number two behind MSC.

Sales Executive
Visit on 16 November 2022
Interviewer/Notulist Henk de Glopper, Diederik Houben and Ramon Wagenaar

Purpose of interview:
Mapping the shipping company's activities, bottlenecks, vision and supply chain flow.

Interview summary:

1. Does food loss occur when avocados are loaded into the container? What percentage?
   There is no food waste in the container
2. What information does Maersk need to ensure timely collection and delivery.
   The ship leaves Nairobi on Wednesday this is also the last day a container can be delivered. preferably deliver the container on the Tuesday. A container is filled on average with 10 to 15 different farmers. Harvesting then usually takes place on Saturday. To keep fresh avocados, they should be no more than 5 days old.
   99% of cargoes are paid for by Europe.
   From Mombasa to Rotterdam is 30 days including transit. Direct from Salalah to Rotterdam
3. What is the biggest challenge during logistics operations for Maersk?
4. The 500 km From Nairobi to Mombasa and thus meet cut-off times
5. A lot can happen during transport, including during the rainy season
6. The farmers have to be ready on time. otherwise there will be delays. If the container is late then it goes with the next ship me. However, this is rare.
   To Bill of lading is most commonly used
7. Where and when will FLW perform during Maersk's operations?
   Up to 5% of containers miss the ship when transhipped. This increases the cut-off time by 7 days and decreases the quality of avocados.
8. Does Maersk have innovative solutions to reduce FLW?
   Captain peter, a kind of application. the customer can look into this in real time. In it, temperatures can be viewed. And also where the container is. Through this system, real-time data can be used to improve the process and reduce FLW.
   4.5°C to 6°C the avocados are transported.
9. How can Maersk contribute to an efficient supply chain for avocados?
   By consolidating shipments of mangoes and flowers, the amount of cargo from Kenya increases, making transport to Europe faster. This creates less FLW.
10. Does Maersk use different types of containers for avocado transport?
    Always 40-foot containers. Those are the only ones that have controlled climate.
11. Why is there no direct sea freight route between Kenya and Europe?
    This is where they are at. Among other things, making it possible to export flowers by sea. Whenever possible, they hope to have once-weekly sailings from Mombasa. It is important that several goods are transported by ship. Including mangoes and flowers