# THE VIABILITY OF AIR TRANSPORTATION FOR PERISHABLE AGRICULTURAL PRODUCE

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## Abstract

This paper evaluates the viability of air transportation for perishable agricultural products. In recent years, fruit has been the major perishable group of agricultural products to use this export option in Brazil, particularly the papaya. The focus of this research, then, will be the assessment of the production and the logistical processes involved the evaluation of the demand and the estimation of the availability of air cargo transportation for the papaya exports. Finally, this paper analyses the obstacles from the exporters' standpoint that hamper the growth of air cargo exports of the Brazilian papaya.

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## 1. RATIONALE

Worldwide socio-economic development has created an appreciation for perishable agricultural products, increasing the demand for fresh, value-added products (Van der Vorst, 2000). The transportation of perishable and temperature-sensitive products is one of the three air cargo segments that have grown the most worldwide (Mergeglobal, 2005).

Perishable cargo is understood to be that one with limited shelf-life, susceptible to deterioration or uselessness if delivered in delay. Perishable cargo may require refrigerated warehousing and transportation to extend its commercial life.

One characteristic of the Brazilian overseas trade operations involving fresh agricultural products is the long distance between the production sites and the main worldwide consumer markets. Fruit, vegetables, chilled meat, and flowers are examples of perishable agricultural products exported from Brazil.

This trend in Brazil is particularly relevant. Air transported exports of this products accounted for over 16% of all air cargo exported in 2003. On average, air transportation of perishable goods abroad has grown at annual rates above that for air cargo in general – at 10.13% and 6.05% respectively (Figure 1).

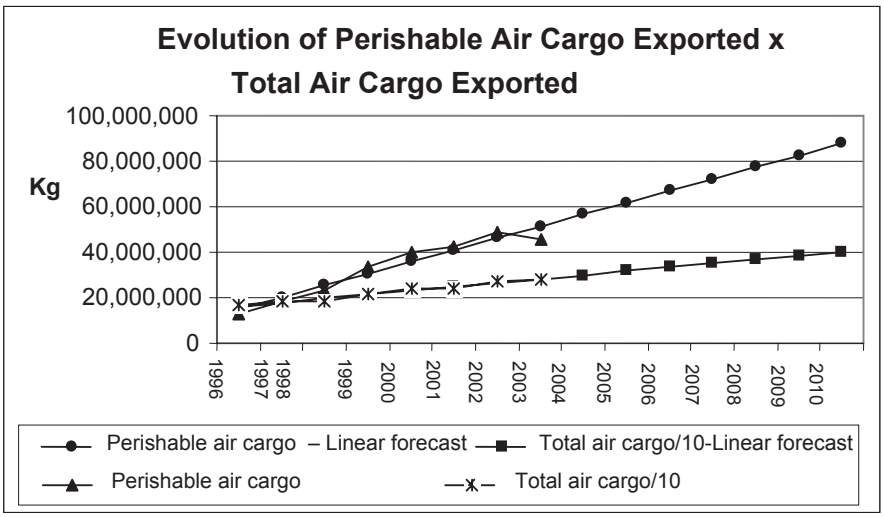



**Figure 1: Comparison between perishable air cargo and total air cargo.**
**Source: Aliceweb (2005) and Infraero (2003)**

Furthermore, Brazil's agricultural export segment has great potential for expansion. In addition, the perishable products export business is labor intensive, therefore with the capacity of creating jobs in the countryside, distributing income and promoting social

development.

In this context, it is appropriate to discuss why, technically speaking, air transportation has been put forward as an excellent mode of transport for the long-distance export of perishable products. Also the question of whether this mode of transport is capable of efficiently responding to the increased demand should be raised, in the view of the incentives for fresh agricultural products exports. So, this paper will assess the production and the logistical processes involved, evaluate the demand and estimate the availability of air cargo transportation for exports. Finally, the aim is to pinpoint, from the critical standpoint of the exporters, the main obstacles that hamper the growth of air cargo exports of the Brazilian papaya.

