COLEAD

SECTOR STUDY: PROCESSED AVOCADO

2. Frozen Avocado (IQF)

Funded by the European Union

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This document is part of the avocado sector study. This study explores the technical and economic feasibility of different processing and waste valorisation activities. The other chapters are available here: resources.colead

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1. Individually quick-frozen (IQF) avocado

1.1 What is IQF avocado?

Individually quick-frozen (IQF) avocadoes are slices, dices and halves of ripe avocados that are rapidly frozen. This creates a frozen product that is made of separate pieces that at a later stage can be defrosted. IQF avocadoes are mainly used in the same way as fresh avocado or, less often, as an ingredient in processed food products.

IQF avocado pieces are particularly important to the food services sector (restaurants, hotels, delicatessens, etc.) Once defrosted, IQF cubes, slices or even halves are used as a fresh ingredient in guacamole, salads or smoothies, on burgers or to replace burger buns, or in many other prepared dishes (Figure 1). IQF pieces can also be found in retail stores. This allows home cooks to prepare similar meals as in the food services sector, or to enjoy homemade smoothies and green juices.

Figure 1. Common end uses of IQF avocado

1.2 IQF avocado's competitors

IQF avocado has a longer shelf life and can withstand rougher handling than fresh avocadoes. This makes it an ideal substitute for fresh, ripe avocado. This is very beneficial in the food services sector, where demand is unpredictable and there is great pressure to minimise waste of ingredients. This makes fresh avocado the direct competitor to IQF avocado.

Sometimes IQF avocado replaces avocado pulp in recipes. It is also possible to use frozen or, more commonly, high pressure pasteurised chunky pulp to replace IQF cubes when making products such as guacamole. Chunky avocado pulp is thus a competing product.

