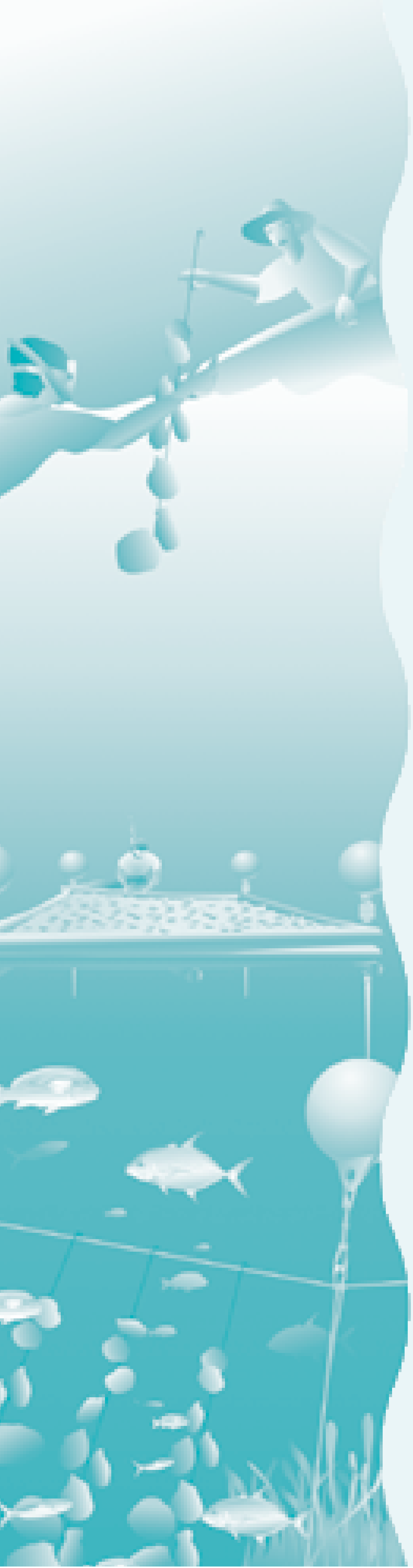

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MILKFISH AQUACULTURE IN THE PACIFIC: POTENTIAL FOR THE TUNA LONGLINE FISHERY BAIT MARKET

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for the Secretariat of the Pacific Community,
Aquaculture Section
Noumea, New Caledonia

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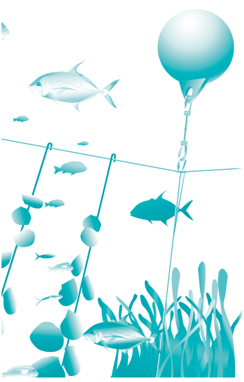

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INTRODUCTION

The Secretariat of the Pacific Community (SPC) initiated a study to assess the market potential of milkfish (*Chanos chanos*) and its culture for tuna longline bait in the region. The aim of this consultancy was to provide a regional assessment of the commercial viability for milkfish aquaculture to supply the baitfish market and other potential niche markets. The Terms of Reference for the study are included as Appendix 1.

The study addresses a component of the SPC 2002 Aquaculture Action Plan that sets direction for SPC's regional aquaculture programmes. The goal of the Plan is to diversify economic activity that will benefit the region and lead to sustainable aquaculture development in the region and that considers social, economic and environmental factors.

STATUS OF MILKFISH AQUACULTURE IN THE SPC PACIFIC ISLANDS

Milkfish occur throughout the Indo-Pacific in tropical and subtropical waters with a distribution extending from the Red Sea and southeastern Africa to Mexico. They occur near coasts with fry entering lagoons, estuaries, mangroves, and nearshore waters. Their distribution is mainly limited to waters with temperatures greater than 20ºC. With this wide distribution, there are geographic variations reported with about nine major populations. Based on electrophoretic data there was reported to be three distinct groups in the 1) Philippine, 2) equatorial Pacific (Palau, Kiribati, Fanning, Christmas Island) and 3) Tahiti and Hawaii (Winans 1980, 1985). Even within the Hawaiian Islands there is reported to be a high level of endemism with the population around Oahu different from populations around Hawaiian Islands 320 miles away (Smith 1978; Winans 1980).

Milkfish is one of the most important aquaculture species in Indonesia, Philippines, and Taiwan. The cultivation of milkfish is reported to extend back over 700 years in Indonesia. It also has a long history of cultivation in many of the Pacific Islands. Characteristics of milkfish lends itself as an excellent species for aquaculture, with wide environmental tolerances, abundant natural fry that migrate into coastal estuary areas, omnivorous with feeding behavior at a low trophic level, and rapid growth. In addition, the life history is well documented with hatchery technology well developed that can use natural spawns or artificially induced spawns. The euryhaline characteristic of the species has allowed for its cultivation in a wide range of aquatic environments from inland freshwater lakes to ocean cages. Furthermore, it is tolerant to crowding, and is disease resistant. This provides great flexibility in the cultivation of this species, which allows it to be adapted to almost any environmental situation in the SPC member countries.

Milkfish culture in the SPC Pacific Islands is limited to only a few islands currently culturing or have a project in progress to culture milkfish. These islands mainly consist of Kiribati, Fiji, French Polynesia, Guam, and Nauru. There have been some past attempts in FSM (Pohnpei and Yap), Palau, and Tonga. Recent reviews of the status of aquaculture in the SPC islands have been conducted as part of an effort by SPC to address the regional issues concerning aquaculture development (Adams et al. 2001; SPC 2002, 2003; Evans et al. 2003). Tanaka et al. (1990) conducted a regional workshop on milkfish culture in the Pacific, which included the status of milkfish culture in the SPC Islands.

A number of attempts have been made by governments and the private sector at aquaculture in the SPC region; however, only a few have proven profitable. The most notable are pearl culture mainly in French Polynesia to shrimp in New Caledonia and Guam (includes products of milkfish, catfish, and other minor products) along with a mixture of success and failure in Fiji. There are also a few small commercial aquaculture production farms among some other islands. In addition, there is production of seaweed in Kiribati.

Kiribati milkfish project for bait culture started in 1971 to supplement live bait for the pole-and-line fishery (Teroroko 1984; Garcia-Franco 1995; Wainwright and Dalley 1980; Tekinaiti 1990). There is limited use of fresh/frozen milkfish by the Fisheries Division's longline vessels (SPC 2000). Production of baitfish in Kiribati dropped to insignificant amounts in 1996, but had been declining since 1986 with reduction and eventual termination of the pole and line tuna fleet, which was the primary consumer of the bait in Kiribati. Even though milkfish in Kiribati is a valued food fish, the current market for milkfish as a food fish is saturated locally. It is difficult to compete price wise against other fishery products. This saturation of the local market makes it necessary to more aggressively seek potential export markets to expand the market for the farm's milkfish products. There is limited export of milkfish from Kiritimati (Christmas Island) to Hawaii (Preston 1992) for the Filipino market along with exports that recently restarted (2002) to Nauru (from Tarawa ponds) are the only exploited export markets. The value added processing of smoked milkfish as an additional product for the market assists in capturing a different market segment; however, at the current AU$5.00/kg it is below the cost of the fresh product plus the expense of processing. It was estimated that the product should be sold for AU$6.71/kg to cover the fresh fish (AU$2.50/kg price) and processing (Trachet 1989). There has been some discussion about focusing on live baitfish production for the Japanese longline fleet in Kiribati's EEZ (Fisheries Division - MNRD Annual Report, 1998); however, that has not materialized to date. The alternative is to find a suitable species to cultivate that could compliment the milkfish production.

Milkfish production at Kiribati's Government operated Temaiku Farm on Tarawa has been relatively low over its approximate 25 years of operation. This low production has been a point of study in numerous technical reports and assessments by various International organizations, government/private cooperative programs, and the Fisheries Division of the Ministry of Natural Resources Development over the years. Despite some optimistic projections of potential production (as high as 4,523 kg/ha/yr; Juario et. al. 1986a, 1986b) based on limited trials, the farm's annual production remains within the range of 90 to 200 kg/ha/yr. In comparison to similar extensive system in Taiwan, production ranges from 1,800 – 2,500 kg/ha/yr (Lee and Banno 1990). Utilizing the "lablab" method of extensive culture, which is similar to that utilized at the Temaiku Farm, the Philippines averages 600-800 kg/ha/yr (Lee and Banno 1990). Extensive milkfish farms in Indonesia are somewhat lower, but averages range from 50 to 500 kg/ha/yr. The ponds at Temaiku fall within the lower range of production of extensive ponds in Indonesia; even though, they did reach a high of 408 kg/ha/yr in 1986. Therefore, realistic production capacity given the constraints of physical and actual operations along with variables of the market for milkfish (highly volatile baitfish market); it would be expected that production will continue to fall within the range of 150-200 kg/ha/yr as it has over the past 10 years. Economic analysis of milkfish ponds on Tarawa has been carried out previously (Uwate 1990, 1986; Uwate et al. 1986; Uwate and Teroroko 1986; Pollard 1988). The previous economic analysis of the Tarawa Temaiku Farm milkfish operation were conducted for the years 1982, 83, 85, and 87 and found the operation did not break-even and had a net loss of up to AU$76,348 (1987).

In Pohnpei, FSM, a private project to culture milkfish started in 1997. It intended to produce milkfish for the live tuna longline bait market (mainly Taiwanese vessels porting in Pohnpei). However, the longline fleets were reluctant to purchase the product due to the relatively high price and the cost of converting bait wells to accommodate live bait on the domestic vessels (National Fisheries Policy Study 1999). The farm had operational problems with production and marketing of the product. The farm has since stopped operation (Linsey 2002). A shortage of industry skills including aquaculture, processing and marketing has been noted as a general problem in inshore fisheries development (Anonymous-D, Undated).

Samoa (Western) has proposed a milkfish baitfish aquaculture project to partially replace imports of frozen baits for the domestic tuna longline fishery (Trade & Investment Promotion Unit 2000). This includes a preliminary economic analysis of milkfish baitfish production to serve 300 small longline vessels that are crewed by 1,000 fishermen utilizing the following criteria. The albacore export value from this fishery is reported to be more than WST$30 million (US$10,604,454).

Current bait requirement for the longline fisheries is 600 MT/year (frozen pilchards/sardines), which is imported at a cost of WST$1.5 million (US$530,223) and sold to the fishery at WST$5 million (US$1,767,409). The imported cost per piece is WST$0.12 (US$0.04) with a vessel price of WST$0.40/piece (US$0.14). The targeted price for the live milkfish is WST$0.60/piece (US$0.21). The cultivation of milkfish would be in earthen ponds (4-ha). Their objective is to capture approximately 30% of the total bait market with a production of 3.5 million pieces. Fry are proposed to be imported from Taiwan. Their projected annual return on the proposed 4-ha farm is WST$253,000 to 284,000 (US$89,431-100,389) after the first 2-years of operation. However, the grow-out production criteria and pricing used in the projections are optimistic.

American Samoa recently received a grant through the Native American Act for US$77,000 to develop a community-based aquaculture project that will partially focus on milkfish as live bait for the local tuna longline industry (Gabbard 2001). An unreleased FAO study of potential milkfish culture in Palau was done in 2001. Fry are collected from the wild. There are two small milkfish operations in Palau (Koror and Peleliu); however, there is no interest in milkfish farming in Ngchesar, Ngatpang, and Angaur (Isamu 2003). Early assessments of milkfish culture in French Polynesia (Tokoragi 1976; Brown 1976) indicated abundance of wild fry stock and the potential for expanded culture in natural ponds and construction of extensive areas of ponds. Penrhyn, Cook Islands, milkfish ponds are generally privately owned and are cultured mainly for special celebrations (SPC Undated). Milkfish is prized in Nauru as a food fish and has a history of being cultured up to the early 1970's when introduced tilapia (1960's) became a problem that hampered milkfish production. An eradication program was initiated in 1979 by UNDP and FAO (Ranoemihardje 1981). Nauru recently (2002) started importing fry from Tarawa for grow-out. Prior to that they imported cultured fresh milkfish from Tarawa and Guam.

A FAO study examined the potential of milkfish farming in Fiji (Dela Cruz 1997). It provided a preliminary fry assessment and recommendation for cultivation methods. The Fiji Islands Trade & Investment Bureau (Anonymous-C 2001) has done an investment opportunity in milkfish farming profile that targets production for tuna live bait. In 1999, 44.5 MT of milkfish bait was harvested for the tuna longline fleet (40 vessels). They were targeting live bait for the local market and frozen bait as an export product. Live milkfish bait was sold at US$1.15/kg, which is lower than the domestic Taiwan price for live milkfish bait. Fiji has a proposed community based milkfish farming project, which is for small scale production of milkfish as bait for bottom fishing initially and later as food and then bait for tuna fishing (Tanaka, personal communication).

