# EXPANSION OF PELAGIC FISHERIES IN CAPE VERDE A FEASIBILITY STUDY

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## ABSTRACT

The profitability of new investments in fisheries operations is designed to take advantage of unexploited harvest potential of fish stocks in the sea around Cape Verde and off the coast of Senegal and Mauritania. The TAC (Total Allowed Catch) in Cape Verde is estimated between 38000 and 47000 tons and mainly are large pelagic (tuna species) and the mean catch is around 7500 tons per year. The status of fish stocks available to Capeverdian fisheries and the potential to be caught are analysed and available data indicates that there is a substantial scope for expanding fishing for tuna in Cape Verde waters and small pelagic in the waters off Senegal and Mauritania. Two alternative scenarios are discussed. New vessel, which means one of the vessels that are in construction and a used vessel, which means a second hand vessel that was constructed and operated in Norway. The operation plans are elaborated according to the seasons of the species and the availability of the fish stock. The profitability of fishing operations for the two vessels is studied and discussed. In order to see how the profitability of the fishing operations is changing sensitivity analyses is made by changing the days at sea, the price of fish on the market and the value of the crew share. The bank will finance the investment so a loan amortisation schedule is made to show how the loan will be repaid. The results indicate that there are possibilities to expand in a profitable way.

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# 1. INTRODUCTION

The Archipelago of Cape Verde is located between the latitude of 14° 50' - 17° 20'N and longitude 22°40' - 17°20'W, approximately 500 km off the coast of Senegal, West Africa. It consists of ten islands and eight uninhabited islets. One of the islands is uninhabited and the total population is 430.000 inhabitants.

The total land area of Cape Verde is 4.033 km$^2$ and the shoreline of the islands is approximately 2,000 km$^2$. The continental shelf is irregular and narrow has a total area of 5,394 km$^2$. The shelf plus the slope down to 500 m constitute an area of 6,500 km$^2$. The climate is dry and the average temperature is around 25°C. There are two seasons, a cold seasons from December to June, in which the average temperature varies between 22-23°C, and a hot season in which temperature varies from 26-27° (Almada 1994).

The sea around Cape Verde is thermally stratified with a thermocline between 40 and 70 m. The average annual temperature is about 24°C and biological diversity is high (Almada 1994). The total surface of the Economic Exclusive Zone (EEZ) is 734,265 km$^2$ (Bravo 1985).

In Cape Verde, further development of the fisheries sector is seen as an important factor to strengthen the national economy. However, the profitability of the fishing operations has been variable. Ship owners are faced with some financial and technical problems since most of the vessels are poorly equipped and old-fashioned (25-30 years) and their operation is costly. In some cases, management tools seem to be inadequate and catching methods inappropriate (INDP 1999).

In Cape Verde, the fishing resources are considered to be under-exploited. The catches only amount to 25% of estimated sustainable yield (INDP 1999) so there should be considerable scope for further expansion and development of the sector.
The approach taken in this project is to analyse the status of the different fishing stocks, estimate the expansion of the fisheries and study the profitability of some potential fishing operations.

# 2. THE FISHERIES IN CAPE VERDE ISLANDS

Although fisheries contribute only around 5% to the GNP, the sector is important to the economy. It employs around 11,000 people. Fish is the main source of animal protein in the diet of the people and exports of fisheries products are of considerable importance to the economy (INDP 1999).
Commercial species are grouped into large pelagics, small pelagics, demersals and lobsters depending on habitat and value.

Tuna species are the most important of large pelagics. These migratory species live at a depth from 0 to 300 m and even down to 400m. They are strong swimmers and have a worldwide distribution  (Medina 2000).

There are six species in Cape Verde waters: yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), bigeye (*Thunnus obesus*), little tuna  (*Euthynnus alleteratus*), Judeu - frigate tuna (*Auxis thazard*), and Serra-Wahoo (*Acanthocybium solandri*) (Monteiro 1998).

Yellowfin is a common species with a tropical and subtropical distribution and forms big schools. It can consume 10% of its body weight per day. Small pelagics and squids are preferred food, but it also feeds with on a variety of other species. They grow fast and live to approximately 7-8 years, reaching 100 kg. The spawning period is from May to November and the main spawning grounds are in the Bay of Guinea and the Caribbean Sea (Monteiro 1998).
The yellowfin tuna found around Cape Verde vary in size from 35-180 cm, which corresponds, to 0.8-110 kg. Cape Verde is on the migration route of the species and it constitutes a secondary spawning zone. Although found in all months of the year, its abundance is greatest during the hot season (Medina 2000).

The bigeye tuna occurs in the tropical and temperate waters of the Atlantic. They are commonly 35-200 cm, weighing 0.9-200 kg. Spawning takes place in the Bay of Guinea, mainly in the first and third trimester (Medina 2000).

The skipjack is also a tropical species, 30-80 cm long, weighing 0.5 to 11.5 kg. It reproduces every year in the Bay of Guinea and the spawning season in Cape Verde is from July to September (Medina 2000).

The Wahoo lives in the hot waters of the Atlantic and it is found in Capeverdian waters all year around (Medina 2000).

The most abundant and important species of the small pelagics are horse mackerel (*Decapterus macarellus),* scad mackerel (*Decapterus punctatus*) and Chicharro-Bigeye scad (*Selar crumenophthalmus*). These species are also strong swimmers. They can be found at 30-200 m depth and usually form big schools at the surface. They are found in Capeverdian waters all year round and usually feed on zooplankton (Medina 2000).

The small pelagics are used as bait for the tuna fisheries, which are most important for export. Also, because of their abundance and low price in the local market, the small pelagics are the most important food fish for the population (Medina 2000).

Tuna fishery is the most valuable fishery in Cape Verde. Until 1991 it contributed around 80% to the industrial catches (Table 1). In 1992 twenty new 11m long purse seiners have started operating, targeting the small pelagics. That, along with a decline in tuna catches, has brought the tuna landings down to about 40% of the total (INDP 1998).

The fisheries in Cape Verde are divided into two sectors: artisanal and industrial/semi-industrial.

Table 1: Tuna catches in the artisanal and industrial fisheries in Cape Verde 1986-1999 (INDP 1999).

| Year | Artisanal catch | % of Artisanal catch | Industrial catch | % of Industrial catch | Total |
|------|------|------|------|------|------|
| 1986 | 2,930 | 62 | 2,215 | 86 | **5,145** |
| 1987 | 2,444 | 61 | 3,007 | 91 | **5,450** |
| 1988 | 2,627 | 64 | 1,840 | 80 | **4,467** |
| 1989 | 2,812 | 44 | 1,860 | 84 | **4,672** |
| 1990 | 2,182 | 44 | 1,351 | 82 | **3,533** |
| 1991 | 1,796 | 41 | 2,105 | 84 | **3,901** |
| 1992 | 1,863 | 43 | 967 | 43 | **2,830** |
| 1993 | 2,032 | 42 | 832 | 38 | **2,864** |
| 1994 | 2,242 | 42 | 940 | 32 | **3,182** |
| 1995 | 1,919 | 42 | 1,737 | 44 | **3,656** |
| 1996 | 2,042 | 42 | 1,640 | 39 | **3,682** |
| 1997 | 1,967 | 40 | 1,233 | 26 | **3,200** |
| 1998 | 1,681 | 32 | 1,152 | 32 | **2,833** |

The artisanal sector is characterised by the use of 4-8 m long wooden boats with 8-25 HP outboard engines. It employs around 5000 fishermen and the fleet is about 1500 boats with 2-3 men on board (INDP 1998).They fish close to the coast and the main fishing gear are handlines for demersal fish and tuna, and purse seine 130x15 fathom and beach seines 50x3 fathom for small pelagics. This sector accounts for more than 50% of the total catches, which supply the local market. The artisanal sector has been stable for several years and fluctuation in catches are small (Table 2).