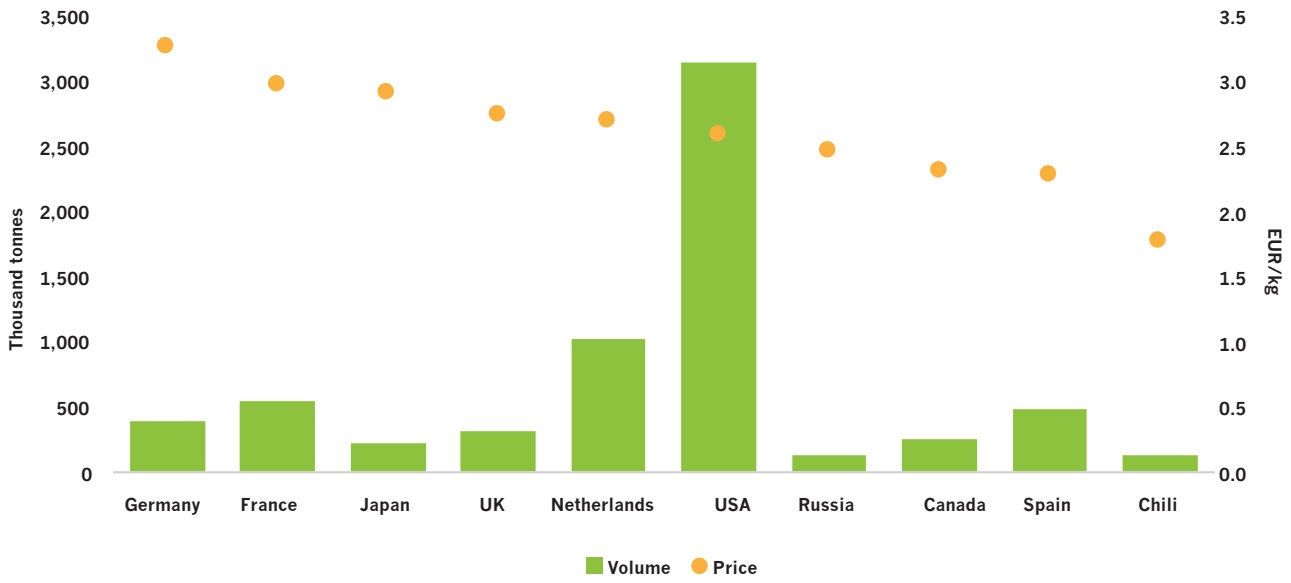
2. Demand forecast

As IQF avocado is used to replace fresh avocado, the sales of fresh avocado is the best predictor of the demand for IQF product. Globally, the USA is the largest importer of fresh avocado. In 2021, the USA imported three times more avocado than the next closest importer by volume, the Netherlands. The Netherlands and Spain re-export the bulk of these imports. In the case of the Netherlands, 97% of imports were re-exported across the EU.[1]

By comparison, France, Germany and the United Kingdom are significantly larger consumers of fresh avocado. The foods services sectors in these countries are also very large and organised. Germany and France import fresh avocado at some of the highest average global prices; Germany imported fresh avocado for €3.26 per kg (€3,258 per ton) Free on Board (FOB) (Figure 2).[2] These high prices for fresh avocado create opportunities for IQF processors to achieve higher prices, or to compete more effectively against fresh avocado.

The role of the Netherlands in redistribution of products across the EU should not be underestimated. Belgium is also a significant player in frozen produce and has some of the EU's largest IQF factories for potatoes and vegetables. Many food manufacturers and food service companies prefer to work with suppliers who can offer a "one-stop shop" for their ingredients. However, as avocadoes do not grow in Europe, suppliers will need to source avocadoes should a client request this. This might create opportunities for IQF avocado suppliers.

Figure 2. Fresh avocado imports and related prices in 2021.
Source: ITC Trade Map https://intracen.org/resources/tools/trade-map



1 Data sourced from ITC Trade Map https://www.trademap.org/Index.aspx

2 Data sourced from ITC Trade Map https://intracen.org/resources/tools/trade-map

2. Demand forecast

2.1 Market trends

Trends in developed markets suggest that IQF avocado products will continue to be popular. Some important trends suggesting continued growth in demand for IQF avocado are plant-based eating, novel and healthy food concepts, low-carb, high-fat burgers and Tex-Mex going mainstream.

Plant-based eating

Source: Prêt a Manger Facebook page

IQF avocado is well suited to blending into green smoothies and juices. In 2020, the EU-funded Smart Protein project found that the plant-based food industry in the EU grew 49% between 2018–2020.

The trend in plant-based eating has driven growth in new plant-based food alternatives, with many shoppers increasing their consumption of vegetables and fruits while reducing meat consumption. Plant-based eating has made a number of new dishes popular. Poke bowls, "green goddess" bowls, green juices and smoothies are now well-known dishes that often use avocado. IQF avocado pieces can be available year-round, ensuring that this core ingredient is continuously available, especially in the food services sector.

Novel food concepts

The popularity of avocados has created many opportunities for innovation. Avocado fries are one such innovative concept. This product uses avocado slices that are dipped in breadcrumbs.

Source: The Avocado Show brand website

Avocado burgers

Source: Canva

Avocado is a popular ingredient for burgers, with slices and halves used as toppings. In rare cases, the buns have been replaced with avocado halves to create a low-carbohydrate version of this popular fast food.

Tex-Mex goes mainstream

Guacamole is now a common product on supermarket shelves. Many suppliers use pulp to create a base for guacamole, but the smooth texture this creates in many cases does not feel "authentic" and fresh. To create texture, some manufacturers have added IQF diced avocado. This gives the product more bite and a more natural texture.

However, to meet the need for texture some pulp producers are supplying chunky pulp instead. This provides the body of pulp and the natural texture that matches the recipes with IQF. This poses a potential threat to IQF suppliers.

Source: the Walmart Retail website

2.2 Importing countries

There is considerable similarity between fresh avocadoes and IQF avocadoes. Both the consumption and the import statistics are helpful in identifying which countries are most likely to be large importers of IQF avocadoes, as well as where there are opportunities for the future.