Guam has been culturing milkfish since the early 1970's. Commercial farms continue to culture milkfish as a food product for the domestic fresh fish market where it competes with frozen imports from the Philippines and Taiwan. Production in recent years has decreased with high quality low priced blast frozen product from Taiwan. The decline in market share started in the early 1990's when Taiwan experienced major shrimp disease problems. Shrimp pond production in Taiwan was partially shifted to milkfish and exports increased into the Guam market. Production of milkfish for the tuna longline bait market initiated in the early 1990's (FitzGerald 1995, 1996) reaching a peak in the mid-90's and has since ended in the 2001-2002 period (Lim, personal communication 2004).

Information on the current status and past experience with culturing milkfish, the Islands' experience at using milkfish as bait, along with the current bait used by tuna longline fleets porting in the respective islands was requested of all SPC Island members. The majority of the islands responded and in those cases where there was no response information was obtained from other sources where possible. The responses are summarized in Appendix 2.

TUNA LONGLINE FISHERY OVERVIEW IN THE REGION

Fisheries serve as the major natural resource in most of the SPC Islands with commercial fisheries a major economic activity and foreign exchange earner in some of the islands. This has been most impacted by the growth of foreign industrial fishing fleets in the region over the past 50-years. This has been particularly noticeable for longline fleets in the past 25-years, which has been driven by the sashimi market. Dalzell et al. (1996) cites less than 7% of the region's tuna is caught by Pacific Island vessels with only 25% of the region's catch processed within the Islands. Gillett (2003) identifies the Pacific Island domestic fishing fleets consisting of 14 pole-and-line vessels, 40 purse seiners, and 495 longliners. Table 1 provides information on the domestic tuna longline vessels and catches for 2002 by Island country. Hampton and Williams (2003) note the recent significant changes in the longline fisheries in the past 20-years with a change in targeting practices of fishing deeper in the 1980's to catch bigeye tuna to obtain the higher price of bigeye tuna compared to yellowfin. In the 1990's there was a gradual development of domestic fleets in the Pacific Islands (Samoa, Fiji, French Polynesia, New Caledonia and Solomon Islands) with albacore the main targeted species. They also noted the entrance and subsequent decline of the smaller sashimi longliners of Taiwan and mainland China based in Micronesia during the past decade. This latter point and the shift in targeting to bigeye tuna is of particular impact on the live milkfish market as tuna longline bait, since these are the vessels that are the main users of live milkfish. The shift towards bigeye and away from targeting yellowfin also impacts on the potential live bait market; since live bait is primarily used in the shallower sets that target yellowfin. Furthermore, it should be noted from Table 1 that the majority (56%) of the tuna catch by domestic island tuna longline vessels is albacore. The effectiveness of live bait over frozen for albacore has not been documented anecdotally or from trials as it has for yellowfin with the exception of a very limited trial by NMFS (Ostrowski et al. 1999). Their limited trial indicated a preference for live bait by albacore.

Table 1. 2002 (except where noted *) domestic island tuna longline vessels, catch (MT) and CPUE (fish/100 hooks) (Lawson, 2003).

SPC MEMBER ISLANDS COUNTRIES	LONGLINERS ACTIVE	ALBACORE TUNA		TUNA BIG EYE		FINE TUNA YELLOW		TOTAL	
		Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
American Samoa	60	5,944	2.58	196	0.09	484	0.15	7,112	3.7
Cook Islands	16	879	2.75	66	0.16	49	0.12	1,118	3.57
Federated States of Micronesia	25	0	0	658	0.39	167	0.09	865	0.51
Fiji	101	8,026	1.52	853	0.11	2,027	0.24	16,472	2.32
French Polynesia	54	4,557	1.59	649	0.16	507	0.12	7,402	2.65
Kiribati*	1	0	0	0	0	0	0	0	0
Marshall Islands*	4	0	0	13		18		32	
New Caledonia	25	1,165	1.45	189	0.09	572	0.4	2,211	2.3
Papua New Guinea	50	136	0.14	324	0.25	1,738	1.13	3,819	2.36
Samoa	114	4,360	2.64	153	0.09	388	0.2	5,359	3.53
Solomon Islands	8	115		370	371	870			
Tonga	35	1,199	1.1	219	0.14	262	0.2	1,957	1.72
Vanuatu	13	225	1.64	20	0.09	107	0.4	428	2.76
TOTAL	**506**	**26,606**		**3,710**		**6,690**		**47,645**	

The number of tuna longline vessels actively fishing in the Western and Central Pacific Ocean has increased 33% over the 32-year period since 1970 (Figure 1 and Appendix 3). This number of vessels fluctuates year to year (slight decrease of 0.87% in the most recent 5-year period); however, the current level is considered to represent a relatively mature industry with further significant regional expansion unlikely. The management and conservation of the resource for future generations will form an upper limit. The composition of the fleets may change over time with country of origin comparative costs varying and impacting the competitiveness of fleets along with the shift in location of fishing resources around the Pacific by foreign fleets and technological changes.

Figure 1. Active tuna longline vessels (all nations) in the SPC region and the tuna catch over the period 1970-2002.

The major fleets in the SPC region are foreign vessels mainly from Taiwan, Korea, Japan, and China. Some of the SPC regional countries have a sizeable domestic based fleet. These consist of Samoa, Fiji, American Samoa, French Polynesia, Papua New Guinea, Tonga, with smaller fleets in Federated States of Micronesia, New Caledonia, Cook Islands, Vanuatu, Solomon Islands, and Marshall Islands as noted in Table 1. Of the fleets in the region, the Taiwanese vessels have been the most active in utilizing live milkfish as bait. Frozen milkfish as bait is used by all of the foreign fleets to a varying extent. There are three kinds of Taiwanese longliners operating in the Pacific region (David Chang, personal communication 2003). They are distinguished by size, equipment, targeted species/product, and the type of bait they use.

- **Small tuna longliners or fresh tuna longliners –** usually use frozen squid and milkfish (frozen and live) and spotted chub mackerel as bait. It is estimated that about 3,500 tons of frozen squid and 1,000 tons of milkfish (frozen and live) are used per year.

- **Traditional tuna longliners or Albacore longliners –** usually use frozen saury and frozen sardines as bait. Albacore longliners use around 10,000 tons of frozen saury and 2,000-3,000 tons of sardines per year.

- **Ultra low temperature longliner –** usually use sardines, mackerel scad, frozen milkfish, spotted chub mackerel and squid as bait. They use more than 15,000 tons of bait per year consisting of 10,000 tons of squid and 500-700 tons of frozen milkfish.

Taiwan tuna longliners consume at least a total of 25,000 MT of bait per year (various types of bait). Table 2 summarizes the use of types of baits by the vessel categories of the Taiwanese fleets in the Pacific.

Table 2. Taiwan tuna longline fleet in the Pacific (David Chang, personal communication 2003).

Vessel category	Number of vessels operating in the Pacific*	Average # of hooks/sets	Average # of sets/trip	Actual fishing days per trip	Length of each fishing trip	Type of bait	Size of bait (source)	Average price of bait	Quantity of bait/ Vessel category/YR
Small longliners 20-22 meters in length	150-200	1,500-1,600	8-20	8-20	20-40 days	Squid, Spotted chub mackerel, and Milkfish (frozen & live)	Squid 48 pieces/10kg; Saury 110-130 pieces/10kg; Milkfish-Frozen 45-50 pieces/10 kg (Indonesia); Milkfish Live 167-250 pieces/10 kg (locally sourced) Chub mackerel 45-50 pieces/10kg (Domestic-Taiwan, China);	Squid US$1,000 -1,200/mton; Milkfish-Frozen US$800-1,000 /mton Milkfish-Live US$0.20-0.25/ piece or US$2,500 -4,000/mton; Chub mackerel US$600-700/mton (China), US$800 -1,000.mton (domestic);	3,500 tons of frozen squid and 500-600 tons of milkfish (frozen), and 400-500 tons of milkfish (live) are used per year
Traditional/ Albacore 40-45 meters in length	40-50	4,000-4,400	120-180	4-6 months	6-8 months	Saury and Sardines	Saury 110-130 pieces/10kg; Sardine 50-60 pieces/5kg (South Africa, USA, Mexico)	Saury US$1,000 -1,000/mton (domestic source) US$1,100-1,200 /mton (Japan source); Sardine US$900-1,000;ton	10,000 tons of frozen saury and 2,000- 3,000 tons of sardines per year
Ultra Low Longliners 50-55 meters in length	60-70	2,200-2,500	180-240	6-8 months	9-12 months	Sardines, mackerel scad, frozen milkfish spotted chub mackerel and squid	Squid 48 pieces/10 kg; Chub mackerel 45-50 pieces/10kg (Domestic- Taiwan, China); Sardine 50-60 pieces/5kg (South Africa, USA, Mexico); Mackerel scad 60-70 pieces /10kg (Indonesaa and Vietnam); Milfish-Frozen 45-50 pieces/10kg (Indonesia);	Squid US$1,000 -1,200/mton; mackerel scad US$1;300-1,500 /mton, Sardine US$900-,000 mton Chub mackerel US$600-700/mton (China), US$800 -1,000. mton (domestic);	More than 15,000 tons af bait per year consisting of 10,000 tons of squid, 4,500-5,000 mtons sardines/ mackerel, and 500- 700 tons of frozen milkfish

*there is an unknown number of "flag of convenience" tuna longliners including all types of tuna longliners operated by Taiwanese in the Pacific

Japanese tuna longliners (50-100 GT) utilize frozen baits and average 35-45 MT of bait per vessel per year. They use sets of 2,200-2,500 hooks, 15-day trips, and approximately 15 trips per year (M. Honda – FFA, personal communication).

Bait is an important component of tuna longline vessels' operation. The bait must be readily available, an effective bait for the targeted species of tuna, and economical. The dependence on catching bait for fisheries such as the pole-and-line tuna fishery required often a major expenditure of time and cost (Gopalakrishnan 1976). It also has had a negative impact on some of the targeted wild bait species. Most bait for current tuna longline operations in the Pacific Islands is imported frozen from a number of sources including, Taiwan, South Africa, New Zealand, Australia, Philippines, Vietnam, and the US. Desirable characteristics of bait for tuna longline fishery include the following (Yuen 1977; Smith 1977).

- Size
- Color
- Effective catch rate of targeted species
- Low cost
- Consistent and reliable availability in quantity required

Factors affecting tuna longline catch ability is summarized by Bach, et al. (2003).

- Bait type and quality
- Soaking time
- Fishing effort at the operational level
- Trophic level of the environment
- Maximum fishing depth or the strategy of the gear deployed according to the fishing ground

The pole-and-line fishery typically uses live bait. Characteristics of desirable bait by this fishery are identified as follows (FAO 1983; Gopalakrishnan 1976).

- Survival in bait tanks (resistance to handling)
- Easy handling by the chummer
- Favorable behavior when chummed – habit of returning to the vessel's side and not diving deep when attacked by tuna
- Size as related to the tuna encountered – 5 to 10 cm in length
- Body form
- Color and color pattern
- Adequate luster
- Quick action
- Fishermen acceptance
- Availability

ASSESSMENT OF THE MARKET DEMAND FOR MILKFISH AS BAITFISH

The potential benefits to the SPC Islands of milkfish aquaculture as a bait include increased economic activity that utilizes endemic natural resources to provide employment opportunities, diversification of economic activity, increased foreign exchange (either through savings on imported baits or export of the product on foreign longline vessels), while enhancing off-shore capture fishery production per unit effort. It has the potential of benefiting the further development of both fisheries and aquaculture industries. In addition, it can assist in conserving populations of natural wild baits from over exploitation in the waters of the SPC region.

MILKFISH AS TUNA BAITFISH

Three basic areas identified by Hester (1974) for the aquaculture of tuna baits (pole-and-line or longline), whether the bait use is as live or dead bait, consist of acceptability of the bait, production in sufficient quantities to support a fleet of vessels, and to produce it at a competitive cost. Milkfish have proven over time to successfully address these hurdles as an aquaculture produced bait. Some of the attributes of milkfish as live bait include the following.

- Wide tolerance to environmental conditions,
- Hardy and tolerant to crowding,
- Survive well the hooking process so that recovered bait from sets are often alive and can be reused,
- Indigenous species to Indo-Pacific,
- Established aquaculture technology for grow-out methods and fry production, and
- Improvement in tuna catch rate (mainly yellowfin tuna).

