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MARKETING OF TUNA FROM THE KINGDOM OF TONGA FINAL REPORT

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ABBREVIATIONS

FDA	Food and Drug Administration
GOT	Government of Tonga
kg	Kilogram
m	Meter
ml	Mililiter
mt	Metric ton
PIMAR	Pacific Islands Marine Resources
RDA	RDA International, Inc.
RDO	Regional Development Office
SP	South Pacific
USAID	United States Agency for International Development

1.0 EXECUTIVE SUMMARY

Longline fishing trials by the PIMAR/Tonga project produced tuna catches that were marketed locally and overseas. Twenty-five trial export shipments were made during 1993. In each case, fish landed in Vava'u by project vessels were surface-shipped in iced containers to Nuku'alofa, where re-packing for air shipment was handled by local seafood exporters. A total of 271 tuna were exported to Australia, Hawaii, Japan and New Zealand. The total headed and gutted weight of the exports was 7,840 kg. The fish were tracked through each stage of export to final marketing. Feedback from this process allowed evaluation of handling and quality control at sea, before and after surface transportation, and before and after air shipment.

Market acceptance in each destination was assessed in terms of preferences for fish species, sizes, body appearance, flesh quality and other characteristics. Evaluation of the marketing trials indicated that, considering the high cost of export, every effort should be made to produce premium, high-value tuna for the Hawaii and Japan *sashimi* markets. Tuna of lower quality or too small for overseas *sashimi* markets could be sold locally or exported to New Zealand. Total reliance on the latter markets, however, is unlikely to be profitable.

About 50% of the tuna caught with horizontal longline and handline gear on offshore seamounts was of export size (> 18 kg). Only 1 percent of the fish taken with "vertical" longline or handline gear in nearshore waters and around fish aggregation devices was of export size.

The trial exports generally met the quality standards of the *sashimi* tuna industry. Approximately 70% of the fish exported to Hawaii were graded as #1 or #2 *sashimi*. If good quality can be maintained and if export-size tuna can be harvested in sufficient quantity, the small-scale longline fishery has the potential to significantly increase Tonga revenues from seafood export.

Exported fish was generally delivered to overseas markets with internal temperatures below 7.2°C (45°F), the *existing* standard enforced by the U.S. Food and Drug Administration (FDA). The FDA has proposed new regulations for U.S. seafood processors and importers. Of special concern to Tonga exporters is the FDA proposal for stricter control of internal temperature in scombroid fish imports to the U.S.. Core temperature of imported tuna could not exceed 4.4°C (40°F) upon arrival. The FDA is also proposing rigorous sanitation requirements for overseas facilities where seafood is processed for export to the U.S.. In their present condition, Government of Tonga (GOT) fish market facilities in Nuku'alofa and Vava'u would not meet the proposed standards. Furthermore, water and ice presently available at these facilities do not meet drinking water standards because of coliform bacteria.

Seafood export is complex and the risk of failure is high for new ventures. Success requires skillful management and coordination of all facets of the business: fishing vessels and crews; vessel support; quality control, transportation and marketing of fish. Because of its poor transportation and communication links and vessel support services, Vava'u poses a special challenge for longline fishery development.

2.0 INTRODUCTION

This report is a contribution to the USAID-funded Tonga Small-Scale Tuna Longline Project, a component of the Pacific Islands Marine Resource (PIMAR) Project. This project will be referred to as the PIMAR/Tonga project or simply as the project in the remainder of this report. The purpose of the project is to assess the feasibility of establishing a small-scale longline fishery in Vava'u, Kingdom of Tonga.

Section 3.0 describes the species, size, and grade composition of the tuna catches and exports during 1993 fishing and marketing trials. Section 4.0 discusses market preferences and purchasing standards for fresh tuna in the five markets tested: Tonga, Australia, New Zealand, Hawaii and Japan. Section 5.0 evaluates all elements of the export marketing chain: fish handling procedures, processing facilities, quality of fish and packing, transportation links, and marketing options. Section 6.0 makes recommendations to improve fish shelf life, to select *sashimi* tuna markets and to develop marketing relationships, to improve packing for better temperature control of fish in transit, and to improve water quality for ice and slurry making and fish processing. Unresolved issues considered in Section 7.0 include the continued reliance on ferry transport and the unreliability of telecommunications in Vava'u, as well as uncertainties about the size composition of the tuna harvest and private sector approaches to fishing industry development in Tonga.

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3.0 CATCH COMPOSITION

This section describes the composition of tuna catches and exports during PIMAR/Tonga fishing trials. Twenty-five shipments of fish were made during 1993 to overseas destinations including Australia, Hawaii, Japan and New Zealand. A total of 271 fish with a headed and gutted weight of 7,840 kg were exported. A detailed accounting of exports is provided in Appendix A.

