Proof of concept – Reefer container trial shipment of avocado to the Netherlands

Full report

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Report prepared by IDH

idh
transforming markets

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Summary

Over the past five years, there has been a notable increase in consumer demand for fresh avocados in Europe, the US, and the Middle East. Mexico, Peru, and Colombia are major suppliers of avocados to the US and EU markets. In Africa, Kenya, South Africa and Morocco have recorded significant market share (FAOSTAT 2022)[1]. Rwanda is ranked with key selling points of quality, favourable climate, proximity to markets, consistency in supply, and authentic products; UAE in the Middle East has offered alternative market for upcoming sources such as Rwanda however the positive outcome of this trial is a pointer that Rwanda can also supply EU market with the best quality avocados.

Sea freight proof of concept project was initiated to boost Rwandan avocado's competitiveness in several markets by using sea freight as an alternative to air freight for logistics. The main goal of the second trial was to determine whether it would be feasible to ship avocados by sea from Rwanda to Netherlands through the Rotterdam port and whether the product's overall quality would be acceptable to the market upon arrival.

The sea freight trial process involved identification and engagement of key partners, drafting of budgets, holding sector meetings to create awareness among key stake holders on the objectives of the project. Several technical trainings were also conducted to equip selected SMEs on key customer requirements and the expected outcomes.

The private sector through Souk IG Ltd identified a buyer for the trial shipment of avocados in Netherlands. The customer in this case was Avor international of Netherlands who received 22,400kgs of fresh avocados for ripening and subsequently distribute to various retail outlets in Netherlands and the rest of Europe.

[1] https://www.fao.org/3/cc3939en/cc3939en.pdf

1 Introduction

Proof of concept shipments
Private sector adoption of this initiative at early stage is key and therefore initial proof of concept trial runs are necessary. The proof concept were intended to (1) Middle East and (2) Europe. The design of the trial aimed to understand factors preventing the unlocking of reefer sea freight logistics as a solution for cheaper and sufficient competitive transport. With the success of the first proof of concept shipment to Middle East, the second proof of concept targeted EU, taking into account the learnings from the first shipment.

The learnings from the proof-of-concept shipments will be used to:

- Identify the opportunities for reefer sea freight logistics from Rwanda as critical driver for maintaining and increasing exports in the future
- Identify improvement points, bottlenecks and critical growth inhibitors of the reefer sea freight logistics to learn what to improve for the future to keep/make Rwanda competitive in the market
- Obtain customer feedback to be used to prepare the SMEs on the technical requirements, developing protocols and improve on gaps identified for a successful commercialization of reefer sea freight logistics
- Develop a report based on the findings to define the way forward and needs to improve this reefer sea freight logistics chain over the coming years to make it a competitive logistics opportunity for Rwanda

For this Reefer container sea freight trial shipment project, the following reports have been made:

1. The Dubai Shipment report 1st shipment (the first report shared and approved)
2. The Report for the 2nd trial shipment to the Netherlands (this report)

2 Second container Project set-up

Below is the description of the steps undertaken for the second trial shipment:

- Concept note development
- Budget Securing
- Project introduction to stakeholders
- Technical awareness training to exporters and NAEB staff
- Contracting processes:
    a) Souk IG (Exporter),
    b) Garden Fresh (for the use of their packhouse for Product processing)
    c) Flying Swans (Logistics planning)
- Selection of shipping carrier line through competitive technical and financial evaluation.
- Container booking
- Product sourcing, fruit processing, cooling and loading.
- Container setting, clearing and release.
- Container reception in Mombasa port.
- Loading of container on the ship deck
- Offloading the container from the ship
- Clearing at destination port.
- Reception, analysis and feedback by Avor International Netherlands.

2.1 Partners

Below is the list of partners who, in one way or another, played a role in the reefer container trial shipment together with IDH:

a) The Embassy of the Kingdom of the Netherlands – Kigali (EKN)
b) Souk IG Ltd representing the private sector (Lead exporter)
c) National Agriculture Export Development Board (NAEB)
d) Rwanda Embassy in Netherlands
e) Rwanda Revenue Authority (RRA)
f) Flying Swans
g) Maersk identifed by Souk to provide logistics solutions
h) Garden Fresh Ltd (Supplying of avocado and Pack house facility use)

2.2 Collaboration agreements

For the successful completion of the proof of concept, there were nine organizations involved in the realization and success of the project. To enable smooth planning, execution and processes control, there was a need for making several contractual agreements to bide key entities on various responsibilities, deliverables and commitments.

The following formal agreements were made:

- Contract between IDH and Garden fresh Ltd on the use of the pack house
- Agreement between IDH and SOUK IG on the whole project execution
- Contract between Souk IG and Maersk on the container shipment

3 Customer for the shipment

SOUK IG identified Avor Netherlands as the customer to receive the first consignment, discussions were held between the exporter (SOUK) and the customer to ensure prior agreement on key requirements which included product specifications, document requirements, customs clearance, dates of out loads and expected dates of arrival of the consignment. This agreement came as a starting point for a long term sourcing relationship between SOUK and Avor Netherlands even after the trial shipment.

Customer for the shipment

Identification of a customer for any trial requires mutual understanding on key objectives of the activities under trial. There was concurrence between the exporter and the consignee on expected outcomes, and both parties maintained their independence in their functions to ensure the trail is not compromised.

with this trial, there was delay in communication of the customer requirements to SOUK; therefore, this report recommends considering in the future to have the customer requirements including document for destination clearance communicated at least three weeks before container departure to ensure the exporter meets all the requirements before container release.