Table 2: Summary of catches (tons) and effort in the artesanal sector, 1989-1996 (INDP 1998).

|  | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|------|------|------|------|------|------|------|------|------|
| Large pelagics | 2,812 | 2,170 | 1,796 | 1,864 | 2,032 | 2,242 | 1,919 | 2,042 |
| Small pelagics | 2,045 | 1,270 | 1,400 | 1,271 | 1,817 | 1,673 | 1,413 | 1,527 |
| Demersals | 1,087 | 765 | 910 | 908 | 629 | 794 | 882 | 1013 |
| Other | 447 | 726 | 276 | 265 | 351 | 638 | 333 | 330 |
| **Total** | **6,391** | **4,931** | **4,382** | **4,308** | **4,829** | **5,347** | **4,547** | **4,921** |
| Effort (tripsx1000) | 150.0 | 138.1 | 131.1 | 112.7 | 123.1 | 135.8 | 128.7 | 134.6 |
| CPUE(kg/trip) | 42.6 | 35.7 | 33.4 | 38.2 | 39.2 | 40.3 | 35.3 | 36.4 |

The industrial fishing fleet consists of 70-80 vessels varying in size from 8 to 25 m with 40-510 HP engines. The production is mainly for export and processing plants. The main species caught are tunas, small pelagics, demersals and lobsters.

Fisheries activities of industrial vessels are regulated through a licensing system. The licenses are issued by the General Directory of Fisheries (DGP) and the Ministry of Fisheries. For national vessels the licences are for one year. Foreign vessels are issued with licenses for up to one year (Table 3).

Table 3: Numbers of licenses issued to industrial vessels in Cape Verde water, 1990-1996 (Medina 2000).

| Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| National vessels | 44 | 16 | 36 | 29 | 64 | 80 | 69 |
| Foreign vessels | - | - | 32 | 16 | 16 | 28 | 28 |
| **TOTAL** | **44** | **16** | **68** | **45** | **80** | **108** | **97** |

Foreign interest in fishing in the Cape Verde EEZ is moderate. Most do not take full advantage of theirs licenses. Foreign vessels are mainly longliners and some purse seiners. Their total catches average around 4000 t annually (Hallier and Vieira 1996).

Most of the industrial fleet targets tuna species using pole and line and longlines with live bait. Some vessels catch small pelagics with purse seines; lobsters with traps and demersals with handlines. Annual catches have fluctuated considerably in the last decade (Table 4) averaging around 3000 tons. Tuna represented more than 50% of the total catches of the industrial fleet until 1991 followed by small pelagics and demersals. Since 1992 catches of small pelagics have increased after foreign vessels were permitted to buy mackerel from national vessels. Catches of pink lobster vary from year to year with a maximum in 1992 due to an experimental fishing cruise that took place at that time.

Table 4: Summary of catches and effort (days at sea) in the industrial sector 1989-1996 (INDP 1998).

| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|
| Large pelagics | 1,860 | 1,352 | 2,105 | 967 | 832 | 940 | 1,737 | 1,640 | 1,233 | 1,188 |
| Small pelagics | 210 | 231 | 299 | 1,157 | 1,193 | 1,786 | 1,990 | 2,230 | 3,230 | 2,734 |
| Demersals | 136 | 16 | 12 | 2 | 20 | 58 | 126 | 240 | 137 | 156 |
| Lobster | 38 | 30 | 58 | 106 | 76 | 68 | 60 | 29 | 25 | 27 |
| Others | 2 | 15 | 8 | 31 | 50 | 57 | 35 | 104 | 82 | 113 |
| **Total** | **2,246** | **1,644** | **2,482** | **2,265** | **2,171** | **2,909** | **3,948** | **4,243** | **4,707** | **4,218** |
| Effort | 2,301 | 2,021 | 2,253 | 1,304 | N/D | 2,829 | 3,116 | 3,426 | 5,057 | 5,359 |

In 1989 to 1991 effort (days at sea) was relatively stable but declined in 1992. In 1992 a new 11m fibreglass vessels, with 180 hp engines equipped for purse seines were introduced. The effort increased and the catches doubled (Table 4).

In 1996 the average catch of the 11m long vessels was estimated at 2000 kg/trip. The CPUE for the biggest vessels (22-25 m long) in the industrial sector is estimated at 5 tons/trip (Tavares 1996).
Of the total of catches in 1999 40.2% was tuna species, 44% small pelagics; 9.2% demersals, 0.4% lobster and 6.2% other species (Table 4).

From 1990 to 1994 the artisanal sector contributed about twice as much to the total catches as the industrial sector, but the catches have increased in both sectors. Since 1996 their relative contribution has been similar (Table 5).

Table 5: Total catches in Cape Verde, 1990-1999  (INDP 1999).

|  | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Industrial | 1,644 | 2,482 | 2,265 | 2,171 | 2,909 | 3,948 | 4,243 | 4,707 | 4,218 | 4,391 |
| Artisanal | 4,931 | 4,382 | 4,308 | 4,829 | 5,347 | 4,547 | 4,921 | 4,920 | 5,241 | 5,831 |
| **Total** | **6,575** | **6,864** | **6,573** | **7,000** | **8,256** | **8,495** | **9,164** | **9,327** | **9,451** | **10,222** |

Export of fisheries products mainly consist of fresh fish, such as tuna loins and fillets, live lobsters, frozen fish, (e.g. whole tuna) and small pelagics (mackerel), usually used for baits in the tuna fisheries. The main markets are European countries, Canary Islands, Japan, and USA.

The value of the fish exports in the last eight years has fluctuated from 160,000-205,000 USD, but there is no apparent trend. The volume is not a good predictor of the importance of fisheries. In 1993 the export volume was only about a third of what it was in 1997, yet export values were similar. This is because in 1997 the main export product was small pelagic (mackerels), which has a low commercial value, compared to other fish products.

Table 6: Export of fishing products in volume and in value, 1992-1999 (INDP 1999)

|  | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|
| **Tons** | 2274 | 994 | 1974 | 1289 | 2636 | 3115 | 2448 | 1236 |
| **thousand USD** | 205 | 184 | 196 | 160 | 171 | 178 | 203 | 190 |

## 3. STATUS OF FISH STOCKS AVAILABLE TO CAPEVERDIAN FISHERIES AND THE VALUE OF CURRENT FISHERIES.

Capeverdian fisheries operate within the EEZ of the islands. There has been a reciprocal fishing agreement with Senegal since March 1985 and Mauritania since November 1995, but until now Capeverdian fishermen has not operated in these areas.

Most of the fish stocks around Cape Verde are considered to be under-exploited (Monteiro 1998). Fishing effort has increased considerably and there is still a considerable scope for expansion of the fisheries with the exception of lobster that is fully exploited (Table 7). Access is free for all practical purposes, as fishermen are only requested to pay a small license fee.

Table 7: Fishing potential in tons and exploitation of the main resources in Cape Verde waters (INDP 1999).

| Resources | Estimated TAC | Average catch | Expansion potential |
|---|---|---|---|
| Tuna species | 25,000-30,000 | 7,500 | 17,500-22,500 |
| Small pelagic | 10,000-12,000 | 2,400 | 7,600- 9,600 |
| Demersals | 3,000-5,000 | 900 | 2,100-4,100 |
| Lobster | 50-70 | 51 | Fully exploited |
| **Total** | **38,000-47,000** | **10,800** | **27,200-36,200** |

Catch statistics for the tuna species include the catches of foreign vessels estimated at 4000 tons.