3.1 Species composition

Bigeye tuna comprised about three-quarters of the catches and exports during 1993 fishing trials. Yellowfin tuna accounted for most of the remainder. A few albacore were also caught. Bigeye tuna is preferred over the other two species in the *sashimi* market, so the species composition was favorable for export.

Bigeye tuna have also predominated in tuna catches made by a private longline vessel fishing the same seamount areas as the PIMAR/Tonga project since December 1993. Available information suggests year-round availability of this valuable species.

3.2 Size composition

Small fish predominated in the catches made by "vertical" longline and handline gear in nearshore waters and around fish aggregation devices (within 50 nautical miles of Vava'u). Only horizontal longline and handline fishing on offshore seamounts produced a significant catch of exportable fish (> 18 kg). Typically, about 25% of the seamount catch was of prime export size (> 27 kg), 25% was of acceptable export size (18-27 kg), and 50% was too small for export (except to low-value specialty markets).

A private longline vessel fishing the same seamount areas since December 1993 has had similar results: about 28% of the fish have been larger than 27 kg; 17% between 18-27 kg; and 55% smaller than 18 kg.

3.3 Grade composition

The quality of each tuna entering the *sashimi* market is evaluated by "grading" the flesh. This qualitative assessment, usually made at every level of tuna distribution, is directly linked to pricing and to consumer satisfaction. During the PIMAR/Tonga export trials, fish were graded according to the Hawaii scale of #1 through #4, where #1 is prime *sashimi*, #2 is acceptable *sashimi*, #3 is marginal for *sashimi*, and #4 is unacceptable for *sashimi* but satisfactory for cooking.

Tuna grading during the marketing trials was limited to fish exported to *sashimi* markets in Hawaii and Japan. Australian and New Zealand tuna buyers do not usually

grade tuna flesh, so reports on grade composition were not available for shipments to the latter destinations. Tuna grades were determined in three ways: (a) inspection of fish by the PIMAR/Tonga Marketing Consultant in Vava'u prior to export; (b) inspection of fish by the PIMAR/Tonga Marketing Consultant after arrival in Hawaii; or (c) inference based on reports by Japanese marketers.

About 3,150 kg of tuna were graded. Of this fish, 24% were considered prime (#1, #2+) *sashimi*, 46% were considered acceptable (#2) *sashimi*, 12% were considered marginal (#3) *sashimi*, and 18% were unacceptable for *sashimi* but suitable for cooking.

4.0 MARKETING ALTERNATIVES

Frozen *sashimi*-grade tuna can bring high prices in Japan but the technical difficulties and investment required to produce acceptable quality are beyond the capabilities of small-scale longline fleets. Not only do harvester vessels need special and costly refrigeration systems to produce frozen *sashimi* tuna but so do all carrier vessels and shoreside cold stores throughout the distribution chain.

The primary buyers of conventionally-frozen tuna are canners, who pay low prices for all species except albacore (US$ 2.00/kg or more). Albacore tuna fishing grounds in the vicinity of Tonga are south of Tongatapu and this species is only caught incidentally in the Vava'u-based longline fishery.

The PIMAR/Tonga project has emphasized fresh tuna markets because of the relative ease of product handling and the potential for higher prices for fresh bigeye and yellowfin tuna (the primary catch) compared to conventionally-frozen products. There are major distinctions between fresh tuna marketed for use as *sashimi* (raw fish) and for use in cooking. The primary use of tuna in Tonga, Australia and New Zealand is for cooking, whereas the primary use of tuna in Hawaii and Japan is for raw fish preparations. Marketing trials were conducted in each of the five locations to determine purchasing standards and preferences.

4.1 Tonga

There are few species-specific preferences in local fish markets in Vava'u and Nuku'alofa. Tuna is substituted with many other fish and, like most other species, can usually be sold for US$ 1.70/kg - US$ 2.00/kg, unless the market is flooded by large landings. No *sashimi* market has developed in Tonga and purchasing standards are flexible. Local markets are the most convenient and least demanding outlets for catches of small, lower-grade tuna. Whenever there are large church conventions or other gatherings requiring feasts (pola), the demand for fish is much higher than normal. At other times, however, demand is readily satisfied and local markets can be flooded by an oversupply of fish.