## 2. OVERVIEW OF THE LITERATURE

### 2.1 The Creation of Value and the Supply Chain

The purpose of a supply chain is to create value for the end consumer, whilst satisfying other members of the chain. In parallel, then, with the creation of value for the consumer, it is essential to create value for the stockholders. The concept "value added" was first pointed out at the work Value Chain, by Porter (1985) who described the organizations' main activities. The value created by these activities, less the costs of their execution represents the profit margin of an organization. The value is the amount buyers are prepared to pay for what the organization supplies, measured through the total revenue.

The value chain offers a systematic way to examine activities, not just in an individual company, but also in a set of companies making up the supply chain. The suppliers do not just deliver products; they can also influence the performance of the company in many ways, as many products pass along the value chain from various suppliers.

### 2.2. Strategic objectives of supply chain management

The objective of supply chain management is to synchronize customer's requirements with the flow of material from the suppliers so as to create a balance between offering a high standard service to the customer, and striving for low stock investment and low unit cost. So, out of the companies' decision making to use their suppliers processes, their technology and capacity as competitive advantages, arose the concept of supply chain management.

From this vision of the supply chain, there follows a definition of logistics management offered by *The Council of Supply Chain Management Professionals* (Lambert *et al*,

1998):

"Logistical management is a part of the supply chain management that efficiently plans, executes, and controls the effective flow and warehousing of goods, services and pertinent information, from the point of origin to the final point of consumption, in order to satisfy the consumers' requirements."

It should be stressed that, besides transport logistics, there is a need for a high level of coordination between the rest of the activities and processes within and among the chain management organizations. Not only the logistical processes, but also all other business processes are involved in internal and external coordination.

### 2.3 The cool chain

According to Welby and Macgregor (2004), the transportation of perishable produce requires specific care as regards packing, labeling, and transport equipment maintenance. Logistical operations must, especially, protect the products from: mishandling during loading and unloading; compression due to excess weight on the packing; impact, vibration and shifts in cargo in transit; elemental loss to or gain from the surrounding air; temperature and humidity above or below the recommended levels, and cross or odor contamination from other produce or residues.

Temperature is the key factor in quality maintenance. According to Van't Hoff's Law, (Cantillano, 2002), for every 10°C increase in temperature, the speed of biological reactions in the products increases by an average of two to three times. Consequently, commercial value and shelf life are inversely proportional to the speed of the products' biological reactions.

Cool chain maintenance in fruit export logistics is of the utmost importance in the preservation of the goods commercial value, in order to:

1) Reduce biological activity in the products;
2) Reduce microorganism activity; and
3) Minimize the loss of water from the products.

So, appropriate packing, environment control and appropriate transport equipment are essential to guarantee that the goods to arrive at their destination in good condition.

### 2.4 Technical aspects that influence the demand for air transportation

The demand for a given type of transportation is related to the dimension of the task. This is the result of a subjective association function between the value of the freight and the technical aspects pertinent to the means of the transport. According to Gayet *et al* (1995), the most important technical aspects are time, temperature, atmospheric pressure and

relative humidity.

*Time*

The reduction of transportation time is undoubtedly the most important factor in air transportation of the papaya, as even intercontinental flights are completed in less than fourteen hours. This minimizes concerns regarding the conservation of the papaya fruit during transportation.

*Temperature*

The temperature during the flight can be controlled in the various compartments of the aircraft. However, the main cargo compartment is generally responsible for the transportation of 70% of the amount of products. Pressurized aircraft have an installed capacity to maintain the temperature between 7°C on extremely hot days (38°C at sea level) to -25°C on extremely cold days (-50°C at sea level) during the flight. They can also renew up to 40 cubic meters of fresh air per minute – that is, they can renew the total volume of the air many times per hour. This makes air transportation of papaya fruit highly recommended from a technical standpoint.

*Atmospheric pressure*

During the flight, atmospheric pressure inside the aircraft will always be lower than at sea level, at around 600 to 650 mmHg. This causes a 20% increase in the loss of water by the fruit.