The product specification sheet was only shared before packing and release of the container from the pack house. Due to the high competence and experience of the IDH team, we knew the average standards and thus, guided the exporter's team in complying to the received specifications.

An initial quality report has been received with an overall performance of 6 out of 10 with appropriate recommendations.

4 Avocado sourcing

The consignee required 22,400 kg net of Hass avocados for Avor International in order to fill this container. According to the customer's specifications, mature Hass avocados with a dry matter content of between 23 and 27% were the goal. The Felix 750 machine was used to measure the dry matter, and a representative sample of every batch that was received in the pack house was also measured.

In addition to dry matter, other sensory measures that were utilized to assess fruit maturity were fruit size of at least 174g (size 22), fruit color change from shiny to dull appearing fruits, and fruit softness level.

4.1 Sourcing by Souk

Prequalification of suppliers of avocados was done by Souk: initially, with Garden Fresh providing additional volumes

1. Garden Fresh Ltd (GF)
2. Souk IG Ltd (SF)

The criteria used by SOUK included: previous service by suppliers and category of suppliers as follows:

1. Own farm production -10%
2. Commercial farmers-50%
3. Small scale farmers-30%
4. Agents or aggregators -10%

In total, over 22.4T of avocado was graded, sorted and packed in boxes as per customer specifications.

A total of 31T was supplied as raw material for processing with a yield of 71% (22.4T) being achieved for export from the initial raw material supply.

4.2 Field and quality selection

An assessment of maturity indices for avocados in various districts was done, the assessment was led by IDH technical staff while the initial prequalification of districts with mature fruits helped SOUK determine the estimated supply for processing.

A one-day technical training was provided by IDH on customer specifications, dry matter/Oil analysis techniques and participants in the training involved all SOUK, Garden Fresh, NAEB pack house staff and other exporters who showed interest in undertaking similar shipments in future.

4.3 Bulking and gathering at pack house

Raw material reception was done based on customer requirements, fruits quality was assessed for size, colour, dry matter, cleanliness, stalk presence, mode of transport and temperature at reception by quality teams of SOUK and Garden Fresh Ltd. Records of average dry matter were filled and kept for future references.

Quality checks were done by Souk and Garden staff with IDH technical staff and NAEB staff provided necessary support.

Analysis of avocado sourcing, field activities and bulking for pack house delivery

The process of supplying raw material from harvest to supply to the pack house was undertaken in an average of three days, in some instances, harvesting of fruits was delayed due to high rainfall experienced in several districts at the time of the project. Fruits arrived at the pack house soiled as a result of the heavy rains with tight timelines to supply.

The mode of transport of the avocados from farms to the packhouse was done in non-refrigerated trucks. The use of non-refrigerated trucks should be discouraged and instead, encourage the use of refrigerated trucks for raw material supply.

Multiple supply sources with limitation in quality supervision is not the best option for container avocados; ideally, dedicated orchards with initial quality checks is preferred to ensure product arriving at the pack house meets most of the quality requirements and thus reducing post-harvest losses.

Challenges observed in the avocado sourcing, bulking and field activities

- Non-refrigerated vehicles were used to deliver avocados to the pack house; however, this mode of transportation generally degrades the quality of the avocados inside the container. Even if this is sufficient for the trial project's needs and is carried out in many other nations, switching to chilled vehicles will improve shelf life and quality of fruits from Rwanda.
- From the moment of start cooling, the cold chain needs to be closed completely to maintain shelf-life and quality
- In regards to quality, several batches evaluated had differing quantities of dry matter in their avocados, a crucial quality criterion. This was partially caused by the distinct sourcing origins, each of which had a different ecological state and thus, a danger of a checkerboard quality effect during ripening.

Conclusions and recommendations

1. As a result of the high temperatures that will cause the fruits to begin to ripen, it is important to consider reducing the amount of avocados that are transported from the farm to the pack house using non-refrigerated vehicles.
2. Provide equipment that is essential for product receipt, such as weighing scales that can record data for later evaluation. Scale location is also important; it is recommended to engrave the scale platform to the floor level to make it easier to weigh pallets of finished goods.
3. Automation of the grading process to ensure minimum time is spent per batch ensuring cold chain is maintained.
4. Consider demarcation of orchards with substantial tree population to generate adequate sea freight volumes of acceptable uniform dry matter levels to ensure top quality during ripening.
5. Technical capacity building for SMEs staff/stakeholders on quality of avocado as per different market requirements.

5 Pack house – packing and cooling

Activities relating to post-harvest handing were handled at the Garden Fresh pack house which is located at Masoro (Kigali Prime Economic Zone).

An initial harvest to supply time of two days was suggested to ensure product shelf life is not compromised. With considerable volumes received, processing was initiated to ensure enough lead time for cooling before loading.

Fig 1: Pallet of plastic crates arrangement in cold room for cooling

Fig 2 Forced air cooling in blast chiller

5.1 Packaging material

In preparation for the shipment, the boxes were planned and formed, as explained below, to be ready before the fruit was harvested. A team of employees was selected and hired to assist with box formation. The crew received training in box formation and was overseen by the IDH technical team. The crew received instruction in box gluing, which covered setting goals, folding boxes, determining the ideal temperature for glue efficiency, and payment methods.