Live milkfish have been mainly used by Taiwanese vessels. However, Indonesian and Philippine longliners also use live milkfish occasionally. Figures 2 and 3 show the transport and loading process of live milkfish on a tuna longliner ported in Guam. In Indonesia, they are often transported in sealed plastic bags filled with water and oxygen. The decision to use live milkfish over alternative bait is dependent on a number of factors. The key factors include the following.

- Attitude and experience of the vessel captain with live baits.
- Capability of vessel to hold live bait.
- Consistent availability of live milkfish.
- Quality of the live milkfish (size, health, pre-acclimated to saltwater).

- Price of the live milkfish compared to other alternative baits.

Figure 2. Specially equipped live milkfish bait transport truck.

Figure 3. Milkfish being loaded from the transport truck to bait well of a Taiwanese longliner ported in Guam.

Live milkfish that are used for tuna longline bait are usually 12-15 cm in length (approx. 40-60 g/piece); however, they are used up to 100 g in size. Indonesian vessels tend to use a larger size 14-16 cm (60-100 g/piece) live milkfish bait for their tuna longliners. Live milkfish is more effective at catching tuna, particularly yellowfin tuna, when compared to other standard baits including frozen milkfish. It is reported that the catch will be up to double (100% increase) with live milkfish over that of other standard baits (David Chang, personal communication 2003). The price can be a deterrent in the use of live milkfish. For example, in Taiwan the cost is usually US$0.20 - 0.25/piece, which means one ton of live milkfish would cost up to US$4,000-6,000, but is usually reduced to US$2,500-4,000 in quantity (David Chang, personal communication 2003). However, one ton of frozen milkfish (70/80 pieces/10 kg) is about US$700-900 depending on the market supply in Taiwan.

Live milkfish bait is mainly used by the smaller class of Taiwanese longliners. However, all size vessels use frozen milkfish as part of the baits utilized. The size of milkfish bait varies by whether it is used as live bait or frozen, price, and preference of vessel captains. For frozen milkfish, Taiwanese captains prefer a size of 150-200g/piece, but will accept 125-150 g/piece when the price on the larger size is high. Japanese captains prefer a size 100-120 g/piece for the frozen milkfish.

Live milkfish is rarely used as the sole bait in a set. Live bait is normally dispersed with frozen bait (various types) at a varying ratio of 20-40% live bait. This live bait is normally used on the hooks nearest the floats (shallower) as described by FitzGerald (1996). This provides the increased effectiveness in CPUE, while lowering total bait cost.

EFFECTIVENESS OF LIVE MILKFISH AS BAIT

Live milkfish as tuna bait has been documented in numerous studies (Samarakoon, 1972; Ostrowksi et al. 1999; Ostrowski 1999; Okuhara 2000), but most information is anecdotal from practical experience in the use of the bait by mainly Taiwanese tuna longliner captains, but also Indonesian and Filipino longliners. Lee and Bano (1990) cite a 4-7% CPUE with the use of live milkfish as tuna longline bait. This represents a 200-400% increase in catch over that obtained by frozen baits.

A limited trial comparing live milkfish versus frozen squid as tuna longline bait (Ostrowski et al. 1999; Ostrowski 1999), resulted in a 64% increase in catch with the use of live milkfish over the squid when the longline set employed one third of the bait as milkfish grouped at either the beginning, middle, or end of the line. This would indicate a 31% increase that the presence of live milkfish improves the overall catch even on the non-milkfish portion of the set. However, this increase was 116% over sets that used squid only. This affect has been noted previously (FitzGerald 1996). In another limited series of trials of the effectiveness of live milkfish as tuna longline bait

(Ostrowski 1999), a comparison of live milkfish and dead sanma (US$18/10kg box 120g fish) was made. Initial results indicated a 2.6 times higher (260%) catch rate than sanma. The findings also noted a preference for the live bait by yellowfin and albacore, while the targeted bigeye displayed no preference. The Hawaii private longline vessel owner that participated in the trial commented on the exceptional hardiness of the live milkfish bait (Cook, personal communication). The live bait was often reused, since they were still in good condition after sets to depths of approximately 156 m. Some of the difficulty in the use of the live bait was identified as shore side problems of transporting the bait from the farm to the boat. He indicated dockside tanks or better transport system would be needed. The reluctance of captains to try new bait over the commonly used baits (sardine @ US$14/10 kg and sanma @ US$18/10 kg) and the lack of live bait wells on most Hawaii based longline vessels discouraged further use of the live bait and trials. The experience of fishermen was noted by Sharma and Leung (1999) as a strong contributing factor in the longline vessels' technical efficiency.

A brief study of the catch efficiency of using live milkfish compared to frozen jack mackerel as longline tuna bait was conducted by the Fishery Experiment Station of Kagoshima (Okuhara 2000). The catch results were 3 bigeye and 3 longfin tunas caught using 1,825 frozen jack mackerel, while the use of 117 live milkfish (20 cm length) caught 7 bigeye and 6 longfin tunas plus 5 other species (not specified). This gives a hook rate using frozen jack mackerel of 0.33%, which is below industry standard (1-3%). Live milkfish produced a hook rate of 15.4% (including by-catch or 11.1% for targeted tuna), which is substantially higher than the industry standard. Even though, this was a limited trial without controls and replication the results further confirm the substantial catch advantage of live milkfish. It should be noted that the live milkfish were larger (20 cm) compared to the size normally used by Taiwan fleets (12-15 cm or 40-60 g).

Targeted tuna species are characterized by tuna longliners fishing at different depths, with moderate depths of 100-250 m targeting albacore and yellowfin while deeper depths of 250-400 m target bigeye tuna (Harramoto 1976; Boggs, 1992). This influences bait selection, since the live milkfish is used only for the moderate depths. As previously mentioned, there has been shift in the targeted species (deeper sets) to a greater proportion of the catch being bigeye than yellowfin, since bigeye are usually higher priced.

Use of fresh/frozen milkfish (80-100 g/fish) as tuna longline bait has been documented in trials conducted in Kiribati (Sokimi et al. 2001). Milkfish were shown to be an effective bait with CPUE for the combined sets of 0.95%. Wellington (in Sokimi et al. 2001) found fresh milkfish to have a better CPUE than frozen milkfish; however, saury was superior by a factor of two over the dead milkfish.

Making assumptions on the average size of primary species of tuna caught (yellowfin and bigeye), their average price, hooks per set, number of sets per trip, size of frozen bait, size of live milkfish, cost of frozen bait, and cost of live milkfish, estimations can be made of the increase in catch required to offset the price difference between live milkfish bait and that of an alternative frozen bait (Appendix 4). Figure 4 provides a break-even point chart utilizing these assumptions showing five CPUE scenarios with the CPUE point to compensate for the additional cost of live milkfish over that of frozen bait. The percent increase in the CPUE to offset the total substitution of live milkfish for frozen bait ranges from 7.1-16.6%, which is well within the reported percentage increase in total catch when live milkfish are used. As previously mentioned, in the practical use of live bait, it is usually a mixture of frozen and live bait that produces the reported increases in catch. Taking this into consideration, it would reduce the use of live bait to 20-40% of the total bait used (FitzGerald 1996). This would reduce the actual cost of utilizing live bait. Incorporating that into the calculation, it would reduce the percent increase in CPUE needed to offset the portion of the total bait utilized as live milkfish to 1.4-6.7%. This is with the assumption that there is no reuse of bait, which in practical use is often done with the live milkfish. Reuse of live milkfish would reduce the bait requirement per trip and subsequently the cost.

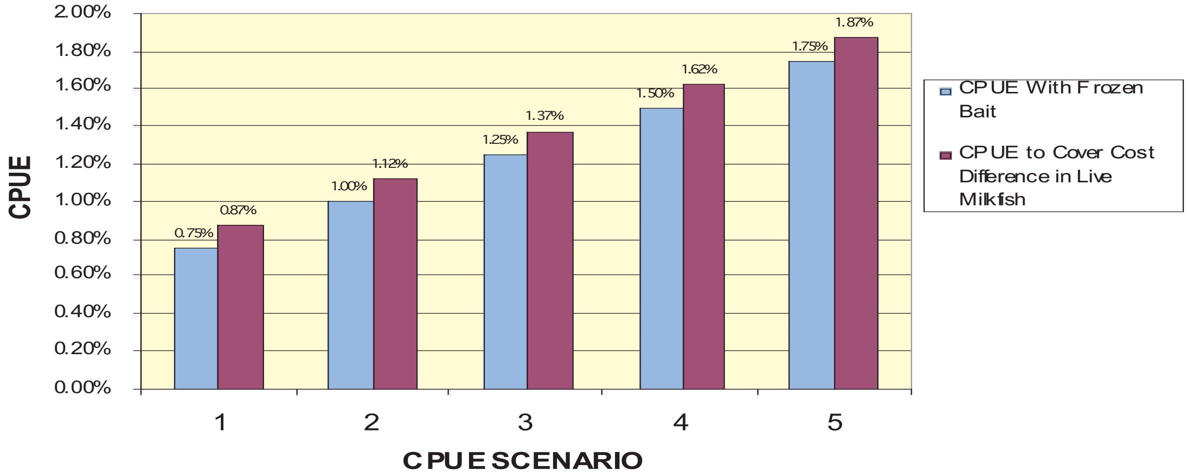

Figure 4. Break-even CPUE (catch as a percentage of hooks deployed) to offset additional cost of substituting 100% of the bait with live milkfish compared to that for frozen bait.

ALTERNATIVE BAITS

A comparison of commercially available competitive baits to that of milkfish are listed in Table 3 with specifics on size and price along with general application for species of tuna. Price of live milkfish will be a major determinant of its use by tuna longline vessels as bait. It will have to be reasonably competitive to alternative baits. Live milkfish does have the advantage of a higher catch rate than other baits so this will allow for a certain premium in price over other baits. However, this is mainly applicable to the catch of yellowfin tuna. Therefore, when bigeye is the targeted tuna species a premium will not be paid, since it is not the preferred bait.

Table 3. Alternative bait comparison.

BAIT	SPECIES	ACCEPTABLE SIZE RANGE	PRICE Per MT	PRICE Per Piece	APPLICATION FOR SPECIES OF TUNA
Live Milkfish	*Chanos chanos*	40-60 g/piece	US$4,200-5,000	US$0.20-0.25	Mainly Yellowfin, used bigeye secondary: in shallow sets. Can be used for albacore
Frozen Milkfish	*Chanos chanos*	100-200 g/piece	US$800-1,000	US$0.08-0.20	Yellowfin, bigeye, albacore
Squid	Teuthoidae (order)	175-225 g/piece	US$1,000-1,200	US$0.18-0.27	Yellowfin, bigeye, albacore
Spotted Chub Mackerel	*Scomber australasicus*	200-225 g/piece	US$600-1,000	US$0.12-0.23	Yellowfin, bigeye, albacore
Mackerel Scad; Muro-aji	*Decapterus macarellus, D. maruadsi*	140-170 g/piece	US$1,300-1,500	US$0.18-0.26	Yellowfin, bigeye, albacore
Iwashi	*Sardina pilchardus*	120 g/piece	US$990	US$0.10-0.12	Yellowfin, bigeye, albacore
Sardines	*Sardina* sp., *Sardinella* sp., *Sardinops* sp	80-110 g/piece	US$900-1,100	US$0.07-0.12	Yellowfin, bigeye, albacore
Sanma	*Cololabis saira*	120 g/piece	US$1,800	US$0.21-0.22	Yellowfin, bigeye, albacore
Sauri	*Cololabis* sp.	80-90 g/piece	US$2,883	US$0.23-0.25	Yellowfin, bigeye, albacore

Note: The frozen milkfish high price is based on the farm gate price in Kiribati.

There has been some work done on developing artificial baits for tuna longline fishing (Januma et al. 1999; Januma et al. 2003). It has a poorer catch rate than traditional natural baits, but it represents a potential option in the future, if the catch rate can be improved.

BAIT DEMAND

The market demand for bait in the SPC region is substantial. The current supply is mainly from outside the region. Therefore, the replacement of a portion of these imports with production from regional countries would provide potential economic benefits to the region.

The estimation of the demand for bait from the tuna longline fishery can be calculated a couple of ways utilizing known data along with making some assumptions (Table 4). The most direct approach is determining the average number of hooks/set, number of sets per trip, and the number of trips/year. This value multiplied by the number of active vessels operating in the region would provide the number of pieces of bait required (assuming one bait per hook and no reuse of bait). Another method would be utilizing the catch data, average size by fish (species specific), and the hook rate. Utilizing the two methods, the conservative demand in the Western Central Pacific Ocean (WCPO) is estimated at 567 to 914 million pieces of bait or 56,743 MT to 91,368 MT (assuming average bait size of 100 g/fish) for 2002. The estimated values (Table 5) for the approximate SPC Region area within the WCPO are 486 to 693 million pieces of bait or 48,638 MT to 69,264 MT for 2002.