4.2 Australia

Australia lacks a well-developed *sashimi* tuna market and most of the demand for tuna is for cooking use. About 20% of the fish weight exported during PIMAR/Tonga marketing trials was shipped to an Australian buyer. Market prices averaged about US$ 5.00/kg. The buyer indicated that the Australian market does not consider flesh color and fat content to be important but that freshness is paramount. Australian tuna fishermen make an effort to deliver fish to market no later than 3-5 days from capture, with an outside limit of 7 days. Best suited for this market are Grade #3 tuna

between 15-30 kg. However, the requirement of delivering tuna within 7 days of capture is a virtual impossibility with the present ferry and plane schedules in Tonga.

4.3 New Zealand

The primary demand for tuna in New Zealand is for cooking. About 8% of the fish weight exported during marketing trials was shipped to a New Zealand fish processor. The average price was US$ 4.18/kg, lower than in any other overseas market (but costs were also much lower). The product was steaked but no reports of the flesh grade were available, presumably because of unfamiliarity with the *sashimi* tuna grading scale. Best suited for this market are small, Grade #3 tuna.

4.4 Hawaii

About two-thirds of the tuna weight exported during marketing trials was shipped to Hawaii. Prices for "normal" shipments ranged from US$ 6.38/kg to US$ 7.70/kg, while two substandard shipments sold for as low as US$ 2.60/kg -- barely enough to cover handling and shipping expenses.

Hawaii is both a final market destination for fresh tuna exports and a gateway to continental U.S. tuna markets. Hawaii residents utilize tuna mainly for raw fish preparations, but restaurants use tuna both for *sashimi* and for cooking. Fresh tuna is a staple in every segment of Hawaii's seafood industry, from wholesale to retail. Seafood companies which re-export seek mainly #2 tuna for transshipment to the continental U.S. Retailers who loin tuna for household consumption and processors who loin tuna for restaurant use require a full range of grades from #1 to #3. Wholesalers have a strong preference for fish over 27 kg (headed and gutted), but tuna between 18-27 kg are acceptable to restaurant fish processors and retailers.

In the continental U.S., fresh tuna is primarily a restaurant, rather than a household, food item. Restaurants serving raw or rare fish preparations purchase higher grades of tuna, whereas those which grill seafood purchase lower grades of tuna. There is a strong preference for tuna over 27 kg (headed and gutted) and smaller fish have to sold at greatly discounted prices.

4.5 Japan

About 6% of the tuna weight exported during marketing trials was sent to Japanese markets. The average price received was US$ 8.88/kg, with a top price of nearly US$ 16/kg for one high-fat bigeye tuna. Shipments to Japan during the PIMAR/Tonga marketing trials were through New Zealand. Freight, packing costs and sales commissions for the small quantities of fish shipped were so high that there was little net return after deducting these expenses.

Considerable savings in air freight to Japan are possible by transshipping through Hawaii (with a freight cost of approximately US$ 3.50/kg for medium to large shipments). Further, fish to be marketed in Japan should be consigned to specialty tuna importers, which customarily charge no more than a 5% sales commission.

There is considerable market segmentation in Japan's *sashimi* tuna buying patterns. The upscale end of the *sashimi* market places a premium on the fat content of tuna. Fat in tuna flesh is a natural phenomenon related to water temperature of the fish habitat and diet. These factors are not under the control of fishermen and are unaffected by fish handling.

Few of the tuna exported during 1993 PIMAR/Tonga marketing trials contained high fat. Bigeye tuna taken in April-May 1994 by a private longline vessel fishing at the same offshore seamounts contained moderate to high fat. There is apparently a seasonal fluctuation in tuna fat content offshore of Vava'u.

The Japanese tuna market has greater breadth than many imagine and preferences for fresh tuna products vary considerably with geographic location, degree of urbanization and income. In Tokyo, for example, bigeye tuna with high fat content (i.e., visible marbled fat) is appreciated but lean tropical yellowfin tuna is not. By contrast, in southern Japan, yellowfin tuna is more appreciated than bigeye tuna. The majority of bigeye is used for restaurant *sashimi*, whereas the majority of yellowfin is used for household *sashimi*. Tuna over 25 kg are strongly preferred in Japan.

4.6 Value-added tuna products

4.6.1 Tuna loins

The PIMAR/Tonga marketing trials focused on export of headed and gutted tuna. The next level of processing (after deheading and evisceration) is quartering of tuna into loins. There are major distinctions between tuna loins marketed for use as *sashimi* and for use as processed products.

Frozen loin production for the *sashimi* market is more demanding and more expensive than chilled loin production. Freezing requires more labor and power, as well as more costly shoreside infrastructure. It is far more economical to produce chilled loins than frozen loins for the Japanese *sashimi* market, especially when working with low-fat tropical yellowfin tuna. Chilled yellowfin loins processed in the Philippines are exported directly to supermarket chains in Japan. Channels to this market cannot be opened without much larger scale and more consistent production of tuna than is possible in the Vava'u longline fishery.