The Netherlands and Spain are the leading importers of fresh avocadoes in the EU, although the Netherlands re-exports most fresh avocadoes. The importers in the Netherlands therefore play a key role in distribution of avocado products across Europe. In Spain, the IQF product is also used in guacamole production.

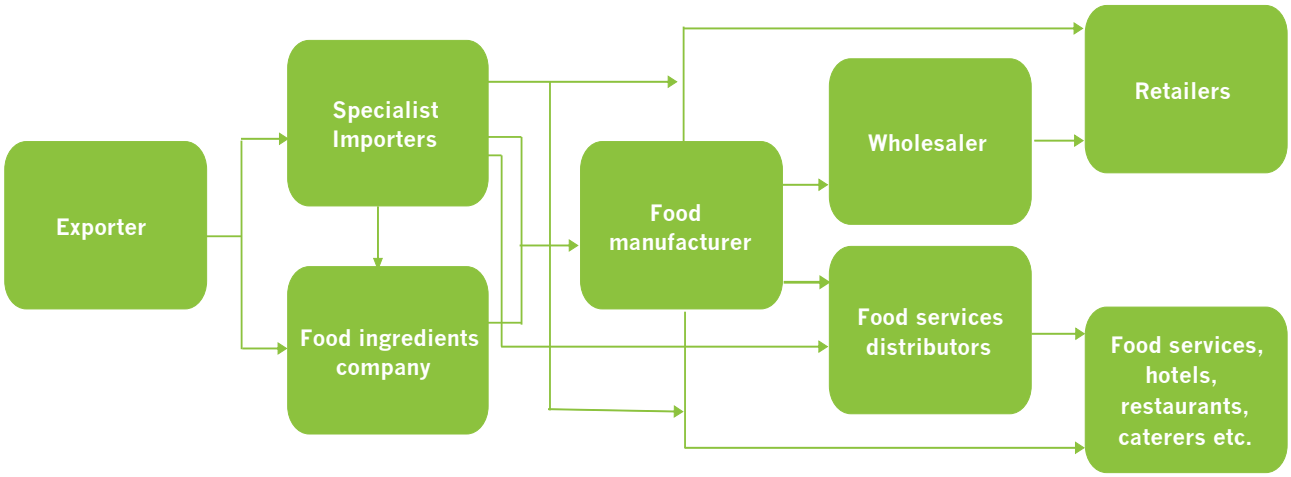
France, Germany and the UK are also large importers of fresh avocadoes, although they have a relatively low consumption per capita when compared to Scandinavian countries (Table 1). There could be opportunities to use IQF avocado products to increase consumption, especially in the food services sector.

Table 1. Import and consumption per capita for EU countries

Country	Imports (tonnes)	Consumption (tonnes)	Consumption per capita (kg per person)
The Netherlands	378,761	10,503	0.60
Spain	214,202	189,777	4.00
France	181,609	149,282	2.21
Germany	120,986	104,873	1,26
United Kingdom	114,273	107,662	1.60
Scandinavia (Sweden, Denmark, Norway, Finland)	65,041	64,775	2.39
Italy	41,655	39,711	0.67

2.3 Market structure

Figure 3. IQF avocado market structure



Specialist importers and food service distributors play a critical role in this value chain (Figure 3).

Several specialist importers (in the EU and elsewhere) import IQF product from around the world. They then sell IQF product to distributors, to food manufacturers or even to retailers. These suppliers also introduce innovative products with interesting new flavours or blends, such as hummus and avocado or avocado mayonnaise.

As so much of the IQF product is used in the food services sector, food services distributors play an important role in the supply chain. They supply goods to hotels, restaurants, caterers and quality healthy fast food/ready-to-eat cafes such as Prêt a Manger in the UK, France and Belgium; La Place in the Netherlands, retailers who produce ready to eat food in their own outlets (e.g. Monoprix in France), or even independent small cafes.