Six employees worked on the box folding task; in just four days, the crew folded 6,000 boxes, tripling their maximum folding capacity on the fourth day.

There were about 15% boxes which were rejected due to weak gluing, and moisture absorption due to long stay after box formation.

In addition to the carton boxes, the exporter used plastic crates for the small fruits above size 22 to maximise on volume exported.

Challenges observed in box folding processes

- Quality of boxes formed was not constant, about 15% of the boxes formed were rejected during product packing due to weak gluing and moisture absorption.
- The technical capacity for box forming staff was inadequate and therefore training and supervision was provided. A significant time was spent in box forming more than normal practice a total of seven (7) days was spent in box formation due to the lack of experience in forming the boxes compared to normal practice where similar activity would take 1 days for 5600 boxes to be ready.
- In terms of cost of packaging, to meet sea freight requirement, the cost was considerably higher compared to regional prices from Kenya mainly due to the transport included in the cost of packaging materials.

Conclusions and recommendations

1. For longer routes, especially EU, waxing of carton boxing is recommended to reduce moisture absorption, considering that the fruits takes over 35 days in the container.
2. Training of SME staff on box formation to build skills of and increase efficiency in box forming processes.

3. Automation of box forming process through provision of box forming machines by SME/stakeholders.
4. In regard to costing, it is recommended to negotiate on transport costs from Nairobi to Kigali to lower cost per kg of the product on a packing perspective.
5. In the future trials, we recommend using plastic 10 kg crates which are low weight, cost effective, improved on air circulation in the container and are currently available for export use.

5.2 Raw material cooling

The raw materials were received at room temperature averaging 26 degrees Celsius. These are high temperatures that, if left unchecked, can cause avocados to ripen in as little as three to four days. Raw materials were delivered at night and pre-cooled to a temperature of 9 to 12 degrees to halt the ripening process in order to reduce excessive heat. The pre-cool cold room has a holding capacity of 15T and was set at six degrees. The following day after produce delivery to the packhouse, the produce was processed by the SOUK processing team to guarantee that the fruits cooled to the appropriate temperature.

Analysis of raw material cooling process

The process of precooling before processing was longer than ideal industry practice due to the following reasons:

- Delivery of avocados at ambient temperature of above 25^0C due to the use of non-refrigerated trucks; therefore, requiring longer period to remove the field and transport heat from the fruits.

Challenges of raw material cooling

The installed capacity for cold rooms can only hold a combined 30MT, which is not enough to handle massive amounts of chilling. If avocados are the only goods exported from this pack house, then the size is sufficient. If additional crops are shipped (by air), there will not be as much space. In the event that avocados from exporters are consistently received and there is insufficient space for the initial pre-product chilling, some products would have to be held at ambient temperature before processing, which could affect their quality and speed up the ripening process.

Conclusions and recommendations

1. Consider investment in an avocado processing dedicated facility to create more cooling capacity, stocking availability, truck loading dock and packing space.
2. Ensure raw materials (avocados) are supplied in refrigerated trucks.
3. Consider automation of the process that will allow hydro cooling of raw materials connected to a processing sorting machine to reduce pressure on cold room space – high investment at a later stage.

5.3 Washing, sorting, grading, packing and palletizing

a. Washing of fruits

The product was received and gently cleaned with 180ppm of chlorinated water to eliminate pathogens, dust and soil particles, sanitize fruit surfaces, and remove any residue left on the fruits after harvesting and processing.

Fig 3: Weighing of fruits to correct box size

Fig 4: Sorting of fruits

b. Sorting of fruits

After being cleaned, fruits were sorted to look for flaws such destalked fruits, extreme sunburn, and mechanical damage. In order to be collected by the corresponding supplier as second graded for local supply, immature fruits were isolated and kept in red crates.

After being cleaned and found to be in compliance with the customer's quality specifications, the fruits were sorted into size groups of 12 to 22 using calibrated digital scales. The resulting size groups were then placed into the proper boxes. After removing the box's 260g tare weight, the graded fruits in boxes were weighed again to make sure they reached the desired 4 kilogram net weight. This resulted in a net box weight that was within the permitted range of 3.9 to 4.1 kg net box weight.

Small size fruits were packed in plastic crates weighing 10kg net weight and palletized.

c. Packing

Fruits of similar weight range were grouped together in a four-kilogram box and reweighed to a net weight of 4.0 to 4.1 kg to fulfil the customer requirements of 4.0 kg net weight upon delivery if they met a weight range according to the weight scale instructions provided by the customer.

d. Palletizing

Pallet formation was directed by the shipping line's maximum skid height through the designated active CA container. In order to make the most use of the available space, the first skids were constructed with 23 layers of cartons spaced 180 cm high, awaiting the availability of finished goods and supplier grouping (to prevent mixing various suppliers on the same pallet). Palletizing the boxes involved using wooden pallets that had been treated and reinforced at the edges to make sure the pallets could resist demanding logistical moves.

Fig 5: Plastic crates pallet formation

Fig 6: Arial view of fruit presentation on a pallet

Analysis of avocado washing, sorting, weighing, packing and palletizing processes

Fruits were washed, cleaned, weighed, and packed by hand. One of the main drawbacks of a manual process is that inconsistent fruit cleaning regimens due to varying chlorine doses for different batches are more likely to occur because fruit handling is not consistent due to human error factors. The method of cleaning individual fruits with a tablecloth soaked in chlorinated water is not advised since it tends to exert too much pressure to the fruits leading to lenticel damages, ruining their delicate lenticel and degrading their quality.