*Relative humidity*

Relative air humidity inside the aircraft is always low, contributing to the increased rate of water loss by the fruit when transported by air.

Nevertheless, as mentioned above, the high speed of the papaya air transportation reduced the importance of the negative aspects regarding atmospheric conditions in cargo holdings.

## 3. METHODOLOGY

In the recent past, it is a fact that fruit has been the largest group of perishable goods to use air transport for export from Brazil. Papaya has been the fruit to make most use of air transportation in recent years (Aliceweb, 2005). Hence, the focus of this research will be on the logistical processes involved in the air transport exports of papaya.

The methodology employed in this research involves two phases: diagnosis of the export environment, and analysis.

Data was collected through detailed research involving the consultation of specialized publications and various interviews with the principal agents in the papaya export sector, namely: producers/exporters - Caliman Agrícola S/A. and Gaia Importação e Exportação Ltda; Road transport companies - Martin Brower Comércio, Transportes e Serviços Ltda, and Rodoviário Schio Ltda;

Logistics operators – Infraero and VARIG Logística S/A; Airlines – TAM Linhas Aéreas S/A, and VARIG Viação Aérea Riograndense. The diagnosis will be divided into three parts:

- The first part is dedicated to the description of some of the main characteristics of the products and of the distribution operations.
- The second part involves a study of the demand for air transportation of the papaya fruit.
- There follows a presentation of air transportation capacity and the main development trends affecting the export of papaya.

In the analysis phase, there is a diagnosis of the papaya exports based on the opinion of specialists in the sector.

## 4. CHARACTERISTICS OF THE PRODUCT AND OF THE DISTRIBUTION OPERATIONS

A lot of agricultural products are seasonal, being harvested only in certain times of the year. The seasonality of products is analyzed using what is known as Sales Amplitude. This indicator is obtained by dividing maximum monthly sales by the minimum monthly sales of products. However, the papaya produced in Brazil is available year around, being supplied continuously to the export market. So, as seasonality has little influence on exports of papaya, this paper will adopt the hypothesis that sales amplitude is 1.

Another characteristic of agricultural products is its low density value. In this instance, papaya is no exception to the rule. In this paper the value density is defined as a function of the value of the product at the point of export and its weight.

Figure 2 illustrates a dilemma. The growth in value paid for airfreight associated to the fall in the value density for papaya exports over the years has raised the cost of airfreight near to 200% of the value of the product exported.

The main characteristic, notably, of fresh agricultural produce is its perishability. The degree of perishability can be defined as the inverse of its commercial validity; that is, 1/(commercial validity). The palatability of climacteric fruit, which ripen after harvest, is a direct function of the time it remains on the mother-plant. Less ripe harvested fruit has a lower level of sugar. The characteristic values of papaya are shown in Table 1.

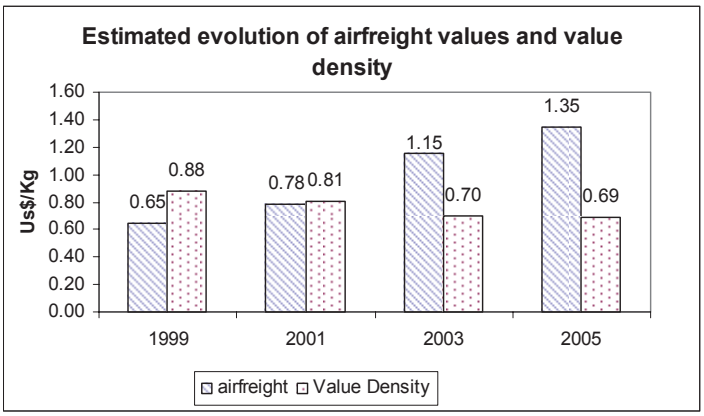



**Figure 2: Evolution of the value paid for airfreight to Amsterdam compared to the evolution of the value density.**

**Source: Aliceweb (2005) and IATA (2005).**

**Table 1 – Conservation period by warehousing temperature according to ripeness at harvest.**

| State at harvest *(Ripeness)* | Refrigeration to 12ºC and 90% relative humidity. (Commercial value days remaining) | Ambient temperature (26ºC) (Commercial value days remaining) | Degree of perishability with aid of refrigeration. |
|---|---|---|---|
| 0 | No value | No value | - |
| 1 | 25 days | 5 to 7 days | 0.040 |
| 2 | 21 days | 3 to 5 days | 0.047 |