It is also unrealistic to expect that frozen loins could be processed in Vava'u for the *sashimi* market. To maintain red flesh color, the freezing of tuna needs to be rapid

and deep. The temperature of the center of the tuna should be reduced to -30°C to -40°C within 4 hours of loining and should be maintained below -55°C throughout storage and transportation. Any lapse in the holding temperature above -55°C will cause undesirable color changes in the flesh. Only the largest tuna processors in Japan go to the trouble and expense of deep freezing tuna from harvest to final distribution.

Processing of frozen yellowfin and bigeye tuna loins for canning or steaking is less demanding but would be uneconomical in Vava'u because of high energy costs to operate freezers. As part of the PIMAR/Tonga marketing trials, approximately 900 kg of small and medium yellowfin and bigeye tuna were quartered into loins, blast frozen, glazed (to prevent oxidation and weight loss) and stored in holding freezers. Metal freezer trays were used to maintain the shape of loins so they did not twist. The procedures generally followed those employed in the Seattle Seafoods' tuna loining operation based in Bali, Indonesia.

The loins retained *sashimi* quality for up to three weeks in freezer storage but then deteriorated to steak quality. It was determined that better longevity could be attained with more expensive packing materials and lower holding temperatures. However, the near-term market outlook for steaking-grade tuna loins is not favorable for Vava'u. The main reason for this is that the market has been established by processors in Singapore and Indonesia who are loining #3 fish for which the market ceiling is a relatively low US$ 3.85/kg (c.i.f. U.S. west coast). It is estimated that US$ 7.70/kg would be necessary for loining to economically attractive in Vava'u, where onshore freezing costs are on the order of US$ 1.00/kg. Furthermore, the infrequency of container ships serving Vava'u (one per month) and the need to transship at another Pacific port means that loins would probably be at least two months in storage and transit before reaching market. The market would have to improve markedly before an investment in better holding freezers is warranted.

4.6.2 Tuna jerky

Dried tuna jerky products are being processed in Hawaii, Guam and Kiribati. The cost of production is on the order of US$ 17/kg. Marketing has been aimed at duty-free stores and upscale food distributors. This type of manufacturing is labor intensive and Tonga, with low labor costs, could possibly compete in the tuna jerky market if finished products could be shipped to distributors by sea freight and if processing skills and facilities were upgraded to manufacture uniformly high-quality products.

5.0 PROJECT FINDINGS

5.1 Evaluation of fish handling procedures

Proper handling of fresh tuna from the time of capture through marketing is essential to maintain high quality and maximize market value. Various organizations have published guidelines and handbooks implying that standardized rules should be rigidly applied in handling fresh tuna. In reality, no two situations are exactly alike and there are always trade-offs between what is theoretically beneficial and what is practical on fishing vessels. The development of workable tuna fishing and handling systems usually involves a large measure of trial-and-error and the Vava'u project was no exception. Furthermore, tuna handling technology continues to evolve and improve. For example, the use of an ice-seawater slurry for rapid chilling, once believed to be a critical element of proper tuna handling, has been discontinued by the long-range Japanese *sashimi* longline fleet in favor of pressurized bleeding with sea water pumped through tuna arteries.

The immediate priorities after capturing tuna are rapid chilling and thorough bleeding of the fish. The primary objective is to reduce internal fish temperatures to -1°C to 2°C within 36 hours of capture. According to Japanese technicians, the first 30 minutes to one hour on deck is the most critical period. If body temperature remains above 26°C for more than one hour after capture, there is a greatly increased risk of flesh deterioration.

In PIMAR/Tonga horizontal longline trials, all export-size tuna were bled, gilled and gutted and submerged in ice as soon as possible after capture. Fishermen were trained to handle fish gently, without throwing or dragging by the tail. A cushioned cradle was installed on the fishing vessel to hold fish for evisceration.

The best method for icing tuna at sea is in a compartmentalized and refrigerated hold below the deck of the fishing vessel. Fish can be separated and well packed in ice without chafing and bruising. The vessel used for horizontal longline experiments lacked a compartmentalized or refrigerated hold during 1993 fishing trials. Fish were subject to damage from contact with other fish, as well as contact with water from melted ice. Most of the export-size tuna were iced in deck boxes (with plugs opened to drain off ice melt) rather than in the hold.

Rapid chilling of tuna catches can be enhanced by submerging the fish in an ice slurry for up to 24 hours before repacking in ice. This treatment was abandoned during the fishing trials because of vessel limitations which agitated the slurry and severely bruised the fish. Export-size tuna had to be wrapped in cheesecloth "socks" or plastic bags and packed tightly in ice to prevent damage to their bodies.