There is great interest in renewing the fishing fleet, in the introduction of new technology and creating a credit system (government guaranty), enabling ship owners to acquire bigger and more advanced vessels. Increased fishing power will mainly be directed towards the tuna fisheries.

An acoustic survey carried out off northwest Africa in 1992 showed high density of small pelagics, particularly off Mauritania, with biomass estimated at about 4 million tons (FAO 1997).

In Senegal the demersal resources are considered slightly over-exploited (Table 8). Total catches of demersal stocks on the Mauritanian continental shelf have decreased from 36,000 t in 1984 to 12,800 in 1992 and FAO (1997) considers this resource to be overexploited.

Table 8: Fishery potential and exploitation status of fish in waters off Senegal and Mauritania (FAO 1997).

| Resources | Senegal | | Mauritania | |
|---|---|---|---|---|
| | Potential | Status | Potential | Status |
| Large pelagics | 15,000-20,000 | Fully exploited | 1000# | |
| Small pelagics | 200,000-450,000 | Moderately exploited | 800,000 | Moderately exploited |
| Demersal | 130,000 | Slightly over-exploited | 12,800 | Slightly over-exploited |
| **Total** | **545,000-700,000** | | | |

# Means the average catch

The potential for increased fisheries is greatest on small pelagics in Mauritania. The total landings in Mauritania in 1972-1995 were 327,000 and caught by vessels from different European and Asian countries. Some reports have quoted that the potential of Mauritania's fishery resources to be around 930,000 tons per annum but only about 90,000 t are caught by the national fleet. (WWF 1998).

Local markets are divided into two categories, as there is a substantial difference in price. One is restaurants, hotels, and the population and the other the processing plants.

To estimate the value of the fishing operations (Table 10) we have considered the export value (Table 5), a mean price on the local market of 1500 USD per ton and the average price to processing plans of 700 USD per ton (Table 9). There has been a substantial increase in the value of the fisheries over the last decade reaching 13 million USD in 1999 (Table10).

Table 9: Market price in USD for different species in Cape Verde (INDP 999).

| Species | Export | | Local market | Processing Plants |
|---|---|---|---|---|
| | Price/kg | Main market | Price/kg | Price/kg |
| Fresh tuna | 6 – 11 | EC,Japan | 2.0 – 3.0 | 1 – 1.1 |
| Frozen tuna | | | | |
| 1-Yellowfin | 1.0 – 1.5 | EC,Japan | 2.0 – 2.8 | 1 – 1.1 |
| 2-Bigeye | 0.8 – 1.0 | EC,Japan | 2.0 – 2.8 | 1 – 1.1 |
| 3-Skipjack | 0.5 – 0.7 | EC,Japan | 1.0 | 0.4 |
| Mackerels | | Canada | 0.5 – 1.0 | 0.3 |
| Demersals | 0. | | 2.2 – 2.8 | |
| Lobster | 25 | USA | 15 | |
| Lobster | 30 | Canada | | |
| Lobster | 30 | EC | | |
| Lobster | 48 | Japan | | |

Table 10: Estimated value in USD of the fishing operations in Caoe Verde, 1992-1999 (INDP 1999).

| Year | Catch | Export | | Local Market | | Processing Plants | | Total |
|---|---|---|---|---|---|---|---|---|
| | MT | MT | USD | MT | USD | MT | USD | USD |
| 1992 | 6,573 | 2,274 | 205,000 | 3,960 | 5,940,000 | 339 | 237,300 | **6,382,300** |
| 1993 | 7,000 | 994 | 184,000 | 5,698 | 8,547,000 | 308 | 215,600 | **8,946,600** |
| 1994 | 8,256 | 1,974 | 196,000 | 5,893 | 8,839,500 | 389 | 272,300 | **9,307,800** |
| 1995 | 8,495 | 1,289 | 160,000 | 6,860 | 10,290,000 | 346 | 242,200 | **10,692,200** |
| 1996 | 9,164 | 2,636 | 171,000 | 6,196 | 9,294,000 | 332 | 232,400 | **9,697,400** |
| 1997 | 9,327 | 3,115 | 178,000 | 5,840 | 8,760,000 | 372 | 260,400 | **9,198,400** |
| 1998 | 9,451 | 2,448 | 203,000 | 6,719 | 10,078,500 | 284 | 198,800 | **10,480,300** |
| 1999 | 10,222 | 1,236 | 190,000 | 8,749 | 13,123,500 | 237 | 165,900 | **13,479,400** |

Potential value of fisheries resources of Cape Verde (Table11) has been estimated on the basis of average price for each category of fish (Table 7), prices however change according to the markets (Table 9)

Table 11: Potential value of the fisheries resources of Cape Verde (INDP 1999).

| Resources | Price/ton | Potential | | Mean catch | | Availability | |
|---|---|---|---|---|---|---|---|
| | | Volume (MT) | Value (Th USD) | Volume (MT) | Value (Th USD) | Volume (MT) | Value (Th USD) |
| Large pelagics | 1,500 | 25,000 | 37,500 | 7,500 | 11,250 | 17,500 | 26,250 |
| Small pelagics | 500 | 10,000 | 5,000 | 2,400 | 1,200 | 7,600 | 3,800 |
| Demersals | 2,500 | 3,000 | 7,500 | 900 | 2,250 | 2,100 | 5,250 |
| Lobsters | 30,000 | 60 | 1,800 | 51 | 1,530 | 9 | 270 |
| **Total** | | **38,060** | **51,800** | **10,851** | **16,230** | **27,209** | **35,570** |

The mean catch represents 29% in volume and 31% in value of the estimated potential. There is still a considerable scope for expansion.

There is a significant difference between the estimated value of the mean catches (Table11) and the estimated value of the fishing operations (Table 10). Prices are lowest when supply is high, so large volumes may be sold at relatively low prices. Also the export value does not specify the species being exported (Tuna, lobsters or small pelagics) and same species can be processed in different ways (fresh or frozen), thus fetching a different price.

However, the available data indicate that there is substantial scope for expanding fishing for tuna in Capeverdian waters and small pelagics in the waters off Senegal and Mauritania.

## 4. OPERATION PLANS AND CATCHES OF THE FISHING VESSELS.

The operation plan for fishing activities is elaborated according to the season and based on the availability of the fish stock. In this project, operation plans have been developed for two different vessels, one new and one used vessel.

The new vessel is one of the vessels that the government of Cape Verde has in construction in a shipyard in Portugal (INDP 2000) and the used vessel is a second hand vessel from Norway. The main characteristics of the vessels are listed in the table 12. Kristjan Kari Jakobsson from Norway (personal communication) provided the information on the used vessel.

We are planning to take advantage of the small pelagics resources in Senegal and Mauritania waters based in the agreement Cape Verde has with those countries. However the new vessel has a limited holding capacity ($70m^3$). Because of that and the distance the operation of small vessels from Cape Verde in Mauritanian waters is not feasible. Therefore we have decided to analyse the fishing operations for the used vessel which has a holding capacity of 210 $m^3$ in these areas.

Table 12: Characteristics and price of the vessels.

| Characteristics | New vessel | Used vessel |
|---|---|---|
| Length | 26 m | 27.5 m |
| Crew | 17 person | 10 person |
| Hold capacity | 70 m$^3$ | 210 m$^3$ |
| Fuel  tank capacity | 44 m$^3$ | 60 m$^3$ |
| Water tank capacity | 17 m$^3$ | 5 m$^3$ |
| Engine's power | 600 HP | 990 HP |
| Velocity | 10.5 knots | 10.5 knots |
| Fishing gear | Pole &line, longline, purse seine | Purse seine |
| Vessel price | 1.3 million USD | 1.8 million USD |
| Fishing gear price | 80 Th USD | 100 Th USD |

 The new vessel will fish for tuna species from June to December and small pelagics, from January to June in Capeverdian waters (Figure 1). It will fish small pelagics for bait in Capeverdian waters during the period of tuna fishing. The used vessel will fish small pelagics around the year in Senegalian and Mauritanian waters (Figure 2).