**Source: Interview with exporters, 2005.**

The standard unit of transportation for papaya is the palette. The standard palette used for papaya exports is made up of 144 boxes, each one weighing 4.5kg gross on average. It has a wooden base measuring 1200mm by 1000mm, and a height of 1630mm, weighing approximately 650 kg in total. The unit load device (ULD - see Figure 3) that takes the wooden pallets of papaya is an airfreight palette. In general, an airfreight palette takes five wooden pallets of papaya.

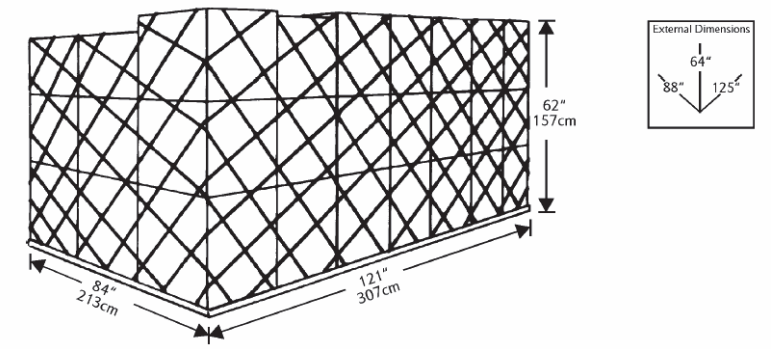



**Figure 3: ULD type P1P.**

**Source: British Airways (2004).**

## 5. DEMAND FOR AIR TRANSPORTATION FOR PAPAYA EXPORTS

The total quantity of papaya exported through Brazilian airports from 1996 to 2004, and the demand by continent are summarized in Figure 4 and Table 2, respectively.

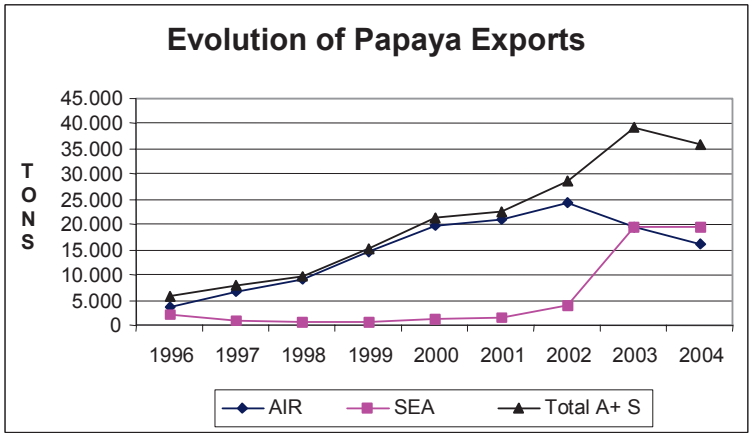



**Figure 4: Demand by means of export transportation.**
**Source: Aliceweb (2005).**

**Table 2: Evolution of demand, by air, by continent in tons.**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|
| AFRICA | 0.0 | 0.3 | 4.7 | 2.5 | 1.3 | 0.9 |
| SOUTH AMERICA | 66.4 | 75.5 | 69.1 | 2.0 | 25.7 | 12.9 |
| NORTH AMERICA | 4,195.5 | 6,822.8 | 7,880.3 | 9,110.3 | 6,944.6 | 4,120.6 |
| EUROPE | 10,345.3 | 12,983.7 | 13,172.8 | 15,306.8 | 12,561.1 | 12,068.7 |
| **TOTAL** | **14,607.2** | **19,882.3** | **21,126.9** | **24,421.6** | **19,532.8** | **16,203.1** |

**Source: Aliceweb (2005). Drawn up by the author.**

With the sales amplitude index of 1 for papaya it is possible to associate the regularity of exports to the need for frequent cargo deliveries, due to its perishability, and to simplify the distribution logistics, shown in Table 3, assuming that papaya is exported continuously and uniformly over the 365 days of the year.