The internal temperatures of the catch were checked as the fishing vessel unloaded in Vava'u. If temperatures were above 0°C, the fish were submerged in a saltwater-ice slurry to reduce core temperatures before shipping. Due to limited air transportation from Vava'u, the 18-hour ferry ride to Nuku'alofa was the most practical means of delivering fish to Nuku'alofa for transshipment overseas by air freight. Fish traveled on the ferry in iced bins, with drain plugs open to remove water.

Private seafood exporters in Nuku'alofa received the tuna from the ferry and arrange overseas sales. They rechecked fish core temperatures, maintained or returned temperatures to 0°C (in a saltwater-ice slurry), and completed processing by removing fish heads and cleaning up the bodies.

Fish were air shipped to overseas markets in waxed shipping cartons insulated with styrofoam or with thermal barrier material (known as "insufoil"). Frozen coolant was enclosed in the boxes to shield the fish from heat transfer while in transit. The coolant consisted of dry ice, wet ice, frozen gel ice or a combination of these materials.

Core temperatures and grades of fish shipped to Hawaii were checked by the PIMAR/Tonga Marketing Consultant upon arrival. Core temperatures were not recorded for tuna arriving in Japan, but the buyers indicated that they were satisfactory and provided comments on fish quality and packing. Core temperatures and grades were not generally recorded for tuna arriving in Australia and New Zealand, but the Australian buyer provided comments on fish condition and packing.

5.2 Evaluation of fish quality

A few markets for cooking-grade tuna were tested during the 1993 PIMAR/Tonga marketing trials but the *sashimi* tuna market was more economically attractive. The quality of fish produced during the project was, therefore, evaluated against the standards of the *sashimi* tuna industry.

5.2.1 Freshness and shelf life

The freshness and shelf life of tuna exported to Hawaii during the PIMAR/Tonga marketing trials were better than average because of short fishing trips. The time between capture and marketing is compared with other longline fisheries in Table 5-1. The results of the trial exports were generally favorable, although three shipments were considered substandard.

Table 5-1. Time elapsed between capture of tuna and delivery to Hawaii market, various longline fishing fleets

Longline Fishing Fleet	Time Elapsed Between Fish Capture and Marketing (Days)
Hawaii	10-14
Federated States of Micronesia and Guam	14-21
Marshall Islands	6-8
PIMAR/Tonga	8
Tahiti	6-8

One small shipment to Australia had to be marketed at a large price discount because of a severe deterioration in freshness. The buyer observed that the Australian market is accustomed to tuna no older than 5-7 days from capture. Tuna exports from Vava'u cannot meet this timetable because of limited ferry and airline service. A large shipment to Hawaii was not iced properly on board the fishing vessel when the crew caught an exceptional amount of fish. A second shipment to Hawaii lost quality during a five-day holding period in Vava'u when the ice facility was partially inoperable. The core temperatures of the second and third substandard shipments were noted to be above the acceptable range at the time of transshipment and the fish would not normally have been exported. The purpose of sending the substandard shipments was to demonstrate to the crew and exporters that proper procedures must be followed throughout the harvesting-handling-shipping chain.

The PIMAR/Tonga Marketing Consultant viewed two shipments at the time of vessel offloading in Vava'u and inspected all shipments to Hawaii upon arrival. Fish were in generally good condition at the time of offloading but lost some quality during the transshipment process. A primary reason for this was the poor quality of ice available in Vava'u during 1993 fishing and marketing trials. Sharp-edged ice caused bruising and chafing of fish bodies during ferry transport in bins. This problem proved to be controllable by bagging fish in cheesecloth "socks" and in plastic.

5.2.2 Grade

Fresh tuna entering the Hawaii *sashimi* market are graded accordingly to a qualitative scale: #1 is prime *sashimi*, #2 is acceptable for *sashimi*, #3 is marginally acceptable for *sashimi*, and #4 is unacceptable. Each tuna buyer keeps records of tuna purchases

by grade of fish but summarized statistics for the entire *sashimi* industry are unavailable.

Approximately 70% of the tuna exported to Hawaii during the PIMAR/Tonga marketing trials were #1 or #2 *sashimi* quality. This percentage compares favorably with the distribution of tuna grades at the daily fish auction in Honolulu and with imports from areas (Marshall Islands, Fiji) with a reputation for producing high-quality tuna.

5.2.3 Internal temperature control

Tuna landed in Vava'u by the project fishing vessels were chilled to 0°C before transport by ferry. When received in Nukalofa, the fish still had core temperatures of 0-2°C. This temperature was maintained until the tuna were boxed for air shipment.