In automated processes, fruit weighing is automated to improve sorting and grading capabilities, lower error margins, and maintain appropriate avocado size weight clusters. This ensures that packing is easy and that boxes can fit a variety of fruits, as opposed to manual weighing, which results in bulging boxes.

Challenges observed during fruit washing, sorting, weighing and palletizing activities

- Consistency in product treatment: Post harvest treatment of avocados was done through wiping of individual fruits with cloths soaked in chlorine, the solution effectiveness cannot be granted, also fruits may be bruised in the process; thus, a chance of product rots and deterioration in quality before arrival at the customer location.
- Weighing of avocado was done manually before packing in boxes. This process is slow and can result in low weights of final product in boxes.
- Some boxes were bulging out after packing due to weight range restrictions this then affected pallet formation.
- High rejection rates during packing and sorting of avocados estimated at 29%.

Conclusions and recommendations

1. Consider automation of the washing, weighing, sizing processes to reduce the challenges of product underweight, rots, size customer complains.
2. Capacity building for staff involved in the entire product value chain on quality parameter to reduce harvesting of immature, under size and quality defective avocados at the farms before receiving at the pack house level.

3. Transformation of rejected avocados through value addition such transformation options include oil extraction, ripening and freeze drying of ripe avocado chunks among others.

5.4 Traceability

To ensure traceability to the farms supplying the avocado for export, SOUK developed special codes which had information indicating the farm, Global gap status, district, and pack date and fruit size affixed on each box. Records were kept to ensure adequate information is kept for future reference.

Fig 7: Traceability details on boxes

Fig 8: Variety and size marking on boxes

5.5 Final cooling according to specifications

After sorting, grading, and packing, palletized avocados were cooled to a core temperature of 5.5 degrees in less than 36 hours. Destructive samples were positioned strategically (top of the skid), at the bottom, and in the warmest area of the cold room for contestant testing in order to guarantee that the fruit core temperature of 5.5 degrees is reached. Fruits were checked every two hours to make sure they reached the ideal temperature and were not harmed by the cold. Reaching a core temperature of 5.5 degrees for fruit.

The blast chiller was set at 4 degrees to accelerate cooling. With constant monitoring, properly chilled pallets were then transferred to the dispatch cold room awaiting loading or re-cooling in the event the temperature rise above 6.5 degrees.

Within 24hrs, all skid pallets had attained a temperature of 5.5 degrees with constant monitoring of the cold room.

Fig 9: Final cooling of packed avocados in the cold room.

Fig 10: Temperature checks (Not ideal)

Analysis of finished product cooling (Critical Control Point-CCP)

Thanks to the outsourced technical experts from KHE, the final product cooling process was effectively managed despite the limited cooling space. Even still, the cooling process showed to have limits in terms of the local skilled workers needed to conduct round-the-clock monitoring while receiving training for subsequent operations. Owing to cold room size restrictions, not all 22400 kg of processed food could fit in the export-only cold room (blast chiller). As a result, frequent cold room movement was necessary, which is not advised because cold room movement causes temperature fluctuations.

6 Container stuffing

A reefer container was booked via Maersk, with the customer's specifications (temperature, carbon dioxide and oxygen set points), loading location, destination port, and consignee information provided so that booking instructions could be generated and recorded in the bill of lading/sea waybill.

6.1 Palletisation

The boxes were palletized using wooden pallets treated with permitted chemicals. Reinforced corners were put in the skids' corner to guarantee the pallets' strength to survive demanding logistical operations. A final pallet height of 230 cm was created with 23 layers of cartons per pallet once the ideal volume of 22,400 kg was reached. There were 276 cartons used in all, with an average of 1,143 kg each pallet for the cartons. 120 plastic crates were used for each skid in cases of plastics crates. Heavy duty strapping tapes were employed to maintain skid integrity, and an electronic strapping machine was utilized to assure consistency in the strength and integrity of the strapping.

Analysis of pallet formation activity

Since the container cannot be loaded partially, the pallet construction procedure requires previous knowledge of the container's fixed maximum capacity and the anticipated final production from the site. The skid height is then calculated to determine the suitable skid height. Enough items were packed to guarantee that the container is completely filled, allowing for optimal air circulation.

Challenges observed during pallet formation

- Tools and equipment for appropriate palletizing process such as electric strapping machines were not available locally.
- Local skills in appropriate palletizing process meeting sea freight requirements were not available, technical knowledge was sourced from Kenya.
- Packaging materials specifically sea freight quality corners that enhance skids strength required for palletizing processes were acquired from Kenya, they are not available in Rwanda.

Conclusions and recommendations

- Avail palletizing tools and equipment's such as corners, electric strapping machines locally, to be easily accessed by exporters or stakeholders interested in avocado business.

6.2 Loading the container

Pre-test inspection (PTI) testing was done for temperature, CO2, and O2 setting, and the container was inspected for cleanliness and tested for performance based on good agricultural practices before loading started. To guarantee that ethylene is scraped from the container during transit, ethylene filters were installed on the evaporators.