Table 4. Assumptions used in estimation of regional tuna longline bait.

ASSUMPTION USED FOR ESTIMATION OF BAIT DEMAND		
ASSUMPTIONS		
Average Weight per Fish (all species -	AWAF	30
Hook rate (percent)	HR	1,25%
Hook per set	HS	1500
Number of Sets per Trip	ST	10
Trips per Year	TY	12
Bait Size/fish (g)	BS	100

Table 5. Estimation of bait demand in SPC region (excluding Indonesia, Philippines, Australia Domestic, and Japan Coastal from the SPC WCPO data) calculated by two methods based on data from the SPC Tuna Fishery Yearbook (Lawson 2003).

SPC TUNA YEARBOOK DATA			METHOD 1 - BASED ON CATCH		METHOD 2 - BASED ON VESSEL OPERATION	
			(Catch x 1000)/Average Weight per fish)/HR		Vessels x HS x ST x TY	
			ESTIMATION OF BAIT DEMAND (PIECES)		ESTIMATION OF BAIT DEMAND (PIECES)	
YEAR	NUMBER OF VESSELS	TOTAL MT CATCH OF TUNA (Albacore, Big-eye, yellowfin)	ESTIMATED TOTAL BAIT DEMAND PER YEAR	ESTIMATED WEIGHT OF BAIT (MTONS)	ESTIMATED BAIT DEMAND FOR LONGLINERS PER YEAR	ESTIMATED WEIGHT OF BAIT (MTONS)
1990	2,730	141,975	378,600,000	37,860	491,400,000	49,140
1991	2,411	114,145	304,386,667	30,439	433,980,000	43,398
1992	3,565	142,643	380,381,333	38,038	641,700,000	64,170
1993	3,964	133,364	355,637,333	35,564	713,520,000	71,352
1994	4,200	156,657	417,752,000	41,775	756,000,000	75,600
1995	4,031	143,622	382,992,000	38,299	725,580,000	72,558
1996	3,584	130,643	348,381,333	34,838	645,120,000	64,512
1997	3,982	139,696	372,522,667	37,252	716,760,000	71,676
1998	3,813	155,991	415,976,000	41,598	686,340,000	68,634
1999	3,744	138,880	370,346,667	37,035	673,920,000	67,392
2000	3,700	151,859	404,957,333	40,496	666,000,000	66,600
2001	3,815	158,995	423,986,667	42,399	686,700,000	68,670
2002	3,848	182,392	486,378,667	48,638	692,640,000	69,264

The demand for live milkfish as bait for the tuna longline fleets has been reported to be decreasing in recent years in Taiwan. Taiwan based longline fleets has decreased their usage of live milkfish by 20-30% in the past 5-years (David Chang, personal communication). Lee (1983) indicated that the demand for milkfish as bait in Taiwan was leveling off in the early 1980's, which constrained further growth in the industry. The shift in fleet resources to other locations in the Pacific has contributed to the decline in live milkfish use in Taiwan. In addition, the high comparative price of live milkfish plus the added handling has made the live bait less attractive despite the improved catch rate. The tuna longline fleets porting in Guam no longer utilize live milkfish from the domestic aquaculture industry (Harris, personal communication 2003; Camacho and Lim, personal communication 2003). The Guam fleets stopped purchasing the live bait in 2001-2002. The main farm that was supplying the milkfish, which was a subsidiary of a tuna longline agent, switched production to tilapia and marine shrimp; however, the parent owner of the farm has since decided to close the farm at the end of 2003. Some of the reasons provided for this decline in the use of live milkfish as bait are as follows:

- The decline in longliners porting in Guam (increase in fuel prices and new policies on immigration).
- Relocation of fleets around the Pacific (particularly the Taiwan fleets).
- Price of bait compared to other bait options.
- Reliable and consistent supply was not always available.
- Prevalence of yellowfin in the catch with use of milkfish live bait (prefer bigeye).
- Decline in Japanese economy (reducing the market size and price for high end fresh tuna).
- Problems with restrictions in fishing permits that have impacted operational efficiency and costs forcing vessel captains to reduce expenditures (e.g., bait cost).

Naamin (1993) noted a tendency of a fishing strategy shift by the Taiwanese 50 GT longliners from using live milkfish bait targeting yellowfin tuna to the use of frozen bait targeting bigeye tuna. During the period of 1990-92, Naamin (1993) reported that most of the Taiwanese longliners and a few Japanese longliners of the 50 GT category in Indonesia tended to use live milkfish as bait with yellowfin as the targeted tuna. The catch consisted of 80-90% of yellowfin (20-40 kg). Since 1993 this has been changing to vessels using frozen bait (e.g., milkfish, scad, and squid) that targeted bigeye tuna (40-60 kg).

Milkfish fingerling production in Taiwan during 1991 was allocated 46% to baitfish and 54% to grow-out for the market size food fish (approx. 250-300 g). The Taiwan fingerling demand for deep-sea fisheries was estimated at 50-60 million (Lee, 1991). This allocation has dropped to the current 25-30% of production going to bait (Chang, personal communication 2004). The reasons provided for this drop in the allocation from the Taiwan milkfish fingerling production was mainly attributed to a greater porting by the Taiwanese small tuna longliners (those that traditionally use the milkfish live bait) in Southeast Asian ports (e.g., Bali, Jakarta in Indonesia, and Davao in the Philippines) over the past 10 years where they purchased the live milkfish bait. This along with the shift away from yellowfin to bigeye tuna was the main reason for the lower demand for live milkfish in Taiwan. The Philippine tuna longline fleets also utilize live milkfish (Eleserio, personal communications 2004). The total annual bait demand is estimated at 1,500 MT and valued at US$1.64 million (Eleserio, personal communications 2004).

The demand for live milkfish bait by tuna longliners in Indonesia has been reported to be increasing (Sugama, personal communication; Budhiman, personal communication). According to Dr. Sugama and Budhiman (personal communication 2004), live milkfish comprises 50-70% of all the bait used by tuna longliners in Indonesia. Studies (Pranowo et al. 1997; Rachmansyah et al. Undated; Anonymous–E,1996) on the production of milkfish as bait for the Indonesian tuna longline fishery discussed the specifics of production and marketing. The size used (15-18 cm, 50-100 g/piece) tends to be larger than that commonly used by Taiwanese vessels elsewhere. There is a preference for live milkfish in Eastern Indonesia, specifically Bali and Eastern Java. Western Java (e.g., Jakarta area) has lower frequency of use for live milkfish as bait. This was partially attributed to a higher valuation of milkfish as a food fish in Western Java compared to that of Bali and Eastern Java.

It is also reported that Indonesia, West Java, has shifted away from using the live bait (Gillett, personal communication 2003). The farm-gate price reported by Dr. Sugama and Budhiman (personal communication 2004) for live milkfish bait is US$0.020-0.075/piece (160-600 Rupiah/piece), while the fry are US$1.18/1000 fry (10-15 Rupiah/piece), which reflects a continuing devaluation of the Indonesian Rupiah. In 1996, the farm-gate price for live milkfish bait (60-100 g/piece) was 300 Rupiah/piece (US$0.13 in 1996 currency conversion) with a vessel price of 600-700 Rupiah/piece (US$0.26-0.30 in 1996 currency conversion) (Ahmad, personal communication 1996). At this current price, it makes live milkfish very competitive to other frozen baits, since it would cost approximately US$600/MT (100 g fish at US$0.06/piece). The farm-gate price for frozen milkfish bait was reported (Budhiman, personal communication 2004) to be 65,000 Rupiah/20 kg (US$390/MT).

Therefore the demand for live milkfish changes over time and location. This is driven by price and competing uses of milkfish (i.e., bait vs. food) along with a very important factor of local market demand, which reflects the movement of those international fleets in pursuit of tuna (movement of fish populations and fishing permits policy and regulations). The decline of live milkfish use in Taiwan reflects the movement of their fleets over the past 10 plus years to other ports in the Pacific and Southeast Asia. The termination of use in Guam was mainly attributed to the declining vessels porting in Guam, particularly Taiwanese, which decreased the demand and the main farm supplying this market terminating operation. Meanwhile the domestic fleets in Indonesia have been reported to have increased since 1995. This illustrates the dynamic nature of the market for live milkfish bait, which is influenced often by external factors.

OPERATIONAL COSTS OF TUNA LONGLINE VESSELS

Bait constitutes a varying amount of the vessels' operational costs. The operational cost structure of tuna longline vessels for different country of origin fleets will also vary. This will affect the percentage of bait cost to the total operating costs. In a study of the economics of the Hawaii-based longline fleet (O'Malley and Pooley 2003), the average annual cost of bait (sanma – *Cololabis saira*, and sardine – *Sardinops sagaxas*) for the medium size (56.1-73.9 ft) tuna longliners amounted to US$34,982 per vessel. Table 6 provides a cost comparison of three size categories of vessels in the study. Bait amounted to 16.1% of the variable costs or 10.6% of the total operating costs (fixed and variable). This represents a significant cost item in the operation of tuna longliners. Therefore, the cost efficiency of that bait in catching the targeted species will influence the net profit.

Table 6. Annual cost of bait per vessel category and cost efficiency for the Hawaii-based tuna longline vessels (after O'Malley and Pooley 2001).

VESSEL SIZE CATEGORY	ANNUAL BAIT COST PER VESSEL	BAIT COST/TOTAL VARIABLE COST	BAIT COST/TOTAL OPERATING COST*	NET REVENUE/ BAIT COST
Small <56 ft	US$26,110	16.1%	10.9%	US$3.874
Medium 56.1-73.9 ft	US$34,982	16.1%	10.6%	US$1.523
Large >74 ft	US$35,979	14.1%	9.6%	US$0.56

*Exclusive of labor cost (usually based on share of catch, but varies).

A closer examination of the cost allocation for the Hawaii-based small tuna longliners (<56 ft) is presented in Table 7. Since the small longliners are the category of vessels that would be the targeted market for live milkfish, their relative cost/revenue breakdown will be utilized as a model in the assumptions for estimating the potential market for live milkfish.

Table 7. Hawaii-based small vessel size category (<56 ft) tuna longline costs in US$ (O'Malley and Pooley 2003).

REVENUE & COST ITEM	AVERAGE ANNUAL COST/VESSEL	PERCENTAGE OF TOTAL COST	AVE RAGE REVENUE & COST PER TRIP*
GROSS REVENUE	$502,740		$41,895
Fixed Costs			
Capital costs	$16,151	3.78%	$1,346
Insurance	$23,318	5.46%	$1,943
Bookkeeping/Accounting	$1,903	0.45%	$159
Mooring	$4,854	1.14%	$405
Overhaul	$3,640	0.85%	$303
Dry dock	$4,333	1.01%	$361
Other repairs	$16,151	3.78%	$1,346
Misc. costs	$6,719	1.57%	$560
Subtotal	*$77,069*		*$6,422*
Labor			
Estimated for captain/crew	$187,685	43.93%	$15,640
Variable Costs			
Fuel	$24,585	5.75%	$2,049
Oil	$1,264	0.30%	$105
Ice	$9,224	2.16%	$769
Bait	$26,110	6.11%	$2,176
Provisions	$11,064	2.59%	$922
Gear resupply	$14,199	3.32%	$1,183
Daily maintenance	$8,349	1.95%	$696
Fish processing	$1,100	0.26%	$92
Communications	$25,704	6.02%	$2,142
Sales	$40,924	9.58%	$3,410
Subtotal	*$162,523*		*$13,544*
TOTAL COSTS	$427,277	100.00%	$35,606
NET REVENUE	$75,463		$6,289

* Average number of trips/vessels were 12/yr

The operational characteristics of the Hawaii-based small vessel category are presented in Table 8. Given the number of hooks/set, sets/trip, and trips/yr the average annual demand for bait would be up to 233,500 pieces/yr. However, a percentage of the bait can potentially be reused in subsequent sets. This can range from 10% to 30%. Therefore, the actual estimated demand would be 163,450 to 210,150 per vessel per year. At current (January 2004) bait prices in Hawaii (sardine 120 pieces/10 kg @ US$1,400/MT, sanma 120 pieces/10 kg @ US$1,800/MT) the bait cost per year would be as high as US$24,518-31,522 for sanma, while for live milkfish at US$0.25/piece the annual bait cost would be US$40,863-52,538. With the risk adverse nature and reluctance to change fishing practices, the nearly doubling in the price of bait for live milkfish would represent a major disincentive for vessel captains unfamiliar with the bait.