3. Regulatory and quality requirements

3.1 Product specifications

Table 2. Typical key product specifications for IQF avocado

Item	Specification
Ingredients	Avocado (99.9%), Stabiliser – ascorbic acid, citric acid, salt
Variety	Hass
Appearance	Characteristic shades of green, typical of fresh avocadoes
Shape	Slices, dices (15 mm x 15 mm) or halves
Freezing process	IQF
Shelf life	18–24 months
Preservatives	Zero, a clean label product is required
Storage conditions	-18°C
Packaging	1 kg bags, with six 1 kg bags per carton, and 84 cartons per pallet.

3.2 Food safety and quality management

IQF avocado slices, dices and halves are often purchased with the aim of presenting dishes in restaurants, hotels and other food services outlets as healthier and more "premium" products. Quality is thus very important and food safety certifications are greatly valued by buyers in the EU. Companies without certification might find it challenging to market their product for export without investing in systems and certification. Some respected and desirable certifications are:

- International Featured Standards(IFS)
- British Retail Consortium (BRC)
- FSSC 22000
- An equivalent standard

3.3 Sustainability and certifications

Specific certifications over and above food safety are not required. Nevertheless, they do assist with marketing especially when competing as a new supplier. The certifications provide reassurance to importers that the supplier is organised and professional. This in turn signals that quality and food safety is being well managed.

Some certifications specifically mentioned by buyers are Rainforest Alliance and Global Gap. However, as certification preferences are specific to each buyer, suppliers should ensure they are familiar with the strategies of the importers to understand the types of certifications that will be impactful and provide added value.

Organic certification of IQF avocado is less important than in the fresh market and is not essential. Nevertheless, there is growing interest in organic product in the EU. This could provide a useful entry point to build a relationship with new buyers or access new markets.

4. Supply

4.1 Supplying markets

IQF technology is expensive and shutting down the line requires time-consuming deep cleaning. The business case therefore relies on a long period of production. Those countries with long avocado harvest seasons are better able to create a business case to make the costly investment. Investors in countries with a short harvest season struggle to build a sensible business case and need to rely on sourcing other fruits and vegetables that can be frozen outside the avocado season. This is a more complex business model, which can be discouraging to potential investors. The result is that relatively few countries participate in the production and export of IQF products. The leading suppliers of IQF avocado are Peru, Mexico and South Africa.

Peru

Peru has a long fresh avocado production season. The avocadoes produced in the country are grown at altitude and have a lower oil content than the avocadoes grown in other parts of South America, Africa and even Spain.

Peru also has a large, established IQF sector. This makes it less challenging to build a case for processing avocadoes alongside established products such as vegetables, mango and pineapple. The avocadoes can be added to an existing programme and can be marketed alongside the better known, more mainstream products. As a result, Peru has more than 30 companies producing IQF avocadoes.

Mexico

There are several large, established companies processing IQF avocadoes in Mexico. These companies have the advantage of a year-round season, which has several benefits. Firstly, companies can produce at a large enough scale to support the considerable investment costs. Secondly, they can develop and afford the specialised skills needed to run a successful IQF plant. Finally, they can be more flexible and more responsive to the market. For example, if there is an oversupply of diced avocado, they can change their strategy and focus on slices or halves.

Mexico has a strong relationship with the USA and focuses on this market.

South Africa

South African processors are able to source avocado from different growing regions, allowing a year-round production cycle. The local market is also well developed, with high demand for IQF product in the food services sector. Both the year-round availability of raw materials and the large local market assist in companies being able to afford the IQF technology.

4.2 Pricing

Pricing of IQF product is difficult to determine. Asian suppliers have been quoting prices as low as €2 per kg (FOB) for buyers of very large volumes. This assumes that the product is available at this price and that the quality will be acceptable. Often this is not the case.

Retail prices in the EU (approximately €9 per kg) suggest that the real import price for IQF product is likely to be about €4.50 per kg landed in the EU. This then allows for companies to pack the product, to distribute it and for retail margins.