Trans pallets, workers, and a forklift were among the equipment available for loading. There was improved loading time from 6hrs of the first trail container shipment to Dubai to 2 hours in the second container trial shipment to Rotterdam; this can be attributed to the improvements done on the loading platform based on recommendations in the first report.

6.3 Container CA curtain fixing, CA parameters settings and dispatch

The Active CA Container was pre-set in Mombasa based on the booking form filling which is guided by industry practices in avocado loading for sea transport, therefore, the following parameters were pre-set:

- Temperature: 5°C
- Carbon dioxide: 6%
- Oxygen levels: 3%

A training for the CA curtain fixing was provided by the Maersk technical team to the Souk and Garden Fresh dispatch team and IDH technical team.

Fig 11: Door to door loading of the container

Fig 12: Control panel settings conformation

- Once loading was complete and the CA curtain applied, the shipping line (Maersk) and Rwanda Revenue Authority (RRA) were invited to seal off the container with the seals recorded in respective documents; documents to accompany the shipment were handed to the driver for purpose of border clearing.

Analysis of container loading activity

- There were significant improvements noted during the loading of the second container; however a few gaps persisted in the second shipment trial that lead to lost time during loading such include Inappropriate loading equipment contributing to lost loading time(1.5hours).
- The packhouse facility was poorly equipped with old and outdated loading equipment that are not efficient there by contributing to the long hours used to load the container.
- Document processing for customs release was efficient, there was adequate communication on the sensitivity of the cargo between governments agencies involved. The documents were processed in time and ready for release. The process did not experience any delays.

Challenges observed during container loading activity

- The loading platform had improvements though not adequate in terms of levelling of the entire packing area that would ease truck movement.
- Loading equipment was not appropriate, the trans pallets used for loading were old and of lower capacity, thereby making the loading a challenge.

Conclusions and recommendations

1. Further levelling of the packing area is required to ensure the truck docks on a flat level to the pack house door. The levelling of the platform will also address issues related to cold chain management gaps. A dock shelter construction is recommended for any future avocado loading sites.
2. Consider investment in electric loading equipment with higher capacity to ease staff loading process, these will reduce loading time from the six hours to an acceptable time of 1hr.
3. Sea freight logistics service providers need to market their products more to the local customers detailing benefits of sea freight options compared to airfreighted options, make the services affordable and competitive.

7 Container shipment

7.1 Positioning of container

The Empty container was positioned at Garden fresh pack house in Kigali for loading from Mombasa which is 1682 Km apart. It took three days for the empty container to be positioned, which was shorter than the five days that were first projected. The fewer days is a good thing, and produce should be prepared for loading when the container comes to avoid incurring further parking fees. However, it is advisable to continue planning with five days of arrival from Mombasa , since potential delays might occur during the trip. In the future, it would be better that there is a stock of empty reefer containers available in Rwanda. This gives the exporters the possibility to react quickly to export opportunities in the market.

7.2 Transport to Mombasa

The container was brought in on truck across Kenya and Uganda on the Northern Corridor to reach Mombasa. This leg took around four days, as opposed to the seven days that were projected. Throughout the voyage, there were no accidents and the truck, trailer, and reefer container all appeared to be in acceptable mechanical condition. On arrival to Mombasa, there was no traffic jam and no significant delays. The gate was facilitated by the utilization of the newly established "Special reefers lane" at the Mombasa port.

7.3 Documentation and customs clearance

The paperwork was completed well in advance of the shipment, and the customs clearance process moved along rather swiftly. In addition to participating in the shipment through NAEB, the Rwanda Revenue Authority also persuaded the customs authorities to seal and release the consignment from the packhouse. Teams responsible for border declarations anticipated the truck's arrival and promptly cleared it through. Furthermore, delays could not have been caused by problems with government systems at border crossing locations.

7.4 Sea freight to Rotterdam

Analysis of the logistics of the container movement (Kigali-Mombasa)

The container truck arrived from Mombasa where all CA containers are positioned before distribution to the region. With adequate planning the activity went as per plan with the truck taking three days from Mombasa to Kigali ready for final day loading.

The carrier usually allows the truck 48hrs at the loading site before penalties are enforced, the truck loading and release was done within the allowed 48hrs; therefore, no penalties incurred despite delayed tripartite contract negotiations.

Monitoring of the container movement was aided by installation of a special program commonly referred to as Captain Peter which availed information such details as the container position, carbon dioxide, and oxygen and temperature readings against set points. With the support of the carrier, the exporter's staff was coached and trained on retrieval on the information as and when necessary.

The container movement was ahead of schedule due to efficient processes of crossing the northern corridor borders of Gatuna and Busia ultimately arriving in Mombasa on 30th of October, 2023 in a period of five days against expectation of seven to eight days truck time.

On the cost aspect, the inland haulage cost was found to be expensive at a rate of USD 3.56 per km for the reefer container for the total distance of 1682 km covered, compared to rates of USD 2.08 offered in 2019 on a dry container. This was due to the limitation within the group to negotiate for a much cheaper options, prevailing rise in diesel prices among others.

Mombasa to Rotterdam

The container was loaded on the vessel named 'Kyparissia' on 2nd November 2023 to Salalah. This is the usual transshipment port in the region for Maersk. on 8th November, it arrived in Salalah and on 10th November, the container was loaded on the Santa Catarina to Rotterdam. There, it arrived on Saturday 25th November, 2023and all this was as per the initial schedule. on Sunday 26th November 2023, the container was gated out from the port and offloaded at the warehouse of the customer in Poeldijk on Monday 26th November. for additional information, please follow: https://www.maersk.com/tracking/232278092.