**Table 3: Average demand for papaya by transportation, air and road, in 2004.**

| International Airport | Annual demand | | Average demand |
|---|---|---|---|
| | kg | ULD | ULD |
| Galeão–RJ | 8,422,604 | 2,592 | 7 per day |
| Guarulhos–SP | 5,594,156 | 1,721 | 5 per day |
| Salvador–BA | 1,149,741 | 354 | 1 per day |
| Fortaleza–CE | 367,136 | 113 | 2 - 3 per week |
| Natal–RN | 335,035 | 103 | 2 per week |
| Recife–PE | 305,714 | 94 | 2 per week |
| Viracopos–SP | 28,734 | 9 | Fewer than 1 per month |

**Source: Aliceweb (2005). Drawn up by the author.**

## 6. ANALYSIS OF THE CHARACTERISTICS OF AIR TRANSPORTATION FOR PAPAYA EXPORTS

Here the research intends to estimate the supply of air cargo transportation for export, especially for the Brazilian papaya.

Not all aircraft are appropriate for papaya exports. Generally, as illustrated in Figure 5, there are two basic elements limiting the transport capacity of an aircraft:

- Their internal dimensions, mainly the height of the cargo holds;
- The cargo hold access door dimensions.

For international papaya transportation, this paper considers only cargo holds capable of taking airfreight pallets of type P1P, PMC or P6P on wide body aircraft, and the main deck of cargo aircraft (as shown in Figure 5 for a B 767-300).

Hence, all narrow bodied aircraft were disregarded – those with a single aisle between the rows of passenger seats, bulk cargo holds, and wide body aircraft with unsuitable access doors for the airfreight pallets used to export papaya.

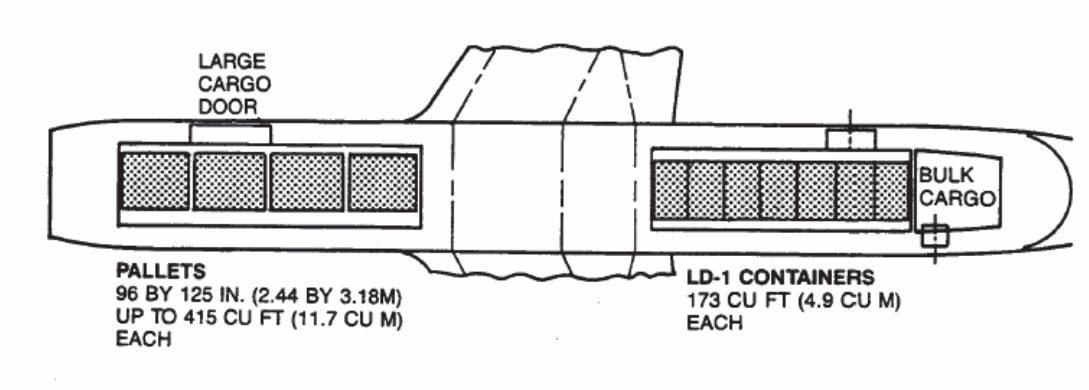



**Figure 5: Configuration of B 767-300 cargo hold.**
**Source: The Boeing Company (1989).**

The following procedure was used to find the total monthly volume offered by the air cargo transport export industry in Brazil:

a) Access to monthly files from aeronautical authorities, HOTRAN (DAC, 2004), which provide weekly frequency of each flight and information on the frequency of all international routes with one leg in a Brazilian airport.

b) Through analysis of the cargo configurations supplied by the *Airplane Characteristics for Airport Planning*, provided by the manufacturers, the quantity of pallets that can be used for papaya transportation can be determined for each aircraft.