Organic product is not widely available in retail stores. However, with the premium on organic fresh product being 20–40% it is reasonable to assume that at least a 20% premium is possible for organic IQF avocado. However, this would be a far smaller share of the market.

4.3 Seasonality

IQF avocadoes have a lengthy shelf life of 18–24 months. This means the product is available year-round (see Table 3 for avocado production seasons). Nevertheless, buyers prefer stock that has been packed recently over that which is ageing. This provides buyers with more time to be able to market the product.

Because IQF avocado can be used to replace fresh avocado and vice versa, the availability and prices of fresh avocado in retail stores and in the food services sector affects the demand for IQF in the food services sector and in households. When fresh avocado is readily available and prices are low, smaller restaurants, juice bars and delis in the food services sector are more likely to purchase fresh produce. However, when availability is lower and prices are higher, they are more likely to use IQF products.

Table 3. Avocado production seasons by IQF avocado exporting country

	J	F	M	A	M	J	J	A	S	O	N	D
Viet Nam					■	■	■					
China	■	■	■						■	■	■	■
Peru			■	■	■	■	■	■	■			
South Africa				■	■	■	■	■	■			
Chile								■	■	■	■	■
Mexico	■	■	■	■	■	■	■	■	■	■	■	■
Spain	■	■	■	■	■							

Note: Green shading indicates avocado production months.

4.4 Variety

It is possible to produce IQF avocado using several of the available export and local varieties of avocado. However, as Hass is the best known and most available variety in the fresh market, it has become the benchmark for buyers. This makes it the most marketable variety, with most importers reluctant to test alternatives.

For suppliers, Hass avocadoes are also easier to process. They are sufficiently large, robust enough to withstand handling and have sufficient flesh for processing. This makes processing Hass avocadoes far more profitable than some varieties that are prone to bruising, or which have large pips. The same level of technology and effort is needed to process each ton of avocado irrespective of the variety. However, as less waste is produced when processing Hass avocadoes, the same effort delivers a larger amount of IQF product.

5. Production

5.1 Production process

Figure 4. Production process for IQF avocado

In ***step 1, reception,*** avocadoes arrive at the processing plant and are sorted so that damaged avocadoes can be discarded, ripe avocadoes can be moved to production and unripe avocadoes stored for ripening (Figure 4).

In ***step 2, preparation,*** the ripe avocadoes are washed to remove any potential contaminants, dirt or residues that could remain in the final product. Some processors, especially those who are focused on the US market, put fruit that has not been rejected at the factory gate through a hot water bath or in a steaming chamber. This is called blanching. The blanching step kills any pathogens and ensures a safe product that has an even lower chance of being contaminated. However, the extra heat does increase costs and, if not done well, can affect the quality of the fruit.

Once clean, any remaining stems are removed, the avocadoes are peeled and the seed (pit) is removed. The avocado fruit is then cut to the required shape and size. This could be small dices, slices or halves depending on the requirements of the buyer. This is typically done manually to prevent browning. However, some processors use cutting machines to remove the pit and cut the fruit to size.

In ***step 3, stabilisation,*** the avocado is treated to prevent browning. When avocado comes in to contact with air, it turns brown due to oxidation. IQF pieces are not shipped in vacuum sealed, airtight packaging and have a long shelf life of 18–24 months, so oxidation is possible. To prevent it, the avocado pieces are often treated with antioxidants such as citric and ascorbic acid, as well as a salt solution. Each processor determines whether this is required and if so, the specific blend of these antioxidants they will use.

In ***step 4, freezing,*** the product is quick frozen in a specialised freezing tunnel.

In ***step 5, packaging and dispatch,*** the frozen avocado is packed into bags. Finally, the product is passed through a metal detector before being returned to chilled storage at -18°C. It is then dispatched to airports or ports depending on the location of the end customer.

5.2 Production technology

Multi fruit washer: A bubble washer uses bubbles to agitate fruit and remove any solid particles clinging to the outer skin. Chlorine is often added to the water to chemically remove pathogens.