Hawaii tuna buyers, as well as the U.S. Food and Drug Administration, are presently using a guideline of 7.2°C as the core temperature that should not be exceeded in tuna imports. Core temperatures of fish received in Hawaii ranged from 2.2°C to 10°C but were mostly satisfactory to marginally satisfactory. Two shipments contained fish with core temperatures higher than the guideline. Fish exported from Vava'u on September 30, 1993, arrived in Hawaii with elevated core temperatures (7.8°C -10°C). This shipment occurred during a heat wave in Hawaii.

Another shipment of fish, exported from Vava'u on December 2, 1993, arrived in Hawaii with core temperatures of 10-11.7°C. This shipment was not iced properly on board the fishing vessel and fish core temperatures were noted to be above acceptable limits at the time of surface shipment. Furthermore, the exporter failed to include frozen gel packs in the shipping cartons. This shipment was treated as a training exercise, demonstrating to the fishing crew and exporters the loss of market value from poor handling and packing of tuna exports.

5.3 Evaluation of packing

The objective in packing fresh tuna for overseas export is to deliver fish with core temperatures below 7.2°C (45°F), the current guideline of Hawaii tuna importers and the U.S. Food and Drug Administration (FDA). Most of the tuna exports to Hawaii during the 1993 marketing trials arrived with temperatures between 4.4°C and 7.2°C. Fish were shipped inside standard waxed cartons insulated with pre-cut styrofoam or with thermal barrier ("insufoil") material and cooled with frozen gel material. Typically, the fish weight:frozen coolant weight ratio in a shipping carton was 12:1.

Packing of the tuna exports was generally satisfactory for all overseas markets tested. The FDA is proposing more rigorous temperature controls for U.S imports of scombroid fish, whereby core temperatures of imported tuna could not exceed 4.4°C (40°F) upon arrival. Without improvements in shipping carton insulation and coolant

to control fish temperatures while in transit, the risk of product rejection could increase for future exports to the U.S.

5.4 Evaluation of transportation system

Air transportation links from Vava'u do not allow for direct shipment of chilled tuna by air freight to major market destinations overseas. The freight compartments of the small aircraft flying from Vava'u to Nukalofa and to American Samoa cannot accommodate large tuna boxes. It is possible to make special arrangements for chartering small aircraft but only at high cost. For tuna to reach overseas markets, it must be transshipped via Nuku'alofa. Various methods can be used to deliver fish to Nuku'alofa:

- Direct delivery by Vava'u-based harvester vessels;
- Transfer by Vava'u-based harvester vessels to Nuku'alofa-based vessels; or
- Surface shipment via ferry boat.

All methods require double handling of the fish, with potential for loss of quality at each transfer point. The ferry is the most practical and least expensive option, especially when time lost from fishing is considered. Limited ferry service forces Vava'u-based fishing boats to adhere to the ferry schedule or risk loss of export opportunities. An additional problem associated with ferry transport is that fish iced in insulated containers are subject to bruising and chafing through contact with ice and with other fish. Damage to fish bodies while in transit was a major problem at the beginning of PIMAR/Tonga marketing trials. The only remedy was to bag fish individually in cheesecloth "socks" or in plastic before shipping. This problem has been greatly reduced with the opening of a private ice plant in Vava'u in February 1994.

5.5 Evaluation of markets

Transshipment of fresh tuna from Vav'au to overseas markets is costly. For fish exported to Hawaii, the cost of transshipment (which includes ice, handling, packing materials, freight and U.S. Customs clearance) is estimated to range from a low of US$ 2.50/kg (for 1,000 kg or more per shipment) to over US$ 3.20/kg (for 500 kg - 800 kg per shipment). To obtain a net return of at least US$ 2.50/kg, tuna exported from Vava'u should sell for a minimum of US$ 5.70/kg overseas. Only tuna that is #1 or #2 grade *sashimi* will generate sufficient sales revenue.

A critical element of tuna marketing is recognizing and rejecting lower-grade fish which are unprofitable to export. Tuna grading skills develop with years of experience

and only the most rudimentary level of grading can be taught through short-term training. Nevertheless, every opportunity was taken during the PIMAR/Tonga marketing consultancy to train government and private fisheries personnel in tuna grading techniques.

5.6 Evaluation of processing facilities

The Government of Tonga (GOT) operates fish marketing facilities in Nuku'alofa and Vava'u. Neither would meet the sanitation requirements that the U.S. FDA has proposed for overseas facilities where seafood is processed for export to the U.S. The primary shortcoming of the Nuku'alofa facility is its open-air construction and lack of insect guards. Private operators rent space at the facility for processing, marketing and freezing seafood. Fresh fish is stored in iced containers.