Table 8. Operational characteristics of Hawaii-based small vessel category (<56 ft) of tuna longliners (O'Malley and Pooley 2003).

OPERATIONAL CHARACTERISTICS	AVERAGE NUMBER
Number of trips/yr	12
Number of sets/trip	11
Number of hooks/float	29
Number of hooks/set	1,769

In comparison to the Hawaii based longline fleet, Taiwan longliners have a different operating cost with approximately 33% allocated to bait cost. This higher percentage of operating cost assigned to bait compared to the Hawaiian fleet provides a greater incentive to identify an effective bait to improve CPUE, while keeping the net revenue to bait cost as high as possible. The captain would be more sensitive to the further increase in bait cost, since it already comprises a large portion of the operating costs. According to a study four years ago in Taiwan (David Chang, personal communication), the total operating cost per trip was approximately US$30,000 for an 80 GT vessel. Of this amount, fuel cost was US$7,000, ship maintenance, depreciation, and provisions amounted to US$4,000-5,000, crew salary of US$8,000-9,000, and bait was approximately US$10,000. Therefore, the cost structure and specifically the percentage allocated to bait varies among fleets and will have an impact on their bait purchase decisions.

FINANCIAL ANALYSIS EXTENSIVE VS. INTENSIVE MILKFISH AQUACULTURE

It is critical that a well informed decision making process is applied to all phases in the development of aquaculture activities as with all businesses. For practitioners of aquaculture, informed decisions are even more crucial due to exogenous factors (e.g., disease, unfavorable environmental conditions that cause mortalities or facility damage, etc.) that increase risk in bioproduction. To facilitate the decision making, a thorough step-by-step process is recommended. Appendix 5 provides a flowchart of these steps. This is critical to the proper evaluation of a proposed development with the determination of its economic viability.

CULTURE METHODS

Development of successful production of a product will depend on a country's comparative advantages in comparison to other producers of the same or similar product. The advantages and disadvantages of aquaculture development in general within the region have been documented (Bell and Gervis 1999; Macawais-Ele 2001). The comparative advantages and disadvantages for milkfish production in the SPC Region are as follows.

Comparative Advantages

- Low cost of labor (majority of countries).
- Conducive weather conditions (temperature, stable environment, for those islands outside the typhoon belt) to optimize growth.
- Natural resources (sea, land, fish fry) utilized to produce a marketable product. This includes the utilization of an indigenous species to the Pacific Islands (avoids the hazards, potential complications and costs of an introduced species) that is low in the trophic food chain.
- Potential synergy with existing domestically based tuna longline fishery providing complimentary economic benefits to both.

Comparative Disadvantages

- Remoteness of location (internationally and domestically) constricts access to potential markets as well as access to farm inputs.
- Limited logistics (shipping frequency, destination, potential fragile nature of consistent carrier service and cost by air or sea). Poor international transport services restrict opportunities.
- Limited support infrastructure (electrical, roads, etc.) – includes delivery of farm inputs and technical services.
- High cost of imports (potential inputs).
- Limited skilled workforce.
- Small domestic market and lower market price structures may restrict viable development along with hampering economical scale.
- Limited capital sources to finance sustained development.
- Fragile ecosystems (includes potential eutrophication).
- Restricted suitable land resource in some islands (limited suitable sites available, and effects of customary marine tenure on access to potential sites).

Assuming that an island has a positive net comparative advantage in the production of milkfish, there are a number of methods that can be utilized for the grow-out of milkfish. These include the following.

- Extensive pond culture – utilizing natural pond productivity as food source.
- Semi-intensive to intensive pond culture – utilizing commercial feed input.
- Pen culture – this can be extensive or intensive depending on location.
- Cage culture – this is usually intensive depending on location.

Milkfish aquaculture methods and production in Taiwan, Philippines, and Indonesia are identified in Table 9. It can be seen that production varies substantially within and between these major milkfish producer countries, with Taiwan being the most technically advanced. A similar range in production occurs in those Pacific Islands that are or have cultured milkfish in the past. Therefore, the projection of an industry based on the higher potential production increases the risk of failure when that production is not met. This contributes to making inappropriate investment decisions.

Table 9. Milkfish culture methods and production (after Lee and Banno 1990; Agbayani 2000).

COUNTRY AND CULTURE METHOD	STOCKING DENSITY	PRODUCTION (kg/ha/yr)
TAIWAN		
Extensive- Shallow Water	6,000-7,000/ha	1,800-2,500 kg/ha/yr
Semi-intensive Deep Water Method	>2,500/ha	8,000-12,000 kg/ha/yr
Pen		
PHILIPPINES		
Extensive	1,500-6,000/ha	800-4,000 kg/ha/yr
Pen	30,000-40,000/ha	2,000-10,000 kg/ha/yr
Cage	35-100/m^3	13-17 kg/m^3
INDONESIA		
Extensive	6,000/ha	300-1,000 kg/ha/yr

The preferred aquaculture production method (pond, pen, or cage) will also be island specific. The determination will depend on a number of factors including the following.

- Size of tuna longline fleet potentially able to utilize live bait.
- Size of pole-and-line fishery.
- Economics of production that would allow for the export of frozen milkfish as bait or food.
- Size of potential non-bait markets domestically.
- Suitable land sites availability.
- Environmental limitations (protected water areas for pen/cage culture, whether they are subject to typhoons, etc.).

Extensive culture with the utilization of wild caught fry is a suitable method for some Island countries as an entry into bait culture, since the additional costs associated with hatchery operations and more intensive operations will make the cost per unit production too high to be competitive against other frozen baits

FINANCIAL ANALYSIS OF MILKFISH CULTURE AS BAIT

The cost of production will vary among the SPC members. Therefore, the financial analysis represents estimated costs, which will change with actual costs in each island. However, the results can be used on a relative basis in a comparison of the different production methods. The assessment of the costs for individual islands should remove the subsidies and other government incentives to determine the true costs of operation. If the government wants to provide subsidies to the industry that should be made as a public policy that responsibly weighs the costs of the incentives to the benefits of development of the industry to be sure that they are justified. Otherwise, it introduces price distortions into the market place and inefficiencies.

A financial analysis of every potential production scenario is impractical for this study; therefore, the financial analysis will focus on generic production scenarios for milkfish as live bait. In the financial analysis, the assumptions for biological, physical, and financial inputs are identified in Appendix 6. The costs of production including capital costs are identified in Appendix 7 for six aquaculture production methods; however, the costs will vary among the 22 SPC Island members (individual costs can vary significantly; i.e., labor, taxes, construction, etc.). Therefore, each country will have to evaluate their specific costs to accurately reflect the potential financial viability of milkfish production. The resulting financial analysis based on these assumptions is presented in Appendix 7. The different aquaculture production scenarios should be utilized as a guide on a relative basis and not the absolute values due to the wide range in costs that are to be encountered in the different islands. The financial analysis for the different culture methods is summarized in Table 10.

Table 10. Summary of financial analysis for different milkfish culture methods for one-hectare area (US$)

	Extensive	Extensive plus	Semi-Intensive	Intensive	Pen	Cage
Variable Costs	$14,920	$26,300	$56,140	$140,070	$140,280	$268,270
Fixed Costs	$1,400	$2,250	$3,000	$24,000	$20,750	$27,000
Revenue	$25,200	$42,000	$84,000	$252,000	$252,000	$420,000
Net	$8,800	$13,450	$24,860	$82,930	$90,970	$124,730
Cost Per Unit $/kg	$2.59	$2.72	$2.82	$2.68	$2.56	$2.81

Baitfish rearing farms in Taiwan produce three crops per year (over winter slow or no growth). The grow-out season usually spans April thru November. The bait is sold per piece. SPC Islands should be able to produce 5 crops/yr due to year round warm conditions. In an economic analysis of milkfish culture as bait in Taiwan (Lee 1983), the average baitfish farm was 1.81 ha with major production costs being fry (75.2%) and labor (14.8%). It should be noted the cost structure could vary significantly from country to country with the different costs of inputs. Net annual revenue averaged NT$44,429/ha (1979 values; US$1,233/ha) for farms under 1 ha in size, with farms over one hectare in size averaged NT$51,954/ha (US$1,441/ha). The cost allocation and returns for the two size categories of farms are summarized in Table 11. It should be noted that the culture method is equivalent to "extensive plus" in which supplemental feeds are utilized in addition to the natural productivity of the ponds with a moderate stocking density of 3.7-4.1 pieces/ha. From Table 11, it can be seen that baitfish culture provides a substantially higher return than that from food fish production for an equivalent area.

Table 11. Production cost distribution for milkfish farms producing for the tuna longline bait market compared to milkfish production for food fish (Lee 1983).

	BAITFISH FARMS		FOOD FISH FARMS	
COST ITEM	FARM SIZE < 1 HA	FARM SIZE > 1 HA	FARM SIZE < 3 HA	FARM SIZE 3-10 HA
Direct Costs				
Fry	69.8%	76.4%	36.2%	40.5%
Feeds	1.9%	2.3%	24.6%	22.6%
Labor	19.6%	13.9%	23.3%	21.8%
Fuel	0.9%	0.8%	1.3%	1.7%
Materials	2.5%	2.0%	5.0%	2.2%
Water Fees	NA	NA	0.4	0.2%
Subtotal	*94.6%*	*95.4%*	*90.9%*	*88.8%*
Indirect Costs				
Land rent	1.2%	1.0%	2.4%	2.9%
Water & Electricity	1.1%	0.9%		
Interest on borrowed capital	0.04%	0.8%	4.2%	5.1%
Maintenance Costs	1.5%	1.0%		
Taxes	0.7%	0.6%	0.1%	0.1%
Depreciation on equipment	0.6%	0.4%	2.4%	3.1%
Subtotal	*5.4%*	*4.6%*	*9.1%*	*11.2%*
Net Revenue/ha	NT$44,429	NT$51,954	NT$6,094	NT$7,399
Rate of farm Income	27.3%	29.8%	6.31%	7.41%
Average Farm Size (ha)	0.75	2.42	1.82	5.75

Effect of stocking density has been examined to determine the best stocking density for the culture of milkfish for bait (Yabo 1994; Baliago et al. 1987) along with managing the growth retardation to provide a continuous supply for bait within a specific size range. As previously mentioned, milkfish spawning is seasonal; therefore, the fry supply will be limited to a few months of the year. In some locations there is a secondary spawning season. There is also differences in the time of year that spawning occurs through the Pacific. However, the grow-out needs to incorporate this fact in the operation of the farm (adds to cost of operation) to allow for output of the proper size and quantity of bait throughout the year to supply the bait market. Therefore, crowding will be required to retard growth for a portion of the crop to meet the demand throughout the year.

As part of the market analysis in the assessment and planning stage (Appendixes 8 & 9), the potential users of the bait need to be evaluated as to their capacity and interest in utilizing the product. In domestic longline fisheries that are not familiar with the use of live milkfish as longline bait, there will be a need for training and awareness programs for the tuna longline vessel captains. Since without the interest to utilize live milkfish as bait, the market will not materialize despite what would seem to be logical projections of its use. In this situation, the demonstration of milkfish effectiveness as bait should be carried out as part of the planning and assessment phase in market analysis. The responsibility of this aspect of development will likely be with a government (local or international) program for economic and fisheries development. In the evaluation of the potential users of the product, it should include the vessels capacity to utilize live bait. This will require live bait wells. The cost of modifying vessels to accommodate live bait wells may prove to be a sufficient barrier for the fleet to utilize live bait despite the efficiency of the bait and is an important component that should be part of the assessment and planning phase.

In an analysis of milkfish culture in the Philippines utilizing the cage culture method, a cost comparison was made at different cage sizes (Lopez, unpublished). This was to produce a food fish size product, which normally shows a lower return compared to baitfish production. Table 12 provides the costs for four different cage sizes. This is with the assumptions of a stocking density of 50/m3, survival rate of 80%, feed conversion ratio of 1.7, harvest size of 3.5 pieces/kg (286 g/fish), and a wholesale price of US$1.07/kg (P60/kg). Of the four surface area sizes evaluated, all showed a profit, with the 1,000 m2 cage having the highest rate of return.

Table 12. Cage culture of milkfish (food fish 3.5/kg) comparison of costs and area (Lopez, unpublished). Exchange rate based on 100 Philippine Peso = US$1.79 (January 2004).