Volume was adopted as the unit of aircraft cargo capacity measurement, in line with that

practiced by *Airplane Characteristics for Airport Planning*, because it is an invariable measurement for the same aircraft. This does not happen with cargo weight, which generally varies a lot as a result of various factors, such as: stage distance, need for fuel tankering, occupation rate of seats in mixed aircraft, elevation, temperature, and length of runways, amongst other factors.

c) Hence, the total average volume is determined by the route-by-route multiplication of flight frequency on a route (number of flights) by the aircraft cargo capacity, operated on the route.

### 6.1. Analysis of the results

The evolution of the total volume (in cubic meters) offered monthly for the air transportation export of papaya, shown in Figure 6, indicates that there has been an increase during the period analyzed.

However, as shown in Figure 7, the capacity offered has grown less than the demand for air cargo overall. A natural effect of this situation is the increase of the airfreight cost. In addition, it must be stressed that papaya is not seen as a preferential cargo by the airlines, as its freight is based on the lowest tariff proposed by the International Air Transport Association (IATA).

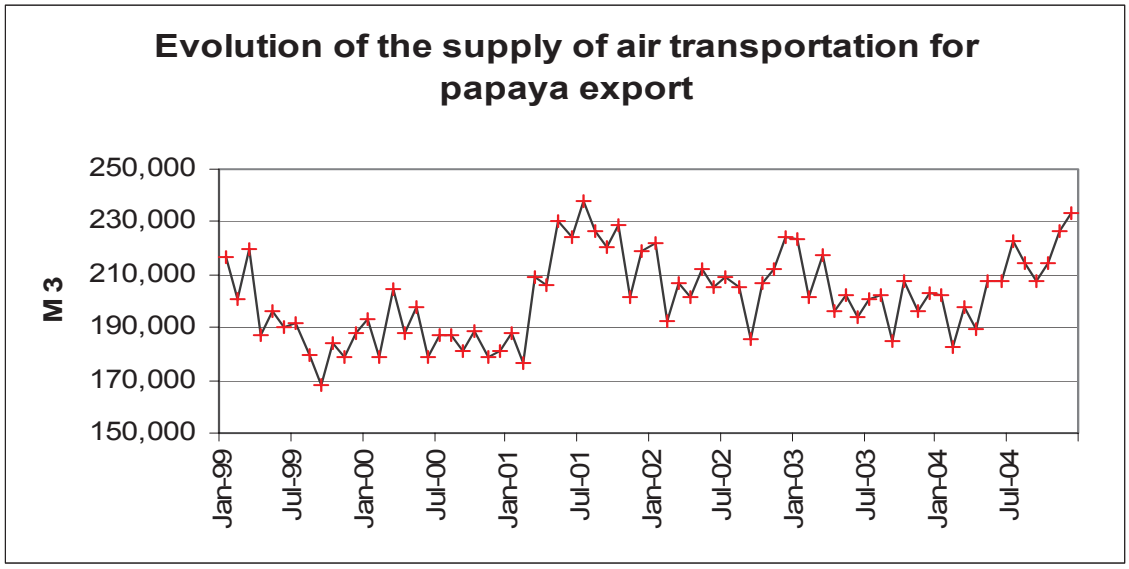



**Figure 6: Evolution of the supply of air transportation for papaya export.**
**Source: Hotran, drawn up by the author.**