Catches from Senegal and Mauritania will be landed in Cape Verde. Each trip will take six days.



Figure 1: Operation plan for the new vessel.



Figure 2: Operation plan for the used vessel.

The catches for the new vessel are calculated considering days at sea and catch per day (Appendix 1) and for the used vessel, calculations are based on catch per trip and number of trips.

The new 26 m long vessel has a holding a capacity of 70 m$^3$ . If we consider that in tropical climate the processing of fish in ice is 1:1(one kg of ice for one kg of fish), we can see that it is possible to manage 30-50 tons of fish per day. We consider 22 days at sea per month from February to November and 12 and 10 days in January and December (Appendix 1). There is a maintenance period in December and January. This time is also used to renew some documents such as the certification of navigability. The total planned catches are 2954 tons per year (964 t tuna and 1990 t small pelagics).

The used vessel from Norway has a holding capacity of 150 tons per trip. We consider four trips per month from February to November and two trips in January and February for same reasons as the new vessel. The catch per trip is 150 ton and the total catches per year are 6088 tons.

# 5. CONSUMPTION AND COSTS

The main consumption in Cape Verde is fuel and ice. Food is estimated in 4 USD per person per day (Table13).

Table 13:Consumption and costs.

| Item | New Vessel | | | Used vessel | | |
|---|---|---|---|---|---|---|
| | Consump. per day | Unit price USD | Total per year | Consump. per day | Unit price USD | Total per year |
| Fuel(t) | 2.45 | 210 | 124,509 | 3 | 210 | 138,600 |
| Lubricants(t) | 0.074 | 1,825 | 32,682.1 | 0.09 | 1,825 | 36,135 |
| Water(t) | 0.5 | 1.5 | 270 | 1 | 1.5 | 540 |
| Bait(t) | | 300 | 26,820 | | | 0 |
| Ice(t) | 10 | 30 | 72,600 | 25 | 30 | 165,000 |
| Food(USD) | 60 | | 21,600 | 35 | | 12,600 |
| Cleaning(USD) | 10 | | 3,600 | 20 | | 7,200 |
| **Total** | | | **282,081.1** | | | **360,075** |

For catching of skipjack and small yellowfin and bigeye tunas the most suitable length for bait is 6-13 cm and for big yellowfin and bigeye more than 13 cm. Scad mackerel is the bait of choice because of it resistance in the tanks. However, horse mackerel is most often used as bait in Cape Verde because of its abundance. One ton of bait is needed for every 10-30 tons of tuna (Monteiro 1999). The estimated catch of tuna is 964 t per year requiring 96.4 t of bait

The depreciation for the new vessel is calculated over a period of fifteen years and 10% of the investment (price of the vessel) and the depreciation for the used vessel is calculated over a

period of ten years. For fishing gear we consider a period of three years for both vessels. The maintenance and repairing cost are estimated as 50% of the depreciation value.

The salary is calculated according to current wages in Cape Verde fisheries. The salary consists of fixed part (table14) and at the end of the year 5% of the sale volume of the total catch is divided among the crew.

Table 14: Fixed salary per month in Fishery per person in Cape Verde (INDP 1999).

| Staff | Captain | 1st.Mech | 2nd Mech. | Cooker | Fisherman |
|---|---|---|---|---|---|
| Wages (USD) | 500 | 450 | 400 | 200 | 150 |

The insurance in Cape Verde covers fire, wreckage and some mechanical breakdown. It is usually is paid twice a year and the amount mainly depends on the replacement value of the vessel and the fishing gear. Insurance costs for the new vessel is estimated the same as the research vessel *"Islandia"* because it costs the same (INDP 1998).

The initial investment is high and the ship owner will have to finance it through bank loans. There will be a credit line that will permit them to acquire new vessels. The interest rate in fisheries is 8% of the total investment and the loan amortisation period is 15 years.

# 6. PROFITABILITY OF THE FISHING OPERATION

The profitability of the fishing operation depends on the income and total costs. The operation costs are divided into variable and fixed costs  (see Appendix 1 and 2).

The income from the new vessel is calculated according to number of days at sea and the value of the catch per day in USD. For small pelagics we consider a mean price of 300 USD per ton and 1500 USD per ton for tuna (Appendix1). The income of the used vessel is calculated according to the value per trip. The value per trip is the mean price of one ton of small pelagics (300 USD) multiplied by the catch per trip (Appendix 2).

The net profit is calculated as the difference between the income and the total operation costs (Appendix 1 and 2). Net profit before and after interests and tax and the present value of the vessels change throughout the period. The net profit increases with time and interest value decreases (Tables 15 and 16). The net present value is the difference between the total present value and the initial investment.

The present value is the value today of a future payment or series of payments discounted at the appropriate discount rate. The present value is calculated according to the following equation.
$$PV = NP / (1 + IRR)^N$$
Where: PV is the present value; NP the net profit after interest and tax; IRR the internal rate of return and N the number of years

Table 15: Net profit and present value for the new vessel.

| Year | Net profit before Interest and taxes | Interest | Taxes | Net profit after interest and taxes | Present value |
|---|---|---|---|---|---|
| 1 | 1,062,399 | 110,400 | 94,650 | 857,349 | 525,980 |
| 2 | 1,066,470 | 106,328 | 94,650 | 865,491 | 325,752 |
| 3 | 1,070,867 | 101,931 | 94,650 | 874,285 | 201,878 |
| 4 | 1,075,616 | 97,182 | 94,650 | 883,783 | 125,197 |
| 5 | 1,080,745 | 92,053 | 94,650 | 894,041 | 77,699 |
| 6 | 1,086,284 | 86,514 | 94,650 | 905,119 | 48,259 |
| 7 | 1,092,266 | 80,532 | 94,650 | 917,083 | 29,998 |
| 8 | 1,098,727 | 74,071 | 94,650 | 930,005 | 18,663 |
| 9 | 1,105,704 | 67,094 | 94,650 | 943,960 | 11,621 |
| 10 | 1,113,240 | 59,558 | 94,650 | 959,032 | 7,243 |
| 11 | 1,121,379 | 51,419 | 94,650 | 975,309 | 4,519 |
| 12 | 1,130,169 | 42,629 | 94,650 | 992,889 | 2,822 |
| 13 | 1,139,662 | 33,136 | 94,650 | 1,011,875 | 1,764 |
| 14 | 1,149,914 | 22,884 | 94,650 | 1,032,379 | 1,104 |
| 15 | 1,160,987 | 11,811 | 94,650 | 1,054,525 | 692 |
| Total | | | | | 1,383,198 |
| Initial Investment | | | | | -1,380,000 |
| Net present value | | | | | 3,198 |
| IRR=63% | | | | | |

Table 16: Net profit and present value for the used vessel.