Item	**100 m^2 (10m x 10m cage)**	**200 m^2 (20m x 10m cage)**	**400 m^2 (20m x 20m cage)**	**1,000 m^2 (50m x 20m cage)**
Construction Cost				
PE net	$128.88	$233.60	$322.20	$572.80
PE rope	$10.74	$15.04	$19.33	$21.48
Kawayan	$35.80	$53.70	$62.65	$89.50
Labor cost	$17.90	$26.85	$35.80	$44.75
Miscellaneous	$8.95	$13.43	$17.90	$22.38
Subtotal	*$202.27*	*$342.62*	*$457.88*	*$750.91*
Production and Marketing Costs				
Fingerlings @ US$0.054	$268.50	$537.00	$1,074.00	$2,685.00
Feed pellet @ US$0.254	$493.90	$987.79	$1,975.16	$4,938.54
Harvesting cost (2% GS)	$24.56	$49.10	$98.18	$245.50
Marketing cost (5% GS)	$61.38	$122.78	$245.46	$613.74
Miscellaneous (5%)	$42.42	$84.83	$169.64	$424.14
Depreciation cost	$50.57	$85.65	$114.47	$187.74
Subtotal	*$941.33*	*$2,267.16*	*$3,676.91*	*$9,094.66*
Calculation of Benefits				
Production output	1,143 kg	2,286 kg	4,571 kg	11,429 kg
Gross sale (GS)	$1,227.58	$2,455.16	$4,909.25	$12,274.75
Net Profit	$286.26	$588.02	$1,232.34	$3,180.10
Break-even price	$0.82	$0.82	$0.80	$0.80
Break-even production	876 kg	1,739 kg	3,424 kg	8,468 kg
Rate of Return	30.40%	31.50%	33.50%	34.97%

The Fiji Islands Trade & Investment Bureau (2001) reported that a milkfish bait project under the Commodity Development Framework sold the milkfish bait to the domestic tuna fisheries at US$1.15/kg (FJ$2.00/kg). This would be about US$.07/fish (live bait at 60 g/fish). This would be a very competitive price compared to the Taiwan price of US$0.20-0.25/fish but slightly higher than Indonesia price, if the farm is operating profitably. Similarly, Kiribati's price of US$1.84/kg (AU$2.50/kg) or US$.11/fish (live bait at 60 g/fish) would be competitive, if it had a market. However, this operation has not proven to be profitable to date.

The calculated cost for fingerlings (stocking size) in the Philippines was 0.33 to 0.83 peso (Librero et al. 1991, 1993) or US$0.013 to 0.032 (US$13 to 32/1000 fry based on 25 peso/US$1 in 1990), which is similar to the Taiwan price. The cost of collected wild fry in the Philippines varies substantially also through the seasonal runs. They go from US$2.69 to 16.13/1000 fry (Smith 1981).

HATCHERY FRY PRODUCTION

The major technological advancement in milkfish aquaculture over the past 20 years is the development of hatchery technology for milkfish since the early 1980's that has allowed commercialization of fry production from hatcheries and reduced the dependence on wild caught fry. This has stabilized the fry supply and has contributed to lowering the fry portion of the production costs (Chen et al. 2001). Lee (1995) identified fry cost as 39.7% in 1979, while in 1990 it was reduced to 19.5% in Taiwan of the grow-out production costs. Part of this shift in the production cost allocation is due to the increase in costs of other input components such as labor and feed.

There are two basic hatchery operation methods for producing milkfish fry and they are intensive and semi-intensive. The intensive system uses tanks for larval rearing with the addition of separately cultured algae, rotifers, and artemia at different stages during the culture period. Larvae are stocked at a relatively high density of 20-30/l. In the semi-intensive system, a pond is utilized and natural phytoplankton and zooplankton growth is promoted through fertilization. The larvae are stocked at a lower density of 5/l. A cost of fry production analysis was done for Taiwan (Lee et al. 1997). The major cost of production for both systems is labor, but the intensive system has the highest labor cost (61.1%). The cost of producing fry from a hatchery utilizing both the intensive and semi-intensive methods is presented in Table 13. They found the semi-intensive method of fry production to be the most profitable under the existing conditions. The semi-intensive method had a lower cost of production at US$6.67/1000 fry compared to the intensive system, which had a US$27.40/1000 fry cost of production. It was further noted that to reach a profitable level a minimum production had to be obtained. For the intensive system, it was 1.4 million fry per cycle, while the semi-intensive required 2 million fry per cycle at a market price of US$24/1000 fry. This is exclusive of the costs of obtaining fertilized eggs (broodstock and spawning). However, it should be noted that this is calculated on the cost of the facility and operational costs only during that portion of the year when the milkfish are spawning (4-months in Taiwan, May-Aug). For the remainder of the year, the hatchery facility's fixed and variable costs require other sources of revenue that at least allow it to break-even or those costs would be added to the milkfish fry production and most likely make it uneconomical. Therefore, it is important to incorporate a multi-species use into the analysis and design of a hatchery.

Table 13. Comparison of hatchery production costs (in US$) for fry from intensive and semi-intensive methods in Taiwan (Lee et al. 1997).

ITEM	INTENSIVE FRY PRODUCTION			SEMI-INTENSIVE PRODUCTION		
	Total Cost	Assigned Depreciation	Percentage of Total Operating Cost	Total Cost	Assigned Depreciation	Percentage of Total Operating Cost
Capital Costs						
Larval readng tanks	$28,800	$2,880		$120,000	$6,000	
Phytoplankton. tanks (size 1)	$57,600	$5,760		$0	$0	
Phytoplankton tanks (size 2)	$9,120	$912		$0	$0	
Phytoplankton txanks (size 3)	$1,200	$120		$0	$0	
Rotifer ponds	$9,120	$912		$24,000	$1,200	
Artemia tanks	$720	$72		$0	$0	
Buildings (including office, lab, plumbing, electrical)	$221,091	$11,055	$76,000	$3,800		
Laboratory and office equipment	$4,000	$800	$4,000	$800		
Blowers	$10,000	$1,250		$14,000	$1,750	
Pumps	$5,000	$625		$10,000	$1,250	
Total	**$346,651**	**$24,386**		**$248,000**	**$14,800**	
Operational Costs						
Feed	$15,714		4.78%	$8,669		5.41%
Labor	$200,746		61.06%	$50,187		31.32%
Energy (for pumps, blowers, others)	$11,105		3.38%	$30,187		18.849
Chemical	$2,416		0.73%	$2,601		1.62%
Repair and maintenace	$17,333		5.27%	$12,400		7.74%
Land rent	$1,665		0.51%	$8,326		5.20%
Interests	$27,732		8.44%	$19,840		
Contingency	$27,671		8.42%	$13,207		8.24%
Depreciation	$24,386		7.42%	$14 800		9.24%
Total	**$328,768**		**100.00%**	**$160,217**		**100.00%**

* Note assigned depreclation and operational costs of the hatchery are only for 4-months of the year during the milkfish spawning/larval rearing period.

In comparison to the hatchery costs in Taiwan, Hawaii has a higher unit cost of production as demonstrated in Table 14 with the cost of production of threadfin, which has similar hatchery procedures to that of milkfish. The unit cost of nearly US$0.23/fry would be very high and would make the production of milkfish as bait not economical.

Table 14. Oceanic Institute, Hawaii, hatchery costs (in US$) for Pacific Threadfin (*Polydactylus sexfilis*) (Lotus et al. 2003).

ITEM	REVENUE & COST	PERCENTAGE OF TOTAL OPERATING COST
Gross Revenue ($0.25/fry)	$300,000	
Variable Costs		
Feed	$5,442	2.48%
Labor	$129,993	59.13%
Energy (for pumps, blowers, others)	$10,228	4.65%
Chemical/Supplies	$24,985	11.37%
Repair and maintenace	$1,557	0.71%
Land rent/Facilities rent	$6,000	2.73%
General Excise Tax	$1,500	0.68%
Fixed Costs		
Equipment Depreciation	$10,331	4.70%
Development Depreciation	$20,817	9.47%
Subtotal	$31,148	

Contingency	$8,985	4.09%
Total Operational Expenses	$219,838	100.00%
Interest Expenses	$45,819	
Net Income Before Tax	$34,343	
Income Tax	$6,756	
Net Income After Tax	$27,587	
Cost per Fry Before Tax	$0.2201	
Cost per Fry After Tax	$0.2270	

*Based on 2nd year when in full production at 1.2 million fry/yr.

A "nucleus hatchery" system is used in Taiwan and Indonesia along with satellite hatcheries. The nucleus hatchery would maintain broodstock and carryout spawning with distribution of the eggs to numerous smaller satellite hatcheries for larval rearing to fry. In Indonesia, this system is often referred to as a "back-yard hatchery" system, which has been promoted with success. In Taiwan, a percentage (40-60%) of the total revenues are paid to the nucleus hatchery. A study on the economics of the Bali, Indonesia, system of nucleus hatchery and satellite "backyard hatcheries" reports a cost of milkfish fry at US$14.00/1000 fry in 1997-98 (Siar et al. 2002). Bali currently has 9 nucleus hatcheries and over 300 "backyard hatcheries" (Sugama, personal communication 2004).

The cost of live milkfish as bait (40-60g) is approximately 10 times the cost of the fry. For example, the farm cost fry in Taiwan is approximately US$0.02-0.025/fry and the bait cost is US$0.20-0.25. In Guam, the fry cost was approximately US$0.05/fry (imported from Taiwan) and the bait price was as high as US$0.50/piece (later dropped to US$0.43/piece and to US$0.30-0.35 just before stopping production). Therefore, it is critical that the fry cost does not exceed US$0.05/fry to produce a bait size fish that is reasonably competitive with alternative baits and provide an acceptable profit margin.

Figure 5 shows the components of a milkfish hatchery. The size and operation varies substantially with demand for fry and the technical capacity of the country. As with the grow-out phase in milkfish production, the hatchery component should be flexible to switch production to alternative species as the demand changes over time. Development of a hatchery facility should not be based solely on milkfish fry production. The production season for milkfish would only span approximately a 4-month period; therefore, the remaining 8-months in a year need to be committed to alternative species production. A hatchery facility would only be a justified investment if it were part of a larger integrated aquaculture program for the development of commercially viable aquaculture. In some islands, the current existence of a hatchery facility would facilitate the adaptation with usually minor modifications to allow for milkfish fry production. The high capital investment along with investment in technically trained staff will make the development of a hatchery not advisable in the initial development of milkfish aquaculture. Utilization of wild fry stocks, that are available in sufficient quantity for initial development or the importation of fry would be the most prudent strategy.

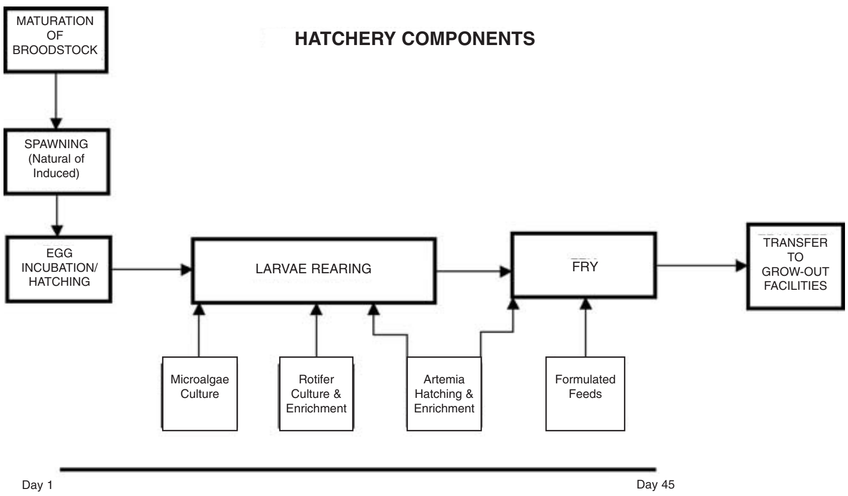

Figure 5. Milkfish fry production and hatchery components

There is available a hatchery operations manual for mullet by the Guam Aquaculture Development and Training Center (Tamaru et al. 1993), which would provide an excellent guide to the specifics in the larval rearing and live food culture that are directly applicable to milkfish. A milkfish hatchery manual is also available through Oceanic Institute Hawaii (Liu and Kelley 1994).