Challenges observed during container movement from Kigali to Rotterdam

Although significantly lower than airfreight, the cost of inland haulage still affects the overall price per kg of shipped product to Rotterdam, with an average cost of USD 3.56 per km travelled for reefer containers compared to the general rates of USD 2.08 per km (northern corridor report, 2019) between Kigali and Mombasa for a normal dry container. The reason is that the containers are transported empty from the port of discharge (Mombasa) to Kigali; there is no rear filling of the containers due to limited fresh produce imports and low production volumes to warrant inland depot positioning of Active CA containers.

Conclusions and recommendations

1. The sharing of future volume projections with the logistics carrier companies by exporters is important to enable logistics companies determine the business cases of positioning CA containers in Kigali based on volume availability.
2. Avail information on the volumes two months by exporters before the season starts so that the logistics providers have adequate time to plan for reefer containers availability.
3. Consider more private trials to justify the reefer sea logistics option as an alternative option to access the markets.
4. Improve on aggregation, cold storage capacity for exporters in charge of the value chain to allow processing of loads equivalent to five containers per session per site.

8 Results

The shipment was received an overall very good grade from the client Avor, with product arriving at better quality when compared with qualities of products received through the air shipment by the same client.

Container performance was exceptional; based on an internal installed Maersk software commonly referred to as Captain Peter that generated the reports, all parameters of CO_2, O_2 and temperature of 5.5^{0}C were maintained according to the set limits with minimal deviations recorded during container movement from truck to port or from port to ship. The deviations were within acceptable range and were in very short periods of time, therefore, not affecting the quality of avocados.

Table 3: Summary of key activities for trial shipment to Dubai and Rotterdam lead time

Activity	Actual duration of time Rotterdam	Actual duration of time Dubai	Improvements in the second shipment
Contracts	All contracts signed three weeks before processing.	30 to 90 days for last contract to be signed	All contracts done 3 weeks before packing
Packaging materials formation	3 days	6 days	3 days less
Harvesting	3 days maximum	4 days maximum	1 day less
Packing operations	4days	5days	1 days less
Cooling	24hrs	36hrs	12hrs less
Loading	2.5hrs	6hrs	3.5hrs less
Transport inland (Kigali to Mombasa)(Average border clearance of two hours-Gatuna, and 12 hours for Malaba border into Kenya)	5days	4days	1 days more
Transport Ocean (Mombasa-Rotterdam)	34 days	14 days	20days more
Port operation (Mombasa)	1day	1day	same
Port operations (Rotterdam)	0day	1day	1 day more
Reception/initial quality analysis at customer site	1week hrs	72hrs	4 days more

Quality of avocados during reception at Avor International in Netherlands

Fig 13: Fruit quality upon reception

Fig 14: Operator at Avor Netherlands receiving the consignment.

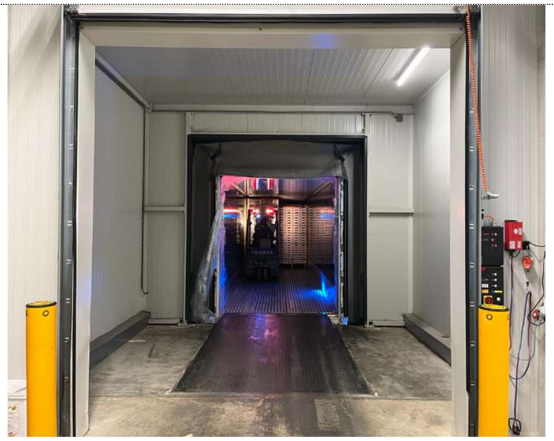


Fig 15: Offloading of the container

Fig 16: Confirmation of the quality status after Avor Netherlands reception.

© Avor Netherlands warehouse

8.1 Cost benefit analysis

The current cost of shipping one kg from Kigali to Netherlands by airfreight is USD 1.6 (Rwandair), and the highest is Ethiopian Air at USD 1.85 compared to sea freight rate cost of USD 0.614 per kg. From the trial as indicated in Table 4, there is a significant reduction in freight charges by 61% in favour of sea freight if we compare the two modes of transport despite the high inland haulage cost.

It is important to mention that the marine insurance and general good in transit (GIT) form of insurance only covers accidents and general liabilities against the cargo. No insurer was willing to provide a product quality insurance cover.

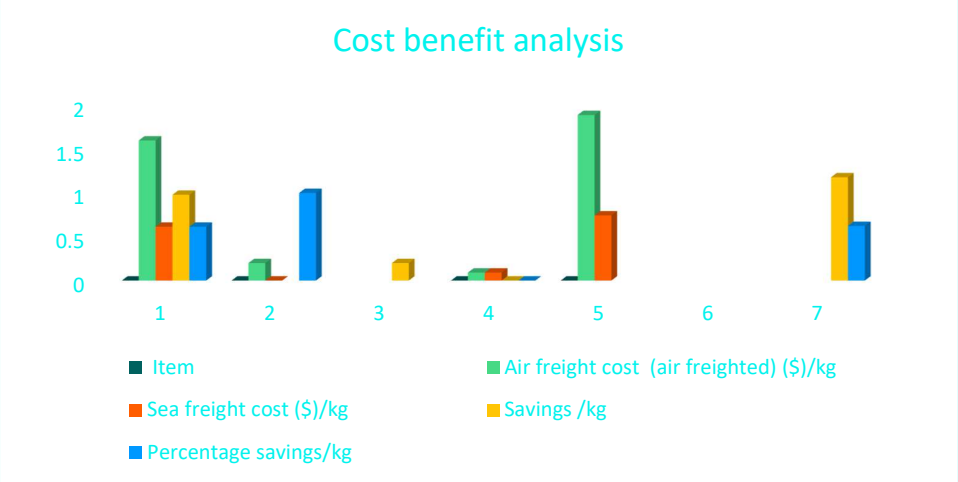
Table 4 Costs per kg of avocados shipped