| Year | Net profit before Interest and taxes | Interests | Taxes | Net profit after interest and tax | Present value |
|---|---|---|---|---|---|
| 1 | 964,219 | 152,000 | 99,000 | 713,219 | 513,846 |
| 2 | 970,255 | 146,402 | 99,000 | 718,817 | 373,112 |
| 3 | 976,794 | 140,365 | 99,000 | 730,890 | 273,328 |
| 4 | 983,846 | 133,826 | 99,000 | 743,968 | 200,445 |
| 5 | 991,462 | 126,774 | 99,000 | 758,071 | 147,150 |
| 6 | 999,687 | 119,158 | 99,000 | 773,304 | 108,146 |
| 7 | 1,008,571 | 110,933 | 99,000 | 789,754 | 79,573 |
| 8 | 1,018,165 | 102,049 | 99,000 | 807,521 | 58,619 |
| 9 | 1,028,526 | 92,455 | 99,000 | 826,709 | 43,236 |
| 10 | 1,039,717 | 82,094 | 99,000 | 847,432 | 31,930 |
| 11 | 1,051,803 | 70,903 | 99,000 | 869,813 | 23,612 |
| 12 | 1,064,855 | 58,817 | 99,000 | 893,985 | 17,484 |
| 13 | 1,078,952 | 45,765 | 99,000 | 920,090 | 12,964 |
| 14 | 1,094,177 | 31,668 | 99,000 | 948,284 | 9,626 |
| 15 | 1,110,621 | 16,443 | 99,000 | 978,733 | 7,158 |
| Total | | | | | 1,900,236 |
| Initial Investment | | | | | -1,900,000 |
| Net present value | | | | | 236 |
| IRR= 38.8% | | | | | |

The initial investment for both vessels is very high but the internal rate of returns (IRR) is also high, which means that there is potential to make good earnings from the investment.

## 6.1 Loan amortisation schedule

This schedule shows how the loan will be repaid. It gives the required payment on each specified year and a breakdown of the payment showing how much is the interest and the repayment of principal (Table 17 and 18). The interest rate is 8% of the investment and that the bank loan should be paid in full in 15 years.

The interest is calculated by multiplying the loan balance at the beginning of the year (beginning amount) by the interest rate.

The interest component is largest in the first years and declines as the remaining balance of the loan goes down.

The payment (PMT) is calculated according to the equation below
PMT = Loan / PVIFA $_{(8\%, 15)}$, where PVIFA is the present value of an annuity of one dollar for a period of 15 years considering the interest rate of 8%.
 PVIFA $_{(8\%, 15)}$, = 8,5595 (Eugene 1989).

The repayment of the principal equals the payment less the interest. The remaining balance is the difference between the beginning amount and the repayment of principal.

Table 17: Loan amortisation schedule for the new vessel.

| Year | Beginning amount | Payment | Interest | Repayment of principal | Remaining balance |
|---|---|---|---|---|---|
| 1 | 1,380,000 | 161,292 | 110,400 | 50,892 | 1,329,107 |
| 2 | 1,329,107 | 161,292 | 106,328 | 54,963 | 1,274,144 |
| 3 | 1,274,144 | 161,292 | 101,931 | 59,360 | 1,214,783 |
| 4 | 1,214,783 | 161,292 | 97,182 | 64,109 | 1,150,674 |
| 5 | 1,150,674 | 161,292 | 92,053 | 69,238 | 1,081,435 |
| 6 | 1,081,435 | 161,292 | 86,514 | 74,777 | 1,006,658 |
| 7 | 1,006,658 | 161,292 | 80,532 | 80,759 | 925,898 |
| 8 | 925,898 | 161,292 | 74,071 | 87,220 | 838,678 |
| 9 | 838,678 | 161,292 | 67,094 | 94,197 | 744,480 |
| 10 | 744,480 | 161,292 | 59,558 | 101,733 | 642,746 |
| 11 | 642,746 | 161,292 | 51,419 | 109,872 | 532,874 |
| 12 | 532,874 | 161,292 | 42,629 | 118,662 | 414,212 |
| 13 | 414,212 | 161,292 | 33,136 | 128,155 | 286,056 |
| 14 | 286,056 | 161,292 | 22,884 | 138,407 | 147,649 |
| 15 | 147,649 | 161,292 | 11,811 | 147,649 | 0 |
| **Total** | | **2,419,383** | **1,037,552** | **1,380,000** | |

Table 18: Loan amortisation schedule for the used vessel.

| Year | Beginning amount | Payment | Interest | Repayment of principal | Remaining balance |
|------|------------------|---------|----------|------------------------|-------------------|
| 1 | 1,900,000 | 221,975 | 152,000 | 69,975 | 1,830,024 |
| 2 | 1,830,024 | 221,975 | 146,402 | 75,573 | 1,754,450 |
| 3 | 1,754,450 | 221,975 | 140,356 | 81,619 | 1,672,831 |
| 4 | 1,672,831 | 221,975 | 133,826 | 88,149 | 1,584,682 |
| 5 | 1,584,682 | 221,975 | 126,774 | 95,201 | 1,489,481 |
| 6 | 1,489,481 | 221,975 | 119,158 | 102,817 | 1,386,664 |
| 7 | 1,386,664 | 221,975 | 110,933 | 111,042 | 1,275,621 |
| 8 | 1,275,621 | 221,975 | 102,049 | 119,925 | 1,155,695 |
| 9 | 1,155,695 | 221,975 | 92,455 | 129,519 | 1,026,175 |
| 10 | 1,026,175 | 221,975 | 82,094 | 139,881 | 886,294 |
| 11 | 886,294 | 221,975 | 70,903 | 151,072 | 735,222 |
| 12 | 735,222 | 221,975 | 58,817 | 163,157 | 572,064 |
| 13 | 572,064 | 221,975 | 45,765 | 176,210 | 395,854 |
| 14 | 395,854 | 221,975 | 31,668 | 190,307 | 205,546 |
| 15 | 205,546 | 221,975 | 16,443 | 205,531 | 0 |
| **Total** | | **3,329,633** | **1,429,649** | **1,899,984** | |

## 6.2 Sensitivity analysis

In order to see how the profitability of the fishing operations changes, a sensitivity analysis is made by assuming various scenarios, like different number of days at sea, price of fish on the market and the value of the crew share (see Tables 19 and 20).

The business plan presented is based on a number of assumptions. Some are more crucial to the operation than others. In Table 19 and 20, the consequences of different scenarios are presented (catches, prices and crew share). Some cases are very profitable and other cases the operations are unprofitable. The business in fisheries is considered very risky and in fact we can see how fast the profitability changes with changes in the operation conditions.

Usually in Cape Verde the crew share is only 5% of the total catches and the salary is very low. For those reasons our fishermen do not feel motivated and consequently the catches can be less than expected. In this project we are analysing the possibility of increasing the crew share to 20-25% of the total catches, to assure that at least the expected catches will be caught.

Table 19: Sensitivity analyses of the profitability of fishing operations - new vessel.

| Scenarios | New vessel | | | |
|---|---|---|---|---|
| | Item | Net Profit | IRR(%) | OBS |
| A | **Crew share** | | | |
| | 5% | 1,172,799 | 63 | |
| | 20% | 888,849 | 42 | Realistic |
| | 25% | 794,199 | 36 | Realistic |
| B | **Days at sea (Catch)** | | | |
| | 22 (2,954 tons) | 1,172,799 | 63 | |
| | 20 (2,784 tons) | 1,039,210 | 53 | |
| | 18 (2,614 tons) | 905,621 | 44 | Realistic |
| | 15 (2,359 tons) | 705,237 | 29.5 | Realistic |
| C | **crew share, 25%** | | | |
| | **Days at sea** | | | |
| | 20 | 693,010 | 29 | Realistic |
| | 18 | 591,821 | 21.5 | Realistic |
| | 15 | 440,037 | 10 | Unprofitable |
| D | **Crew share, 20%** | | | |
| | **Days at sea** | | | |
| | 20 | 779,560 | 35 | Realistic |
| | 18 | 670,271 | 27 | Realistic |
| | 15 | 506,337 | 15 | Unprofitable |
| E | **Price (USD/ton)** | | | |
| | Tuna and small pelagics | | | |
| | 1200 tuna, 300 small pelagics | 846,284 | 40 | Realistic |
| | 1000 tuna, 250 small pelagics | 691,624 | 28.5 | Realistic |
| | 800 tuna, 250 small pelagics | 536,964 | 17.6 | Unprofitable |

In scenario A price of fish and the days at sea remain the same. The initial IRR is very high, even when the crews share is increased up to 25% The IRR goes down slightly but the fishing operations are still profitable.