Hawaii has the hatchery capability and technology and potential farms that could produce milkfish; however, it has failed to develop despite a substantial domestic demand from the Filipino population. This can be attributed to a number of factors including the high cost of fry US$0.20-0.25/fry from the Hawaii hatchery, inadequate farm demand to support hatchery activity, competition to cultured product from imports, slower growth (winter period of lower water temperature), and low return on the farm grow-out (Kam et al. 2003). Oceanic Institute that served as the broodstock and hatchery facility in Hawaii for milkfish production will be terminating fry production (shifting research to other species), since there is inadequate domestic demand for fry production to justify the cost of operation and maintenance of the broodstock. Domestic production could not compete with the import price on milkfish from lower cost producers. This exemplifies that it is not only the issue of technology (Oceanic Institute is a leading research center for aquaculture), market demand (large domestic demand as a food fish), infrastructure (internal and external), and farm capacity (facilities and skill labor) that determines the viability of sustainable aquaculture. All these factors would indicate a potentially favorable environment for milkfish cultivation; however, the current production economics in Hawaii do not support its viability. This emphasizes the importance of a thorough analysis of the industry that includes the long-term economic viability prior to major investments.

A hatchery facility for milkfish should only be considered once an aquaculture industry is established for milkfish and there is sufficient demand for further production expansion to support the minimum hatchery production level to obtain break-even. Utilization of fry from wild stock or imported fry from a low cost producer would provide seedstock for the initial stage of development. Establishment of a milkfish hatchery should be part of a broader aquaculture development program that has identified multiple-uses for the hatchery so that it can be fully utilized throughout the year when milkfish are not spawning. The alternative species for the hatchery should also reflect economically viable production. The establishment of a regional (sub-regional) hatchery facility serving many of the SPC Islands may prove to be a more efficient and cost effective strategy. The concept of a "nucleus regional hatchery" for the maintenance of broodstock and spawning to provide fertilized eggs to small satellite hatchery facilities in different islands in the region would also be an option that would incorporate efficiencies of operation within a cooperative regional approach to development.

POTENTIAL NICHE MARKETS

Alternative markets for milkfish other than tuna longline live bait include the following.

- Fresh milkfish for human consumption – This will remain the major market for worldwide production. However, in some of the SPC Islands where it is not traditionally consumed this is unlikely to be a significant market.
- Frozen milkfish for human consumption – This is the major export form for human consumption. With modern processing and packaging technology, the blast-frozen product is of high quality.
- Smoked milkfish for human consumption – This form provides a value added product that can expand the total market with some new market demand. However, all of the additional costs of processing must be incorporated into the final product pricing to make it an economically viable product.
- Processed milkfish products – This would include bottled, canned, surimi, dried and fermented. "Boneless milkfish" processing along with stuffed processed milkfish all target specialty niche markets that are usually ethnically based. Processing of bait size milkfish to various products has been proposed by Peralta (2001) and Orig (2001).
- Frozen milkfish as bait for tuna longline fisheries – This may represent a substantial area for expansion of the milkfish market, if the product can be produced competitively priced to other traditional frozen baits used by longline vessels.
- Pole-and-line tuna fisheries live bait – The successful use of milkfish in pole-and-line fisheries has been documented (JICA 1978; Kearney and Gillett 1978). In an evaluation of bait efficiency in Kiribati (FAO 1983), it was shown that milkfish had the highest bait chummed/tuna catch among four baits tested (sardine, bouke ami, combination milkfish and bouke ami). In an extensive evaluation (Argue et al., 1987) of live bait in pole-and-live fishing with a comparison of six baits (anchovies, sardines, hardyheads, mollies, milkfish, and sprats), milkfish had an overall positive rating among the evaluation criteria used. Sardines and anchovies ranked the most effective followed by milkfish, mollies, sprats, and finally hardyheads. This would indicate that live milkfish is a suitable pole-and-line bait that may partially capture this market niche, if priced competitively with other baits.
- Sport fishing bait – This will be a small niche market for live milkfish, but potentially lucrative for a limited portion of production.

Total milkfish production over 10-years from the three major world producers of milkfish is presented in Figure 6. Over this period, the production remained relatively stable during 1992-98 with an increase in 1999 of approximately 16.3% and has since remained relatively stable during the following period. Production capacity will grow with technology, but will be limited to a relatively stable mature market demand that only partly reflects population growth. Lee (1995) noted there has been a decrease in consumption by the younger population groups.

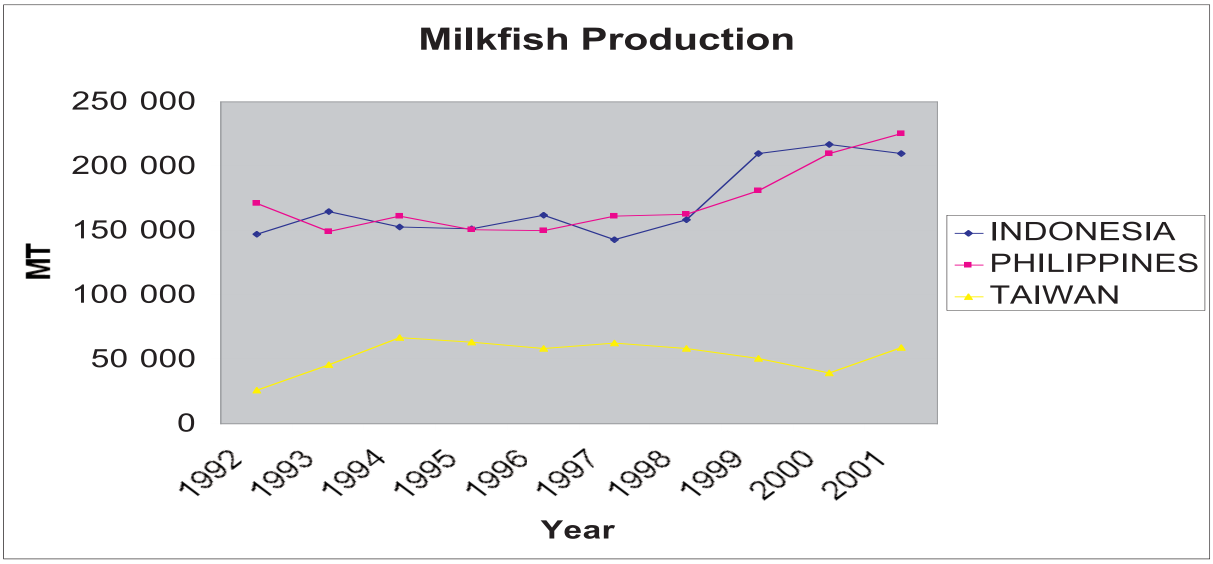

Figure 6. Annual total milkfish production from the three major producer countries (FAO Yearbook 2001).

Milkfish aquaculture area in Taiwan has decreased from 31% of the total aquaculture area in 1975 to 17% in 2002 (Lee, 1995; Taiwan Fisheries Yearbook). Actual production has gone from 33,309 MT to 72,435 MT, while the market price has decreased in this same period. During this period the production efficiency has increased to allow for greater production per area. In addition, the more profitable culture of alternative species has been developed along with other economic uses of the land, which has utilized some of the area that was once in milkfish culture. Similarly, the milkfish aquaculture area in the Philippines has decreased from 88% in 1981 to 45% in 1996 of the total aquaculture area (Ahmed et al., 2001).

To address export markets for the non-live bait products, the islands will have to be competitive on a world commodity market price basis. With major low-cost producers in the Pacific region, that include Indonesia, Philippines, and Taiwan, it will be very difficult to enter this market. However, there may be some opportunities for small exports within the region that allows for some competitive advantages such as nearby islands (keeping export costs to minimum), and to other island counties that have inherent high costs of the product due to remoteness from major market centers and high transportation costs.

The price for milkfish will be set by the supply and the consolidated demand for the different uses, which include various product forms as a food fish and as a live or frozen bait. The supply side will be influenced by production costs, and competitive aquaculture species that may provide a farm better returns on investment. The general lower value of milkfish means it must compete for production area with higher value species such as shrimp, crabs, and other higher valued fish. Therefore, the price will vary with the supply/demand, competitive products, and influenced to a certain level by international prices (lower cost producers with comparative advantages of production).

As an example of how market supply and demand impacts on economic viability, the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) reported the Laguna Bay milkfish producers farm-gate price had dropped to US$.80/kg, which is below production cost of US$.90-1.00/kg (Stream Philippines Communications Hub 2003). This was due to market pressures with production exceeding market demand; therefore, the BFAR was looking at export to Japan for tuna bait (frozen) as a means of increasing market demand. In addition, production of milkfish from the Philippines is being promoted for the tuna bait market in Taiwan by the BFAR (Philippine government). This is targeting the estimated 150,000 MT/yr demand for milkfish bait in Taiwan, with about half of that requirement being imported (Anonymous-A 2003). BFAR is initially projecting an export of 4,500 MT from the Philippines for this market (NADCFI 2003). This is part of an effort to expand and diversify the market for the Philippine's milkfish product. The milkfish for the bait market is that portion of production that develops off-flavor (blue green algae consumption) that is not suitable for human consumption. The farm-gate price for this product is US$.42/kg (P23.5/kg) for fish that are 5-6 pieces/kg and blast frozen for export (Anonymous-B 2003). This is aimed at capturing part of the frozen milkfish bait market, which is dominated by Indonesia.

A price quotation from one of the many bait/seafood wholesalers (seafood@sujama.com) that are available through the Internet (Appendix 10) was provided for frozen milkfish bait shipped to key Pacific ports (Table 15). The product comes in 10 kg blocks and in various sizes (i.e., 41-45, 46-50, 51-55, 56-60, 61-65, and 66-70 pieces/carton). There is a minimum quantity per order of one 40 ft FCL (26 MT). The cost to reach some of the Pacific Islands will be higher due to shipping routes, while others may be slightly lower. Therefore, this would set a competitive basis the domestic producers would have to compete against (farm gate price + processing/transport costs + marketing costs). The advantage of domestic producers is that they could possibly be more competitive on smaller quantity purchases when the demand for bait would not meet the minimum order requirement from an international wholesaler. Live bait from a domestic source would be more vigorous than bait shipped long distances and the difficulty of shipping live quantities of fish will make it economically prohibitive in most cases.

Table 15. Frozen milkfish bait price (in US$) from Indonesia delivered to ports around the Pacific (January 2004). Minimum order 40 ft. FCL (26 MT) in 10 kg box units.

COUNTRY	PRICE DELIVERED TO PORT
Bali, Indonesia	$0.93/kg
Singapore	$0.95/kg
Kaoshung, Taiwan	$0.98/kg

To enter the international market, the SPC Islands will have to compete with other producer countries with significant comparative advantages (e.g., lower input costs, better logistics and infrastructure, established market linkages and established supplier in international trade) such as key producers in Asia (e.g., Philippines, Indonesia, Taiwan). Each country may have country specific characteristics that influences markets along with favorable or unfavorable regulations and structure. Even though milkfish is not traded internationally to the extent of shrimp or other marine products, international market prices will influence the market and price in a specific country. For example, Guam's milkfish production dropped off during the early 1990's with the importation of high quality blast frozen milkfish from Taiwan, which retailed at one-third to one-quarter the price of the fresh Guam product. This market influx of lower priced milkfish was partially the result of increased production from Taiwan shrimp farms that suffered from major shrimp disease problems. These farms switched to alternative species for production including milkfish. This increased product supply lowered prices and the export to Guam impacted the local milkfish farms production and margins.

To be competitive in the international market for frozen or processed product, the production costs will have to be competitive with international prices for the product. In the domestic market, this import price will be impacted by potential import tariffs and taxes on the product by each island along with the shipping costs. So the domestic market may provide opportunities for the product, while the export market will have to be competitive with the world market price. For example, the wholesale price in Manila Philippines for milkfish (food fish) is approximately US$1.20/kg. Taiwan tends to be a slightly lower (US$0.90-1.10/kg) cost producer, and Indonesia is the lowest cost producer of the major producers. These prices will fall below the best-case scenario for production in the SPC regional Islands. Therefore, the products from the SPC region will not be competitive with these major producers. However, in the case of live milkfish for bait the high cost of shipping that product and logistics would make it prohibitive even from these low cost producers. This provides a potential domestic opportunity, if there is a market for live milkfish bait. The exception being cases where longline vessels could make port of calls in those countries (i.e., Indonesia and Philippines) where they could reprovision and purchase bait and then fish within the SPC region.

FUTURE TRENDS FOR MILKFISH AQUACULTURE IN THE PACIFIC

The past experience in the Pacific Islands with aquaculture in general should be noted and shared. Both successes and failures are learning experiences that help reduce risk in future developments. It should be noted that the two islands that had significant programs of milkfish production targeting the tuna baitfish market (Guam for the tuna longline fleets, and Kiribati for the pole-and-line fleets) are no longer supplying to those markets (the case of Guam) or at substantially reduced amounts from that originally planned (the case of Kiribati, which is mainly a government funded or subsidized operation). This emphasizes the fragility of an aquaculture operation that is developed around one product for a single market, particularly when that product can be readily substituted with a lower cost product, and that market is mobile and has alternative suppliers. In the case of Guam, the established private aquaculture industry was presented with the opportunity for a new market (milkfish bait) and shifted production from mainly existing farms to meet that market opportunity. When that market was no longer available they had the flexibility to economically switch production to other viable products. This flexibility of production will be critical to any long-term aquaculture operation in the region.