Item	Current cost (air freighted) ($)/kg	Sea freight cost ($)/kg	Savings /kg	Percentage savings/kg
Freight to Rotterdam	1.6	0.614	0.98	61.4%
Documentation processing	0.2	0	0.2	100%
Phytosanitary fee	0.091	0.091	0	0%
Total (Excluding packaging, fruit and labor cost)	**1.891**	**0.743**	**1.18**	**62.4%**

Some of the reasons that would need to be addressed for sea freight to come down in future from the rates observed include:

- Connection through the Nairobi Standard Gauge Railway (SGR), which is less expensive than driving.
- Later on, connecting the train network from KGL to MOM direct (current network not possible)

- Reefer placing within the inland depots better when more refrigerated imports are done.
- Building relations with reefer companies to work on CA container availability in KGL
- Longer term logistics agreements and sufficient service off take always eases the process and reduce on price as preferred partner.



**Over time, it is likely that the sea freight cost will come down*

8.2 Carbon emission analysis

The available scientific study data has demonstrated that various modes of transportation have varying environmental effects, with the amounts of carbon released into the atmosphere serving as important markers. In terms of greenhouse gas emissions and climate change, the less carbon the better. As a result, companies should work to promote solutions that are environmentally friendly while maintaining business sustainability and climatic safety.

Sea transportation has the lowest carbon emission rating, at 10 to 40g per kilometre travelled, while air transportation has the highest, at 500g per km covered. On the other hand, road transportation depends on the type of vehicle or truck; in our instance, a huge truck has been shown to release 57 grams of pollution every kilometre[2].

For the purpose of carbon emission calculation for the trial, we shall limit the study to already available scientific data as referenced in Table 5 below.

Table 5: Carbon emissions per kg of avocados shipped *

Activity	Transport Route	Distance km	CO_2 emission rate in g/km	Total CO2 emitted(g)	CO_2 in kg.	Percentage
Sea freight section	Mombasa to Rotterdam	23305	40	932200	932.2	24%
Road section	Kigali-Malaba-Mombasa	1682	57	95874	95.874	

[2] https://www.cbo.gov/system/files/2022-12/58566-co2-emissions-transportation.pdf

Air freight	Kigali Airport-Rotterdam Airport	6486	500	3243000	3243	76.%

**Calculation based on literature and routing information[3]*. For more comprehensive calculation further analysis is required.

The available data indicates that choosing the sea freight option results in lower environmental carbon emissions; the goal of the study is to determine the trial's benefits in terms of quality, cost, and carbon emissions. The graphs in Fig. 17 display the analysis. When considering air freight options for a similar cargo load, sea freight has substantially fewer emissions.

According to research on CO2 emissions from sea freight models, trial cargo releases seven times less carbon dioxide to the same destination when compared to products that are air freighted. This is a definite benefit of the sea freight model.