The GOT facility in Vava'u is enclosed but the door is not protected by insect guards. The major sanitation problem is the accumulation of dirt and mud on the floor. Fortunately, fishermen have discontinued the practice of placing fish on the floor while weighing their catches. This facility was used by the PIMAR/Tonga project but fish was always stored in iced containers and processing was done according to approved sanitary practices.

The water available for ice-making and fish processing at the Nuku'alofa and Vava'u facilities does not meet U.S. drinking water standards. Water and ice samples taken at both facilities in May 1993 were tested at a Hawaii laboratory for total and fecal coliforms. Total coliforms were present in the water and ice at concentrations of 4-6 coliforms/100 ml. Fecal coliforms were not detected, indicating that there is no contamination by sewage. The PIMAR/Tonga project used seawater exclusively for fish processing and for brining.

The make-up water used by a private ice plant which opened in Vava'u in February 1994, has not been tested.

6.0 RECOMMENDATIONS

6.1 Fish handling

The primary handling constraints faced by the project during 1993 fishing trials were the poor quality of ice and the inability to brine fish because of vessel limitations. The ice problem has been solved with the opening of a private ice facility in Vava'u in February 1994. Commercial longline operators would be well advised to consider installation of brining tanks on their vessels or, alternatively, to implement the pressurized tuna bleeding technique which has replaced brining on long-range Japanese *sashimi* boats. Proper care of tuna may not be as crucial in fisheries where tuna are offloaded from the vessel and immediately air shipped, but the ferry ride and limited air service make fish shelf life a key issue for the Vava'u fishery.

6.2 Target the *sashimi* market

Considering the high cost of export, it is unprofitable to export lower-quality tuna. It is essential to differentiate lower-grade and higher-grade fish in each catch. When demand is strong in overseas *sashimi* tuna markets, #1 through #3 fish can be exported. When markets are weak, only #1 and #2 fish should be exported. Each export company should dedicate one person to the critical task of grading tuna. Recognition and rejection of lower-grade fish requires continual improvement of grading skills. The grader should receive feedback on every shipment and should communicate with Hawaii and Japanese tuna specialists whenever possible.

6.3 Develop overseas marketing relationships

Fresh tuna is an internationally-traded commodity. Fish are usually sold on consignment, through auctions or wholesale distributors, and to final processors. The quantities and prices of tuna sold through auctions or wholesale distributors fluctuate widely with supply and demand. Final processors, on the other hand, have commitments to supply steady customers with regular amounts of fish. To obtain a steady supply, tuna are purchased from the spot market (auctions, wholesalers) and directly from fishing fleets and exporters. As they become more consistent in the production of export-size, *sashimi*-grade tuna, Tonga exporters can expect to develop steady relationships with processors in Hawaii and possibly in Japan. Such relationships are valuable to both parties. The importer can rely on a consistent supply of fish that can be blended into normal sales. The exporter, in contributing to a more stable business climate for the importer, can expect to receive a more consistent price than by selling in the volatile spot market. Small-scale longline operators in Tonga should strive to develop mutually-advantageous relationships with Hawaii and Japanese tuna processors.

6.4 Improve packing for overseas export

FDA has proposed new regulations for U.S. seafood processors and importers that could place scombroid fish species, including tuna, under stricter temperature control guidelines (4.4°C or 40°F). If the FDA proposal is implemented, Tongan tuna exporters will need to improve packing for better temperature control. The ratio of fish weight:frozen coolant weight in shipping cartons should be reduced to 8:1 or lower. A heavier grade of "insufoil" or one-piece styrofoam coffins with better insulating properties should be used. These improvements should allow fish to be delivered to Hawaii with core temperatures below 4.4°C (40°F).

6.5 Improve water quality

Tap water presently available at the GOT fish markets in Nuku'alofa and Vava'u does not meet U.S. drinking water standards. This water should not be used for ice make-up, slurry make-up, or fish processing unless it is treated. The preferred method of treatment would probably be ozonation, which can be accomplished with small-scale, relatively inexpensive equipment and without chemicals.

7.0 UNRESOLVED ISSUES

7.1 Transportation system

Commercial longline operators in Tonga should not expect any short-term improvement in ferry or air transportation service. Tuna export will continue to require careful scheduling around ferry and airline service. The ferry will continue to be the best method of delivering export fish to Nuku'alofa for transshipment to overseas markets. Double-handling of fish will remain unavoidable. Training exercises conducted during PIMAR/Tonga have stressed careful handling at every transfer point to minimize the loss of fish quality.