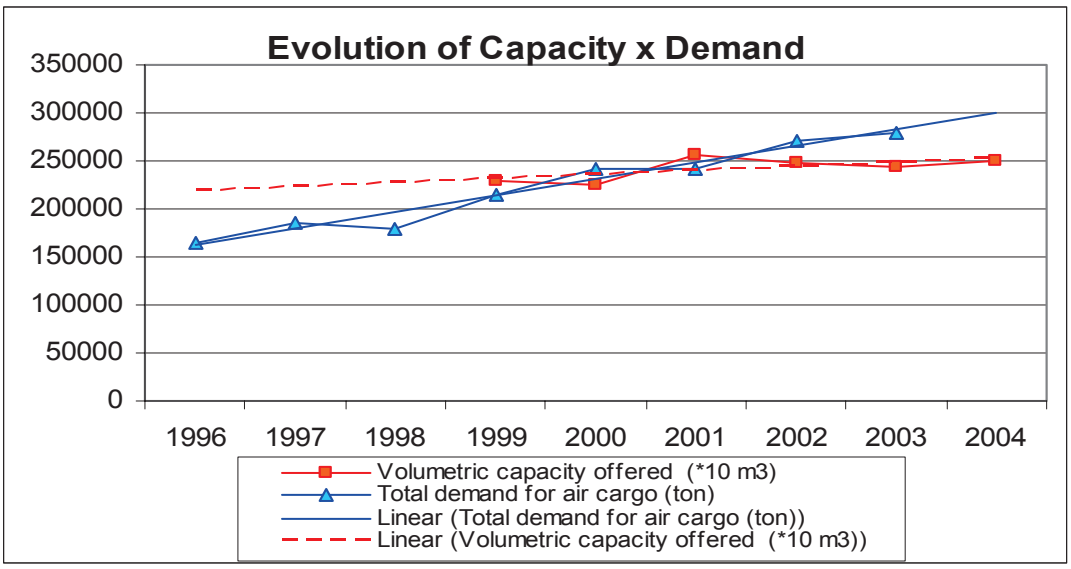



**Figure 7: Evolution of air cargo capacity for export compared to the evolution of total export air cargo from Brazil.**

Other characteristics of air cargo transportation in Brazil, such as the fall in the total number of flights from Brazil (Figure 8); and the increase in the number of cargo aircrafts for exports (Figure 9), have hampered papaya exports in the period under analysis.