Cutter and dicer: Most IQF fruit is cut using an automated cutting machine. Two sets of cutting machines are required to cut the fruit in half before the fruit is manually destoned (pit removal) and scooped out. As the flesh is scooped out of the skin, the avocado does not require further peeling. If slices or dices are required, the fruit then undergoes a second cutting step.

Freezing (IQF) line: This consists of a long flat bed, with a conveyor belt. Cold air is blown over the fruit, resulting in the product rapidly freezing.

Dosage machine: This allows for automatic dosing of the IQF product into packaging (bags or boxes).

Freezer: A freezer is required to store the IQF product before it is dispatched.

Table 4 compares the investment cost and energy use for a 2–3 tons per hour plant from Europe versus China.

Table 4. Estimated investment costs for a 3 ton per hour production line

Equipment	Estimated cost Of line sourced from EU	Quoted cost of line sourced from China	Power installed
Production hall 500 m^2, cold storage, office, and toilet/changing room, excluded development of surrounding area	€400,000	€400,000	
Multi fruit washer, capacity circa 3 tons/ hour	€30,000	€14,200	6.0 kW/2.2 kW
6 stainless steel tables for 38 cutters & peelers and conveyor belt for transport to cutters	€15,000	€12,000	1.5 kW/ 0.75 kW
Dicer, capacity 2–3 tons/hour, comprising 3 groups of adjustable knives	€35,000	€14,700	1.1 kW/ 2.2 kW
Freezer, capacity 3 tons/hour, comprising start-up and training on site	€450,000	€223,110	220 v/50 hz single phase 380 v/50 hz three phase 11.2 kW and 62 kW Suppliers from the EU claim 30% energy saving
2 screw elevators, incl. collection hoppers and adjustable speed gear drives	€15,000	€12,300	4 kW/1 kW
Separation vibrator for rejection of slivers	€13,500	€3,900	1 kW/ 0.5 kW
Plant service, comprising water treatment plant, control panel, air compressor, set of sundry items	€27,000	€27,000	5.0 kW
Automatic 20 kg dosage packaging machine, manual tools for box sealing and labelling	€35,000	€39,500	1.0 kW/1 kW
Refrigeration container storage	€15,000	€15,000	
Two diesel-electric generator sets, 350 kVA new ZA	€60,000	€60,000	
Ammonia refrigeration plant	€300,000		10 kW

2 x 40 ft freezer rooms + 4 x 20 ft fridge rooms		€38,000	8 kW
Spare parts	€40,000	€30,000	
Shipping cost to West Africa	€34,000	€30,000	
Cost of erection, commissioning of equipment on site	€30,000	€30,000	
Subtotal	€1,499,500	€1,029,710	
Various cost and unexpected 10%	€149,950	€102,971	
Total estimated cost	€1,649,450	€1,132,681	
Total power installed			334.6 kW/110.8 kW

Source: Sourced from different independent suppliers

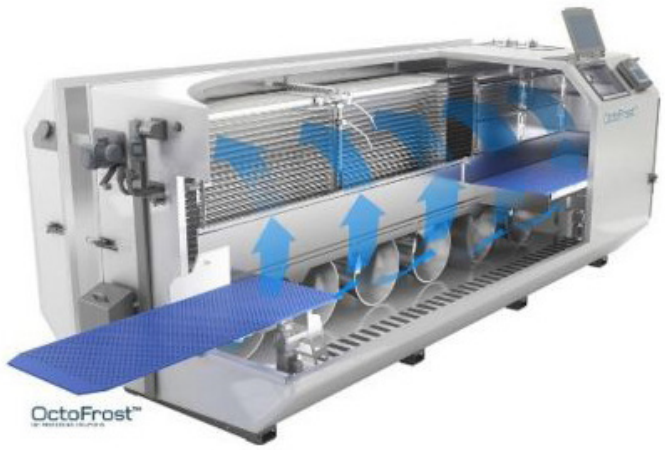
The total estimated investment costs are around €1.15 million for a line from China, commissioned and with training provided. A line with a similar capacity but sourced from Europe would cost approximately €1.65 million (Figure 5).[3]

Energy usage and power supply of the factory

The total energy usage of the factory for the line from China is estimated at 110.8 kW, compared to the line from Europe requiring 334.6 kW. This excludes the cold storage for ripening avocado prior to processing as well as energy needed for storing the finished product.