In B the crew share is 5% and price of fish remains constant and the days at sea are varied. The catches include tuna and small pelagics. Reducing the days at sea down to 15 the IRR decreases sharply but the operations remain profitable.

In scenarios C and D the crew shares are 25 and 20% respectively but price is kept constant. IRR decreases sharply as the numbers at sea are reduced and the fishing operations becomes unprofitable.

In scenario E the price of tuna and small pelagics is changed and the crew share is kept at 5%. Reducing the price of fish down to 800 USD for tuna and 250 USD for small pelagics, the fishing operations becomes unprofitable

Similar sensitivity analysis for the operation of the used vessel is presented in Table 20.

Table 20: Sensitivity analyses of the profitability of fishing operations - used vessel.

| Scenarios | Used vessel | | | OBS |
|---|---|---|---|---|
| | Item | Net profit | IRR (%) | |
| **A** | **Crew share** | | | |
| | 5% | 1,110,621 | 38.8 | Realistic |
| | 20% | 813,621 | 23 | Realistic |
| | 25% | 714,621 | 18 | Unprofitable |
| **B** | **Number of trips** | | | |
| | 4 trips/month | 1,110,621 | 38.8 | Realistic |
| | 3 trips/month | 728,121 | 18.8 | Unprofitable |
| **C** | **Crew share, 20%** | | | |
| | 4 trips/month | 813,621 | 23 | Realistic |
| | 3trips/month | 498,621 | 5.6 | Unprofitable |
| **D** | **Price (USD/ton)** | | | |
| | 300 | 1,110,621 | 38.8 | Realistic |
| | 250 | 797,121 | 22 | Realistic |

In scenario A, price and the number of trips are kept constant and the crews share is increased up to 25% the IRR becomes low and the fishing operation unprofitable. Scenarios B and C show that the operations become unprofitable if the average number of trips is reduced to 3. Scenario D shows that the operations is sensitive to the price of fish, but will remain profitable at 250 USD/t, as long as the crews share is only 5%.
For the two different types of vessels, the new one seems to be more profitable than the used vessel. However, the operations are not directly comparable. The used vessel will dedicate to small pelagic fisheries in Senegal and Mauritanian waters and the new vessel will fish for tuna and small pelagics in Capeverdian waters.

Figures 3 and 4 show how the profitability of the operations of the new and the used vessel respectively will change with different number of days at sea, given different crews shares. The calculations are shown in Appendix 3. It also shows the effect of changing prices, when crews share is kept fixed at 5%. In this analysis, the baseline has been set at 18 days at sea and 1000 USD/t for the mixed catches of the new vessel and 250 USD/t for the used vessel
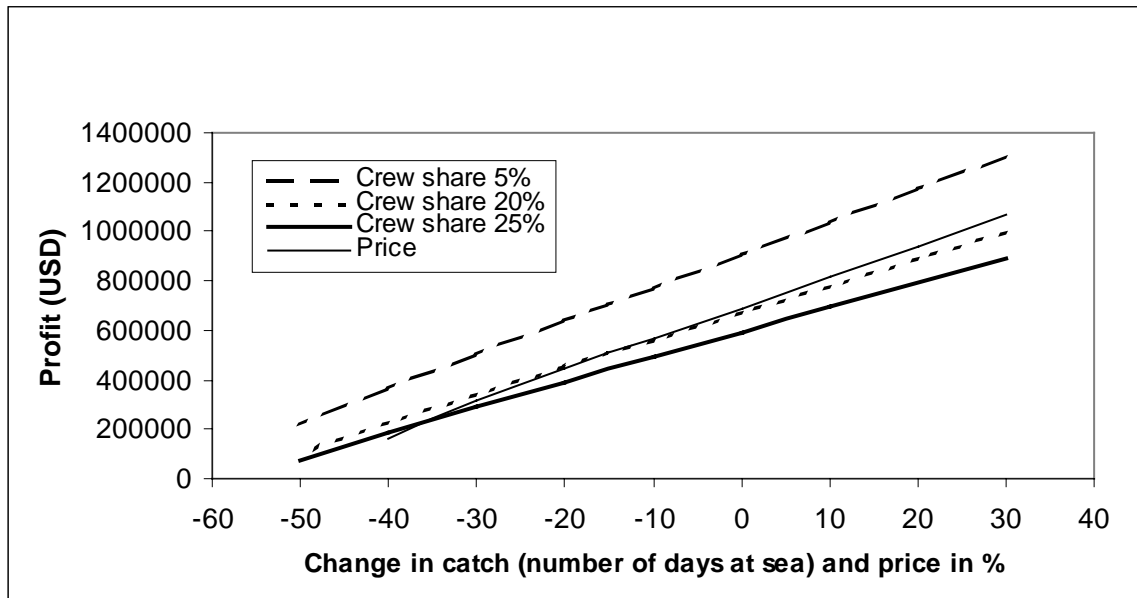
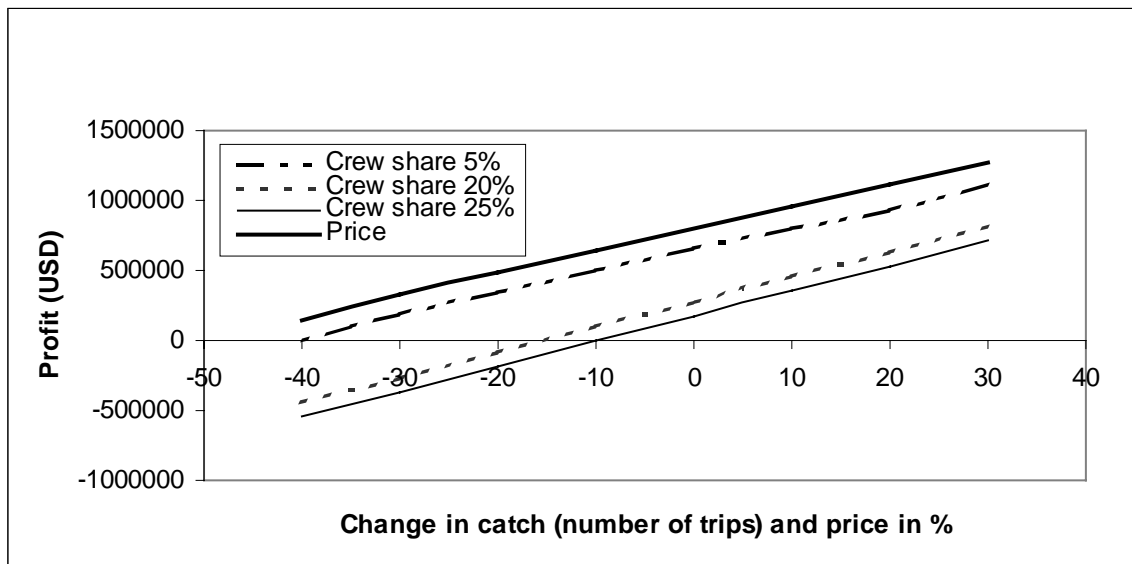Figure 3: Sensitivity analysis of the profitability of fishing operation using the new vessel.