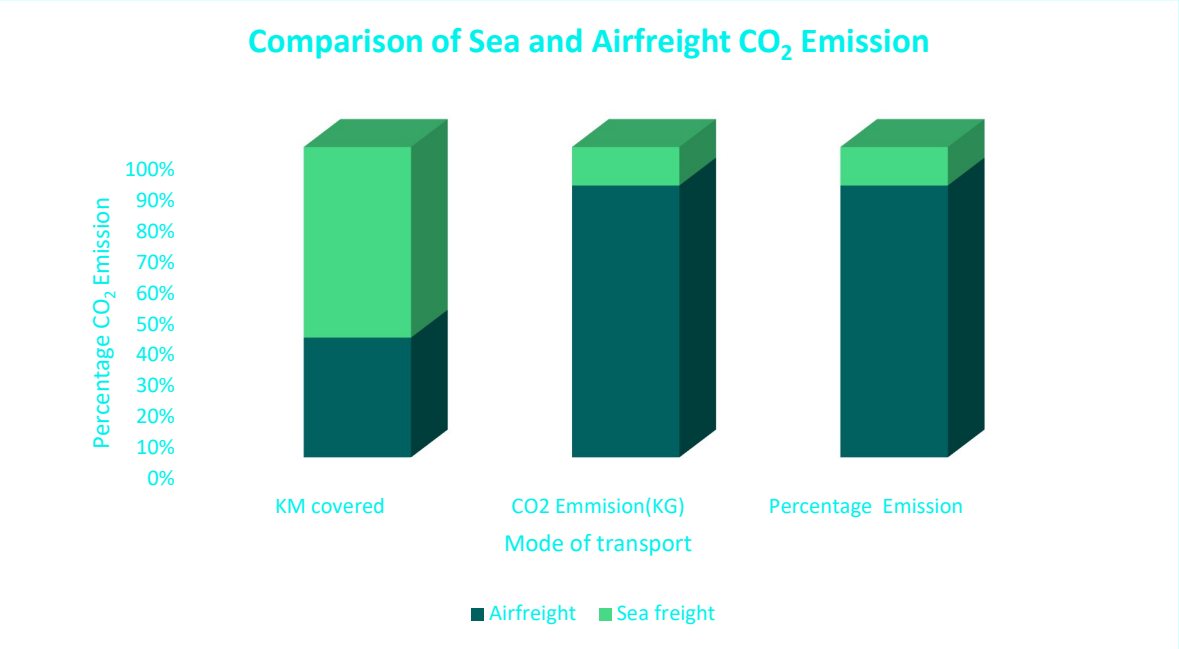


Fig 17. Carbon emission levels for various logistics options

9 Recommendations

Recommendations of this summary report are based on the second proof-of-concept shipment from Kigali to Rotterdam. Some of the recommendations will appear the same as those recommended in the first report since there have been no meaningful implementation of the initial recommendations. Additional proof-of-concept shipments are required to draw broader conclusions and to validate the findings of this report.

[3] https://www.ecta.com/wp-content/uploads/2021/03/ECTA-CEFIC-GUIDELINE-FOR-MEASURING-AND-MANAGING-CO2-ISSUE-1.pdf

Recommendations to the exporters

Customer relations and partner selection

1. The exporter to ensure they have capabilities to fulfil customer requirements. Make sure all contracts and product specifications are clear well in advance.
2. The exporter to Identify and engage key service providers, suppliers and partners needed early. Take into consideration their specific internal requirements and lead times.

Sourcing and product quality

3. Exporter to Introduce food safety certification standards for production sites (orchards) and pack houses such as Global gap and Global Brand recognition systems certification standard (BRCGS) key to accessing European markets.
4. Exporter to provide capacity building of employees involved in the value chain from fields, pack house to logistics on the technical and good practices applicable to sea freight option: quality measures, cold chain management, packaging and loading.
5. Exporter to train farmers on on-farm improvements and best practices.
6. Exporter to consider limiting the use of non-refrigerated trucks in transport of avocados from the farm to the pack house to prevent ripening of fruits.

Packhouse facilities

1. The exporter to consider setting up a specialized pack house facility with increased cooling capacity from the current cooling capacity of 30 MT to 120 MT capacity and consider investment in a processing facility dedicated for avocados to create more cooling capacity, stocking availability, truck loading dock and packing space.
2. Exporter to ensure appropriate packaging materials for sea freight packaging is availed 2 weeks before packing (currently not available locally in Rwanda).
3. Exporter to consider pack house automation possibilities: packaging material preparation (box forming), grading, hydro cooling, sorting, washing, weighing, sizing to improve quality and efficiency.
4. Exporter to Identify opportunities for side stream (rejected avocados) utilisation, such as oil extraction, ripening and freeze drying of ripe avocado chunks among others.

Recommendations to the industry

1. Future expansion of avocado processing facilities should involve construction of aggregation centres with cold chain facilities, construction of pack house that meet loading requirement for container trucks and cold rooms with a 120MT capacity to handle volumes equivalent of five containers at a go.
2. Promote and encourage the implementation of social , food safety and quality standards (GlobalGAP, social ethical certification, BRCGS and SMETA)
3. Build technical capacity of the exporting companies' employees and key stakeholders on quality and market requirements for avocados.
4. Consider additional trial shipments to gain knowledge on reefer sea logistics as an alternative to air freight in accessing the markets.
5. When possible, utilise train and rail networks (Nairobi/Kampala) to reduce cost and risks of inland transport.

6. Identify ways to cooperate with packaging material suppliers to improve the packaging material from Rwanda or identify regional packaging material suppliers (e.g., Kenya).
7. Cooperate with importers of cooled products in reefers in Rwanda to identify opportunities for synergies in CA reefer containers flow to and from Rwanda.
8. Benchmark operations sites undertaking similar activities in the region.
9. It's critical for exporters to share future volume predictions with carrier companies so they may assess the viability of placing CA containers in Kigali depending on volume availability. These can be compiled through existing platforms like HEAR.

Recommendations to the governmental organisations and other partners

1. Identify ways to ease documentation and customs requirements for purposes of border clearance, introduction of express clearance for fresh refrigerated container of avocado at border crossings to limit time taken at borders.
2. Set up ecological zoning of orchards and develop a national coding system (avocado growing areas) to ensure consistency in quality and traceability.
3. Increase production through advocating of more investments through increased tree plantings per year to ensure availability of avocados throughout the high season to make the sea freight option sustainable.
4. Promote and increase awareness on food safety and quality standards.
5. Improve the logistical corridor with border crossings and inland transportation, there was a significant delay at the Malaba border with high traffic of heavy commercial trucks reported leading to 12-16hrs delay in crossing (There are no reefer green channels at Malaba/Busia border-Express passage).
6. The achieved lead time of 34days between origin and destination is untenable since the quality and shelf life of fruits is at risk, advocate for ways of reducing the lead time to between 27 to 28 days between Kigali and Rotterdam port.
7. Gather data and pinpoint areas that could be improved by sending more maritime freight shipments to enhance the enabling environment.

References:

Northern corridor observatory 14th Edition report. June 2019

Evaluation report for the Ethiopian avocado sea freight transport trial, 202