One of the most critical parts of the production is the supply of the energy. In principle it is cheaper to run most equipment on locally provided electricity than on electricity generated by a diesel generator. However, the electricity needed for the refrigeration plant may exceed what can be supplied locally. This can be due to power outages or restrictions on the amount of energy the factory can use, for example. This is a real risk to an IQF factory as the frozen product will defrost or the freezing cycle will be interrupted. For this reason, the calculations above include a diesel generator and a spare.

Figure 5. Example of an IQF line from the EU



Source: www.octofrost.com

3 It is possible to source a smaller IQF line from China. A 500 kg per hour line would produce 300 kg of finished product and costs about €170,000.

5.3 Production economics

There are several factors that must be well controlled in order to succeed in IQF production. The first is managing the conversion from fresh fruit to final product.

Conversion ratios

A skilled IQF facility is able to convert 50–60% of their avocado to a final product.

Next, we will consider the impact of increased waste levels on the profitability of an imaginary business that is processing 1 ton of fresh avocado.

Table 5 outlines five possible scenarios. In scenario 1, the factory is poor at converting fresh avocadoes to IQF product. They only manage to convert 40% of the fresh avocado and so produce 400 kg of IQF pieces. If they achieve a price of €4 per kg for the IQF they produce, they will earn €1,600.

All five scenarios assume that the factory uses the same process, technology staff and energy to process the product. With an assumed production cost of €1,000, in scenario 1 the factory achieves €600 profit, which is a 38% gross margin.

Scenarios 2 to 6 assume that the only factor that changes is the percentage of the fresh avocado that becomes IQF product. In each scenario, the factory gets better at selecting, handling and processing the fresh fruit so that the final product produced rises from 40% to 60%.

Table 5. The impact of various conversion ratios on profitability

		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Volume	Total weight at reception (kg)	1,000	1,000	1,000	1,000	1,000
	% flesh recovered	40	45	50	55	60
	Final volume processed (kg)	400	450	500	550	600
Revenue	Sales price per kg	€4	€4	€4	€4	€4
	Total revenue	€1,600	€1,800	€2,000	€2,200	€2,400
Costs	Total costs (assumed)	€1,000	€1,000	€1,000	€1,000	€1,000
Margin	Gross margin (revenue)	€600	€800	€1,000	€1,200	€1,400
	Gross margin %	38	44	50	55	58

These scenarios clearly show that the factory is able to increase their gross margin purely by being more careful with the fruit. This might incur some costs as more careful handling might need the company to invest in training, or even in higher wages to attract more skilled staff. However, it could be worth their while to do so. In reality, most IQF avocado factories target 50% as the minimum standard.

5. Production

Operations and logistics

An IQF plant needs to run for 24 hours a day to avoid having to deep clean equipment. As a consequence, a 3 ton per hour line would produce 72 tons of finished product per day. If the factory is relatively successful at managing waste and can convert 50% of the fresh fruit to final product, they would need to source 144 tons of fresh fruit per day. Over a four-month season, this would mean that 17,280 tons of fresh fruit need to be sourced and processed. This rises to 50,400 tons per year if the factory runs year-round (Table 6).