Figure 4: Sensitivity analysis of the profitability of fishing operation using the used vessel.

# 7. DISCUSSION AND CONCLUSION

As has been mentioned before, the tuna fisheries will take place in the Cape Verde EEZ and small pelagic species in Senegal and Mauritania waters. Until now, the mean catch of tuna species is 7,500 tons and the availability of tuna stock is 17,500-22,500 tons.

According to the calculations for new vessel, the catch will be 964 t of tuna per year. This catch can be considered optimistic, as the vessel has to operate 22 days per month to secure this catch (Appendix 1).

The profitability of the fishing operations for both types of vessels can be high. For the new vessel, the profit is slightly more affected by relative changes in price than in days at sea. If our assumptions are correct a salary system based on 20% crew share could be implemented.

For the used vessel the crew share seems to be the most important factor that can affect the profitability. With a crew share 25% the fishing operations will be unprofitable. A crew share of 20% is still profitable and it could be implemented. Profitability greatly depends on the number of trips (catches) as is shown in Figure 4. When the number of trips are decreased less than 10% the profitability becomes negative. This means that the used vessel must secure more than 3 trips per month or 32 trips per year to be profitable (Appendix 3). Reduction in the price of fish also affects the profitability but not as much as the number of trips. Even reducing the price by 10% from the minimum price in the local markets (250 USD per ton), the fishing operations remain profitable (Figure 4).

It is necessary to point out that the fish market can be a problem that can affect the results. The national market is very small, particularly for small pelagics and the export market (usually Canary Islands) is limited. For tuna species the risks are less if taking in consideration the processing plants in Cape Verde with a production capacity of 20 tons/day (Cruz 1999) and the existing export market for tuna (USA, EU and Japan). In order to solve the market problem, in long run, the fishing activities can be expanded by establishing processing plants for small pelagics (mackerels). Another possibility is try to get contracts with buyers, as for example Russian buyers.

**Conclusion**

1. There is scope to expand the fishing operations in a profitable way and make the fisheries sector attractive.

2. The introduction of the used vessel in small pelagic fisheries constitutes a great possibility to benefit from the fisheries agreement with the neighbour countries in a profitable way.

3. The fishing operations of the new vessel are profitable. The main factor for the profitability of this vessel is high tuna catches. This may be possible with higher crew share. However, due to its limited holding capacity, it seems be unprofitable to target only small pelagics.

4. The business in fisheries is risky. The profitability of the fishing operations analysed and the Internal Rate of Return can change dramatically in response to changes in operating conditions.

5. An introduction of a new crew share system may become an important management tool. It will be beneficial both for fishermen and ship owners. The fishermen will be motivated and consequently, the foreseen captures in the operation plan can be assured or even increased.

6. The current analysis has been based on only one new vessel. At present ten are being built. According to this analysis there is enough expansion potential in the tuna fisheries to accommodate all the vessels, but the fisheries for small pelagics in the off-season will only support 4-5 vessels. Therefore other options for their operation must be considered.

# ACKNOWLEDGEMENTS

This project reflects the great efforts and contribution of many people, whose reviews and comments have contributed to make it a success. It is with great pleasure I would like to thanks the staff of United Nation University Mr. Tumi Thomson and Mr. Thór Asgeirsson who gave freely of their time, talents and patience. I also wish to thank the supervisor of the project Mr. Jón Thordarson for his talents, constructive and imaginative comments, which were instrumental in making the project. A very special words of thanks to Mr. Kristján Jakobsson and Mr. Eyjólfur Gudmundsson. My thanks are extended to all the talented staff of Marine Research Institute, and University of Akureyri. I am deeply grateful to the Director of ICEIDA in Iceland Mr. Bjorn Dagbjartsson and the Coordinator in Cape Verde Mr. Gisli Palson, to the companies we have visited in Iceland and to my colleagues at UNU. My overriding debt to all INDP staff and especially to my friend Carlos Santos in Cape Verde who has spent his time in providing me all documents and information needed.
Last, but foremost I am grateful to my parents who have graciously put up with my extended absence.

I would like to dedicate this project to INDP-National Institute for Fisheries Development and to all the fishermen in Cape Verde.

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Appendix 1: Income, operation costs and profitability of fishing operation for the new vessel.

| | Year | | | | | | | | | | | | Total |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Set | Oct | Nov | Dec | Annual |
| Yellowfin | 0 | 0 | 0 | 0 | 0 | 0 | 77 | 88 | 88 | 88 | 0 | 0 | 341 |
| Bigeye | 0 | 0 | 0 | 0 | 0 | 88 | 33 | 66 | 66 | 66 | 88 | 0 | 407 |
| Skipjack | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 66 | 150 | 216 |
| Mackerels | 120 | 330 | 440 | 550 | 550 | | | | | | | | 1,990 |
| **Total catch** | 120 | 330 | 440 | 550 | 550 | 88 | 110 | 154 | 154 | 154 | 154 | 150 | **2,954** |
| Days at sea | 12 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 10 | **242** |
| Catch per day (tons) | 10 | 15 | 20 | 25 | 25 | 4 | 5 | 7 | 7 | 7 | 7 | 15 | |
| Value per day (USD) | 3,000 | 4,500 | 6,000 | 7,500 | 7,500 | 6,000 | 7,500 | 10,500 | 10,500 | 10,500 | 10,500 | 7,500 | |
| **Total income (USD)** | 36,000 | 99,000 | 132,000 | 165,000 | 165,000 | 132,000 | 165,000 | 231,000 | 231,000 | 231,000 | 231,000 | 75,000 | **1,893,000** |
| **Variable costs** | | | | | | | | | | | | | |
| Salary | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 3,500 | 42,000 |
| Crew share | 1,800 | 4,950 | 6,600 | 8,250 | 8,250 | 6,600 | 8,250 | 11,550 | 11,550 | 11,550 | 11,550 | 3,750 | 94,650 |
| Fuel | 6,174 | 11,319 | 11,319 | 11,319 | 11,319 | 11,319 | 11,319 | 11,319 | 11,319 | 11,319 | 11,319 | 5,145 | 124,509 |
| Lubricants | 1,620.6 | 2,971.1 | 2,971.1 | 2,971.1 | 2,971.1 | 2,971.1 | 2,971.1 | 2,971.1 | 2,971.1 | 2,971.1 | 2,971.1 | 1,350.5 | 326,82.1 |
| Food | 1,800 | 1,800 | 1,800 | 1,800 | 1,800 | 1,800 | 1,800 | 1,800 | 1,800 | 1,800 | 1,800 | 1,800 | 21,600 |
| Bait | 0 | 0 | 0 | 0 | 0 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 2,100 |
| Water | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 540 |
| Fishing materials | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 30,000 |
| Ice | 3,600 | 9,900 | 13,200 | 16,500 | 16,500 | 2,640 | 3,300 | 4,620 | 4,620 | 4,620 | 4,620 | 4,500 | 88,620 |
| Cleaning materials | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 3,600 |
| **Sub-total variable cost** | 21,339.6 | 37,285.1 | 42,235.1 | 47,185.1 | 47,185.1 | 31,975.1 | 34,285.1 | 38,905.1 | 38,905.1 | 38,905.1 | 38,905.1 | 23,190.5 | 440,301.1 |
| **Operating Surplus** | 14,660.4 | 61,714.9 | 89,764.9 | 117,814.9 | 117,814.9 | 100,024.9 | 130,714.9 | 192,094.9 | 192,094.9 | 192,094.9 | 192,094.9 | 51,809.5 | **1,452,699** |
| Depreciation-fishing gear | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 27,000 |
| Depreciation-vessel | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 87,000 |
| Insurance | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 12,000 |
| Maintenance and repairs | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 43,500 |
| Interest | 9,200 | 9,200 | 9,200 | 9,200 | 9,200 | 9,200 | 9,200 | 9,200 | 9,200 | 9,200 | 9,200 | 9,200 | 110,400 |
| **Sub-total fixed cost** | 23,325 | 23,325 | 23,325 | 23,325 | 23,325 | 23,325 | 23,325 | 23,325 | 23,325 | 23,325 | 23,325 | 23,325 | 279,900 |
| **Total operation cost** | 44,664.6 | 60,610.1 | 65,560.1 | 70,510.1 | 70,510.1 | 55,300.1 | 57,610.1 | 62,230.1 | 62,230.1 | 62,230.1 | 62,230.1 | 46,515.5 | 720,201.1 |
| **Net profit** | -8,664.6 | 38,389.9 | 66,439.9 | 94,489.9 | 94,489.9 | 76,699.9 | 107,389.9 | 168,769.9 | 168,769.9 | 168,769.9 | 168,769.9 | 28,484.5 | **1,172,799** |