7.2 Vava'u telecommunications

Seafood export requires frequent communication with overseas marketers, usually by telefax. Telecommunications to and from Vava'u are notoriously unreliable because of the "troposcattering" technology used to relay signals to Nuku'alofa, where there is satellite-based telecommunication. Poor telecommunications will continue to interfere with the exchange of information with overseas seafood buyers and customs brokers.

7.3 Size composition of tuna catch

Only larger tuna (> 18 kg) can be profitably exported to Hawaii and Japan, the primary *sashimi* markets that should be targeted by Tonga's small-scale longline fishery. Fishing trials during PIMAR/Tonga showed that virtually all of the catch from nearshore waters and around fish aggregation devices consisted of small tuna. Export-size fish were caught only on offshore seamounts. Even there, small fish comprised about half of the catch. The fishing trials demonstrated the importance of deploying the gear to the swimming depth of large bigeye tuna, the primary export species.

The best methods for achieving deep sets were to use a line shooter, leaded swivels on branching lines, long float lines, and 20 branching lines between floats. Training exercises have emphasized these techniques. Unless longline operators continue to use the proven methods, they will not fish deep enough to capture export-size tuna. A longline fishery which relies entirely on local marketing of small tuna will not achieve profitability.

7.4 Business-like approach

Like every other business, the tuna longline fishery has a turnover of participants as some succeed and others fail. There is no single formula for success in this industry, but there are three very common pitfalls: (a) failure to develop all facets of the fishery

(vessels, crews, support services, transportation, marketing) in concert; (b) loss of fishing time while vessels wait for repair or re-supply; and (c) a "get rich quick" approach rather than a more business-like approach which gradually builds toward long-term growth.

APPENDIX A. 1993 Tuna Exports by PIMAR/Tonga Small-Scale Longline Project

(1) Date of Export (D/M/Y)	(2) Fishing Vessel	(3) Species and Pieces Exported	(4) Weight of Fish Exported (kg)	(5) Market Location	(6) Fish Core Temp. on Landing in Vava'u (°F)	(7) Fish Core Temp. on Arrival in Overseas Market (°F)	(8) Grade of Flesh
01/07/93	EK	2 BE	140	Hawaii	N/R	N/R	#2
		1 BE	39	NZ	N/R	N/R	Ungraded
02/09/93	EK	1 BE	54	Hawaii	30-37°	36-42°	#1 -
		2 BE	57	"			#2 +
		1 YF	22	"			#1 -
		2 YF	57	"			#2 +
		2 BE	96	Tokyo	34-36°	N/R	#3[1]
		2 BE	89	Southern Japan		N/R	#2[1]
09/09/93	EK	2 BE	121	Hawaii	36-46°	38-45°	#1 -
		2 BE	64	"			#2 +
		4 BE	120	"			#2
		1 BE	23	"			#2 -
		1 BE	21	"			#3
		2 YF	53	"	37-44°		#2 +
		2 YF	55	"			#2
		1 YF	24	"			#3
23/09/93	EK	1 BE	34	Hawaii	32-44°	43-46°	#2 +
		11 BE	390	"			#2[1]
		1 BE	24	"			#2 -
		1 YF	32	"			#2 +
		3 BE	155	Japan	32-38°	N/R	#2[1]
		2 BE	72	"		N/R	#3[1]
		1 YF	51	"		N/R	#1[1] (w/ fat)

(1) Date of Export (D/M/Y)	(2) Fishing Vessel	(3) Species and Pieces Exported	(4) Weight of Fish Exported (kg)	(5) Market Location	(6) Fish Core Temp. on Landing in Vava'u (°F)	(7) Fish Core Temp. on Arrival in Oversea Market (°F)	(8) Grade of Flesh
02/12/93	EK	3 BE	62	NZ	38-45°	N/R	Ungraded
		2 YF	38	"			"
		40 BE	1,100	Hawaii		51-53°	#3/4[3]
10/12/93	EK	5 YF	80	NZ	35-40°	N/R	Ungraded
		65 BE	1,300	Hawaii		40-43°	#3/4[3]

Notes: EK = F/V *Ekiaki*

DM = F/V *Dora Malia*

BE = Bigeye tuna

YF = Yellowfin tuna

ALB = Albacore tuna

NZ = New Zealand

N/R = Not recorded

[1] Grade of flesh was inferred from comments by buyer.

[2] Grading was performed in Vava'u by PIMAR/Tonga marketing consultant.

[3] Tuna judged to be unsatisfactory for commercial export were shipped to Hawaii as a training exercise.