Table 6. Estimated fresh fruit requirements per day and for varying season lengths

	Scenario 1 (4 months)	Scenario 2 (6 months)	Scenario 3 (12 months)
Production capacity per hour in tons	3	3	3
Daily production volume (tons)	72	72	72
Total number of days	120	180	350
Total annual volume (tons)	8,640	12,960	25,200
Conversion ratio from fresh to IQF	50%	50%	50%
Fresh product required (tons)	17,280	25,920	50,400

This business model requires a large volume of quality fresh fruit, so the factory would need to be in a location where this can be sourced. This fruit also needs to be relatively affordable. At this scale, the logistics needed to source and manage the incoming fruit on a continuous basis are very important, requiring skills at sourcing from different growing regions (as is done in South Africa), or an ability to competitively source and import produce, as in Spain and the USA.

A factory that produces using a 3 ton per hour line and which is reasonably good at turning fresh fruit into IQF product (50%) could produce up to 2880 tons of product per month. That is equivalent to 144 20-foot containers of IQF product, a very large volume. This can be absorbed by the global market, but it requires that the company is flexible and responsive to the market's needs. Being able to sell some of this product locally would also be very helpful.

The long shelf life of IQF product is helpful as it gives companies some time to market their product. However, it also means that competitors are able to offer IQF product outside of their harvest season. Being aware of the market and competitors is thus crucial to being able to succeed.

6. Proposed options for marketing strategy

6.1 Key opportunities and challenges

Table 7. Opportunities and challenges

Opportunities	Challenges
▪ Growing interest in avocadoes in Europe, USA and in parts of Asia ▪ IQF avocadoes solve real challenges in the food services sector – waste, shelf life and handling concerns ▪ Relatively few suppliers due to high investment costs and requirements for scale ▪ Certifications offer opportunities for consideration from buyers.	▪ High cost of equipment ▪ Requires excellent logistics and cold chain management ▪ Existing suppliers are very skilled at IQF and have access to client relationships from marketing other IQF products ▪ The large scale of production in Mexico and Peru make these countries very competitive. ▪ Requires excellent sourcing and factory operations ▪ Large volume of fresh fruit needs to be sourced and processed per day and per season ▪ Short seasons, or few production programmes make profitable business challenging, if not impossible ▪ Reliable energy and good management of energy is required to ensure continuous cooling.

6.2 Ingredients for success

Investment capital

The high investment costs for this model require that the investor be skilled at accessing finance, or that they have sufficiently large cash reserves to self-finance the investment.

Operate at a large scale

Being able to afford the technology and compete with established IQF suppliers has implications for potential investors in IQF production. The best scenario involves producing large volumes of avocado per day over a lengthy production season. Year-round production is ideal. However, if this is not possible the company should aim to develop several products that can be frozen and brought to market outside the avocado season, such as mango, pineapple or even vegetables.

Operations and sourcing excellence

Running a successful IQF plant requires careful attention to ongoing sourcing. The company should invest in developing strong sourcing and operations capability.

Marketing excellence

The scale of production required for IQF product requires that investors gear up to be able to sell this product. This needs a good understanding of the market and an ability to be flexible. When dices are flooding the market, companies need to know this and be able to hold back and produce slices and halves. In some cases, companies might need to be prepared to hold back product altogether for a few months until prices rise, or they may need the ability to target new markets where existing companies are not active.

This need for market intelligence suggests that most suppliers from Africa would benefit from working together, or from working with agents in importing countries. This would provide the best visibility and allow them to respond quickly.

6.3 Conclusion

Producing IQF avocado would give an investor access to a growing market that has great potential in the future. The scale of the operation would, however, need careful management of sourcing, operations and marketing. Without access to capital and the skills needed to run year-round operation, companies are likely to struggle. However, if these ingredients are in place, then the opportunity could be very interesting.

SECTOR STUDY: PROCESSED AVOCADO

1. Avocado Oil
2. Frozen Avocado (IQF)
3. Avocado Pulp

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Belgium - Avenue Arnaud Fraiteur 15/23 - B-1050 Brussels
France - Avenue du Viaduc, 3 - Bât B3A - CP 90761 - 94550 Chevilly Larue
Kenya - Laiboni Center, 4th floor, P.O. BOX 100798-00101, Nairobi
network@colead.link | www.colead.link