Appendix 2: Income, operation costs and profitability of fishing operation for the used vessel.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Set | Oct | Nov | Dec | Total Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yellowfin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bigeye | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skipjack | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mackerels | 300 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 300 | 6,600 |
| **Total catch** | 300 | 600 | 600 | 600 | 600 | 88 | 600 | 600 | 600 | 600 | 600 | 300 | **6,088** |
| Days at sea | 10 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 10 | **220** |
| Catch per trip (tons) | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | |
| Value per trip (USD) | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 | |
| N° of trips | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 44 |
| **Total income (USD)** | 90,000 | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 | 90,000 | **1,980,000** |
| **Variable costs** | | | | | | | | | | | | | |
| Salary | 2,450 | 2,450 | 2,450 | 2,450 | 2,450 | 2,450 | 2,450 | 2,450 | 2,450 | 2,450 | 2,450 | 2,450 | 29,400 |
| Crew share | 4,500 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 4,500 | 99,000 |
| Fuel | 6,300 | 12,600 | 12,600 | 12,600 | 12,600 | 12,600 | 12,600 | 12,600 | 12,600 | 12,600 | 12,600 | 6,300 | 138,600 |
| Lubricants | 1,642.5 | 3,285 | 3,285 | 3,285 | 3,285 | 3,285 | 3,285 | 3,285 | 3,285 | 3,285 | 3,285 | 1,642.5 | 36,135 |
| Food | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 12,600 |
| Bait | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Water | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 540 |
| Fishing materials | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 30,000 |
| Ice | 9,000 | 18,000 | 18,000 | 18,000 | 18,000 | 18,000 | 18,000 | 18,000 | 18,000 | 18,000 | 18,000 | 9,000 | 198,000 |
| Cleaning materials | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 3,600 |
| **Sub-total variable cost** | 27,787.5 | 49,230 | 49,230 | 49,230 | 49,230 | 49,230 | 49,230 | 49,230 | 49,230 | 49,230 | 49,230 | 27,78.,5 | 547,875 |
| **Operating Surplus** | 62,212.5 | 130,770 | 130,770 | 130,770 | 130,770 | 130,770 | 130,770 | 130,770 | 130,770 | 130,770 | 130,770 | 62,212.5 | **1,432,125** |
| **Fixed costs** | | | | | | | | | | | | | |
| Depreciation-fishing gear | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 2,250 | 27,000 |
| Depreciation-vessel | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 7,250 | 87,000 |
| Insurance | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 12,000 |
| Maintenance. and repairs | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 3,625 | 43,500 |
| Interest | 12,667 | 12,667 | 12,667 | 12,667 | 12,667 | 12,667 | 12,667 | 12,667 | 12,667 | 12,667 | 12,667 | 12,667 | 152,004 |
| **Sub-total fixed cost** | 26,792 | 26,792 | 26,792 | 26,792 | 26,792 | 26,792 | 26,792 | 26,792 | 26,792 | 26,792 | 26,792 | 26,792 | 321,504 |
| **Total operation cost** | 54,579.5 | 76,022 | 76,022 | 76,022 | 76,022 | 76,022 | 76,022 | 76,022 | 76,022 | 76,022 | 76,022 | 54,579.5 | 869,379 |
| **Net profit** | 35,420.5 | 103,978 | 103,978 | 103,978 | 103,978 | 103,978 | 103,978 | 103,978 | 103,978 | 103,978 | 103,978 | 35,420.5 | **1,110,621** |

The title "Year" spans the monthly columns (Jan–Dec).

Appendix 3: Sensitivity analysis of profitability of the fishing operation.

**New vessel**

| Crew share 5% | | | Crew share 20% | | | Crew share 25% | | | Price of product (USD) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Days at sea | % of change | Profit(US$) | Days at sea | % of change | Profit | Days at sea | % of change | Profit | Price | % of change | Profit |
| 24 | 30 | 1,302,587 | 24 | 30 | 995,237 | 24 | 30 | 892,787 | 1300 | 30 | 1065401 |
| 22 | 20 | 1,172,799 | 22 | 20 | 888,849 | 22 | 20 | 794,199 | 1200 | 20 | 940809 |
| 20 | 10 | 1,039,210 | 20 | 10 | 779,560 | 20 | 10 | 693,010 | 1100 | 10 | 816216 |
| 18 | 0 | 905,621 | 18 | 0 | 670,271 | 18 | 0 | 591,821 | 1000 | 0 | 691624 |
| 16 | -10 | 772,032 | 16 | -10 | 560,982 | 16 | -10 | 490,632 | 900 | -10 | 567031 |
| 14 | -20 | 638,443 | 14 | -20 | 451,693 | 14 | -20 | 389,443 | 800 | -20 | 442439 |
| 12 | -30 | 504,854 | 12 | -30 | 342,404 | 12 | -30 | 288,254 | 700 | -30 | 317846 |
| 10 | -40 | 367,464 | 10 | -40 | 230,214 | 10 | -40 | 184,464 | 600 | -40 | 160241 |
| 8 | -50 | 218,023 | 8 | -50 | 108,223 | 8 | -50 | 71,623 | 500 | -50 | 21399 |

**Used vessel**

| Crew share 5% | | | Crew share 20% | | | Crew share 25% | | | Price of product (USD) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N° of trips | % of change | Profit(US$) | N° of trips | % of change | Profit | N° of trips | % of change | Profit | Price | % of change | Profit |
| 44/year | 30 | 1,110,621 | 44/year | 30 | 813,621 | 44/year | 30 | 714,621 | 325 | 30 | 1,267,371 |
| 40 | 20 | 930,621 | 40 | 20 | 633,621 | 40 | 20 | 534,621 | 300 | 20 | 1,110,621 |
| 36 | 10 | 804,621 | 36 | 10 | 453,621 | 36 | 10 | 354,621 | 275 | 10 | 953,871 |
| 32 | 0 | 651,621 | 32 | 0 | 273,621 | 32 | 0 | 174,621 | 250 | 0 | 797,121 |
| 28 | -10 | 498,621 | 28 | -10 | 93,621 | 28 | -10 | -5,379 | 225 | -10 | 640,371 |
| 24 | -20 | 345,621 | 24 | -20 | -86,379 | 24 | -20 | -185,379 | 200 | -20 | 483,621 |
| 20 | -30 | 192,621 | 20 | -30 | -266,379 | 20 | -30 | -365,379 | 175 | -30 | 326,871 |
| 16 | -40 | 39.6 | 16 | -40 | -446,379 | 16 | -40 | -545,379 | 150 | -40 | 140,175 |