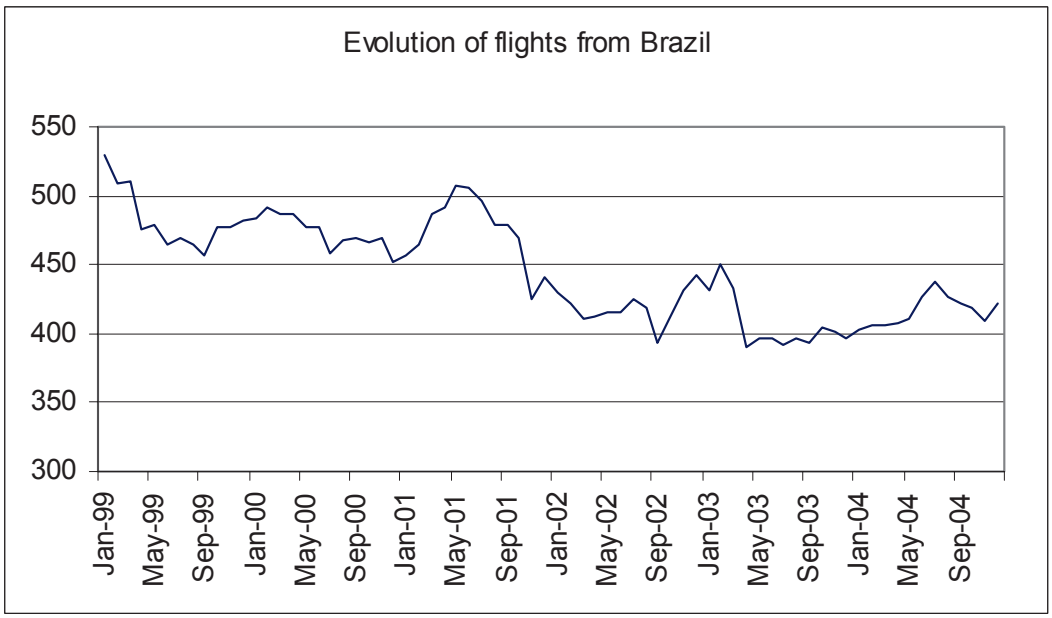



**Figure 8: Evolution of flights from Brazil.**
**Source: Hotran, drawn up by the author.**

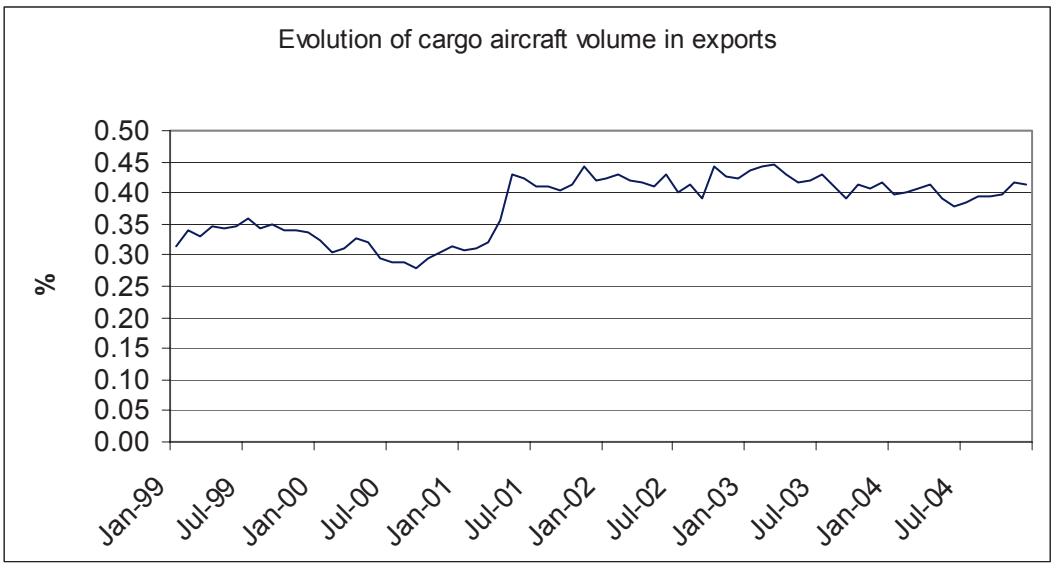



**Figure 9: Evolution of volume offered by cargo aircraft.**
**Source: Hotran, drawn up by the author.**

Some of the difficulties imposed by these characteristics in the period are reflected in the increased cost of freight, turning cheaper the transport in mixed aircrafts, and in the reduction of frequency of flights, which is very important in the transport of perishable goods.

## 7. CONCLUSIONS

The main obstacle to the exports of papaya by aircraft in the period under analysis was the increase in freight costs, added to fuel costs, significantly increasing the total cost of logistics. In addition, the growth in demand for air cargo in general at rates superior to the growth in the capacity offered is decisive, minimizing airline discounts on freight. Hence, papaya - a low value density item – has given way to higher added value cargo.

Adapting to sea transport, however, has its downside, with the fruit having to be harvested earlier. This reduces the quality of the product, harming its palatability, creating potential rejection of the product in some markets, and causing a possible fall in its value density.

One additional comment is necessary. The airport warehousing charges and handling tariffs on cargo weight at Infraero export terminals, added to the extra perishability rate, is worth future study. Such tariffs, charged on weight exported, do not consider the lower value density of the fruit, which makes transportation even more expensive and thus reducing international competitiveness. This cost methodology affects directly exporters'

profits, discouraging the use of this transportation.

Finally, to achieve a consistent growth of perishable air cargo exports it is necessary to implement a new commercial and logistical incentive schemes. Certainly, air transport is technically superior to sea transportation of perishable products, and has an important role in strengthening the Brazilian export market. There are sectors of agribusiness in the country that depend on the evolution of this means of export, and the perishable product market will identify new opportunities for air transportation in the future.

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