The technological trends for the future development of milkfish aquaculture will include the following.

- Refinement of the maturation/spawning/larval rearing for hatchery produced fry. This has stabilized fry supplies and price. This could be further improved upon to include hormonally or environmentally controlled spawns throughout the year to reduce seasonality of fry supplies.
- Improved efficiency in the grow-out phase of production with improved efficiency of inputs and increased output per unit area. This will allow for reduced farming area, while maintaining production level at a lower cost.

The future trends for the markets are uncertain, since a number of factors determine the demand; however, areas for future development or improvement include the following.

- Traditional food fish – improvement of transportation services to improve market access from production areas will assist in expanding markets. However, new markets will be difficult to establish since milkfish is a bony fish. Lee (1995) implies that milkfish cannot be a luxury food item. Thus its markets will be mainly limited to those with a historical cultural preference for milkfish. Lee (1995) also states that even within cultures that historically preferred milkfish the younger populations are trending toward alternatives.
- Expansion of milkfish markets – The fresh or frozen food product has limited markets for expansion due to its bony nature. Boneless forms of processed milkfish and possibly canned product, as labor-saving technology develops to process the product, do have potential for market growth. New markets will require time, and promotion to develop awareness of the product and its various forms. Expansion of milkfish markets will require research and development in both the marketing and the processing of milkfish.
- Milkfish as bait for tuna longline fishery – Even though there has been a trend away from using milkfish as live bait by the longline fishery in some locations, it remains as an effective bait that can improve the catch rate. A major deterrent to the use of live milkfish as bait is the cost. With improved production efficiencies, it may become more attractive as a bait. Furthermore, controlled extensive studies will be needed to demonstrate its most efficient utilization by the fishery along with the economic viability of its use and demonstration of improved catch revenue over the additional cost of live bait (cost/benefit ratio comparison to traditional frozen baits).

Some issues that affect future trade in aquaculture products in general are the following.

- Externalities – Environmental and social concerns influence aquaculture exports particularly to North America and Europe (e.g., shrimp, live marine fish, along with chemical and drug issues, etc.). The importance of attaining sustainable aquaculture with no or limited externalities will force many exporting countries to adopt more sustainable production practices. The introduction of eco-labeling schemes will further increase this trend.

- Quality – With growing concern about food safety, increasing efforts have been undertaken to improve the quality of aquaculture products. International codex standards cover aquaculture products, and the introduction of mandatory HACCP requirements for exports to the USA and the European Union will have strong impact on trade in aquaculture products in the near future. Some countries have developed comprehensive HACCP plans for selected aquaculture products in the USA. In other countries, individual aquaculture producers undertake voluntary certification (ISO 9000) for control as well as marketing purposes.
- Tariffs – Despite steady reductions in tariffs on fish and aquaculture products in recent years, tariffs as well as import licenses continue to represent barriers to trade in many countries. This is especially the case in many fast-growing Asian economies, but important markets such a Japan, the European Union and the USA all give competitive advantages to domestic producers of many species, especially in the case of processed products. Average tariffs on imports from developing countries are now estimated at 4.8%, a cut of 27% from the previous level of 6.6% (FAO, 1995). The long-term trend, with growing membership in the World Trade Organization, will be for further reduction in tariffs.
- Food security – Aquaculture is an important source of seafood because most of the production is consumed domestically by producing nations. It has also become a significant source of foreign currency to many developing nations because the products exported usually are the more valuable ones (e.g., shrimp), destined for markets in the developed world. These revenues allow the countries to import other less costly protein, and as such, aquaculture can be considered important to food security even when the output is exported.

CONCLUSIONS

Each Pacific Island should carefully evaluate its own individual market potentials and costs of production, since some of these will be unique to each island. A diversified production strategy for multiple markets that may be available domestically along with built in design flexibility of aquaculture facilities that allow for the efficient culture of alternative products for these domestic markets will reduce the operational risk and increase the likelihood of success for a sea or land based aquaculture operation. The flexibility of design will be critical to sustainable aquaculture. This will require the evaluation and identification of alternative species that are economically viable. This will allow production to be shifted to alternative crops as markets and demand changes. Reliance on a single market (e.g., baitfish) or species (milkfish) increases the financial risk of the operation. This evaluation should be part of a thorough planning and assessment analysis that is conducted prior to investment.

A recommended strategy for the cultivation of milkfish for the live bait market is to incorporate it into a versatile aquaculture program that allows the farm operator to take advantage of diverse market opportunities as they develop. The transient nature of tuna fleets and the numerous external factors that impact on their operations would place at risk an aquaculture venture's sustainable successful operation that was developed solely to meet a potential live bait market. Therefore, there should be the option of other viable products that an aquaculture farm can produce.

In the initial stage of milkfish aquaculture development, the demand for fry should utilize natural fry resources from the wild followed by importation from low-cost producers (e.g., Indonesia, Taiwan) to meet fry demand. From a long-term regional perspective, the development of milkfish bait production should be in the most efficient and viable locations to serve the whole region. This should include consideration of the application of a central "nucleus hatchery" strategy, as previously described, with smaller satellite facilities for larval rearing to fry throughout the region at strategic locations. This could prove to be the most cost effective and efficient method to meet fry demand in response to a potential expanding bait industry scenario. The "nucleus hatchery" would develop and maintain broodstock, and conduct spawning for the distribution of eggs to smaller satellite facilities in the region. This would allow cost efficiencies in hatchery production that would not be obtainable by most of the individual Island countries operating isolated complete hatchery facilities. As an alternative, the importation of eggs from hatcheries from the low cost producer of Indonesia (i.e., Bali) would further reduce costs, if cost-effective transportation links can be established.

Even though the government will often play an important role in the initial phase of development through demonstration/pilot farms and other industry supports, this needs to be done in coordination with the private sector, since it will ultimately be the private sector or in some cases community cooperatives that will have the role of operating economically sustainable enterprises. The private sector (production and market) along with community interests should be involved from the early planning stage of aquaculture to assure their input and full participation. Aquaculture (milkfish or other species) can make a valuable contribution to the economies of the Islands within the SPC region when done in a carefully planned and executed manner that takes full account of financial resources needed, natural resources, environmental issues, manpower, markets, and economics of production.

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APPENDIXES

APPENDIX 1. TERMS OF REFERENCE:

The aim of this consultancy is to provide a regional assessment of the commercial viability for milkfish aquaculture to supply the baitfish market and other potential niche markets.

The geographical scope of this consultancy will target milkfish (*Chanos chanos*) farmers from the Pacific region comprising of the twenty-two SPC member Pacific island countries and territories.

The project will consist of four (4) weeks of gathering literature, data on current and potential markets, and identifying specific advantages/disadvantages for participation by the SPC member island countries and territories in milkfish culture. Two (2) weeks will be utilized to compile the collected information and data and prepare the report.

Specifically, your consultancy will produce a written report that will include the following information:

- a review of the status of milkfish aquaculture in the Pacific;
- an assessment of the market demand for milkfish as baitfish. Particularly for the Pacific region's tuna fishing industry;
- financial analysis to investigate cost-profit scenarios for extensive (e.g. fry collection) versus intensive (e.g. hatchery) milkfish aquaculture;
- an examination of potential niche markets, other than baitfish, for milkfish producers in the Pacific;
- an assessment of the future trends for milkfish aquaculture in the Pacific.

APPENDIX 2. SUMMARY OF COUNTRY RESPONSES

Country	Milkfish fry present	Aquaculture of Milkfish	Milkfish used as Tuna Longline bait	Current bait species	Current bait demand for Tuna Longline Fishery
American Samoa	Fry not available	No	No	Sanma and mackerel	
Cook Islands					
Federated States of Micronesia	Fry available, but may not be adequate quantity for large culture.	No. Not a popular fish in the local mkt. One previous trial proved unprofitable. Targeted the longline bait market. Terminated approximately 2-years ago.	Taiwan vessels have used live milkfish. Problem with quality/size (small) of live milkfish provided from local producer. Local vessel trial from previous project to culture milkfish as bait – local vessels did not have live bait wells so used as fresh bait – only noticed difference was less loss of fresh bait as compared to old frozen bait on hook.	Muroashi and Iwashi. Squid used by Chinese vessels. Muroaji (brown-striped mackerel or marckerel scad) is US$1,300/mt; Iwashi or sardine US$1,100/mt	6,000 cases /month (10kg, 100pc/case) of muroashi & iwashi. Squid averaging 28mt of imported bait per month to supply 9 longline vessels. Bait sold at US$15-18 /case (10kg) for muroahi (US$1350 & iwashi (US$990/MT wholesale). Over 200 foreign longliners licensed for FSM waters.
Fiji Islands	Fry available and documented runs	Significant milkfish project by government 1997-2001. Poor site selection of demonstration. Information gathered on spawning seasons, fry collection sites, and culture techniques.	Marketing of milkfish as tuna longline bait investigated.		
French Polynesia					

Guam	Fry reported but not available in adequate quantities. Imported from Taiwan	Yes, since the early 1970's.	Private farms	Yes, used in the past live milkfish from local aquaculture industry supplied to longliners based in Guam, since mid 1990's. However, demand declined and stopped in 2000-2001	The demand for live milkfish as bait from the fleets porting in Guam stopped 2-years ago (bait demand peaked in 95-98 period). Current produ ction of milkfish is solely for food or farms formerly supplying live bait have chan ged species pro duced, since there is no longer a market with the tuna longliners for live bait.
Kiribati	Fry available on all lagoonal islands	Yes, approx. 80 ha government farm on Tarawa plus additional ponds on Kiritimati Is. (1,100 ha). Smaller pond areas in all 12 atolls with lagoons. Tarawa in 2002 was 19mt (2.2mt as bait, 9.7mt sold fresh as food, 2.7mt smoked). Bait sold at AU$2.50/kg. Production from Kiritimati is sold at AU$2.50/kg.	Yes (as frozen milkfish not live), for domestic fisheries – Central Pacific Producers Ltd. Fisheries training and Fisheries Division's long line vessel (TeKokona III)	Milkfish (*Chanos chanos*). Some trials with flying fish.	Current produ ction of 2.2mt/yr meets current domestic demand. There are no foreign fleets. The frozen milkfish bait is US$1,830/MT from the ponds in Tarawa and Kiritimati.
Marshall Islands					
Nauru					
New Caledonia	Unknown, milkfish reported to be rarely found in local market	No	No	Sardines and mackerels are the predominate bait	
Niue					
Northern Mariana Islands	No	No, but aquaculture of shrimp and tilapia	No		No tuna longline fleet based in NMI.

Palau	Yes	Some low intensity culture, but very limited. Some culture by MMDC in 70's	Some private sector trials by longline company with live milkfish brought in from Philippines. Use 8-10,000 pieces/trip (minimum 5,000 pieces/trip).	Live milkfish imported from Davao, Philippines and Taiwan (12 times/yr). Frozen squid and mackerel from Taiwan (24 times/year).	123 vessels consisting of 90 Taiwanese (milkfish uses at 8-10,000 pieces/trip or squid 400 boxes/trip – 12 kg/bx); and 32 Chinese vessels (Squid used at 100 boxes/trip – 12 kg/bx or mackerel at 80 boxes/trip – 10 kg/bx).
Papua New Guinea	Readily available in wild – not harvested	No – some interest in culturing for bait, but did not materialize.	Trial appox 1999 with frozen milkfish – poor results – believed to be poor condition old, low fat	Scads (*Decapterus maruadsi*) from S. Africa, and juvenile Skipjack and squid from Taiwan. Sardine 100-110 gm imported from South Africa & California. Small amount of sanma, squid and mackerel. US$800-850 to US$1,300/ mt for sardines with avg. US$1,050/mt	Over 50 (approx. 35 active vessels) boats fishing 1000-1500 hooks/day (10-day trips). One company uses 30mt /month (2x20fci sardine from SA, 55pcs/5kg or 91g/pcs).
Pitcairn Islands					
Samoa	Yes, but not in abundant quantities.	No, but identified as potential project.	No, but identified as potential project for future in support of tuna longline fishery. May utilize milkfish from Fiji aquaculture as production becomes available as a trial.	Sardine and anchovies, which are all imported.	
Solomon Islands					
Tokelau					

Tonga	Not verified fry availability, but adults are by-catch of gill nets in lagoons.	No	No	Sauri imported from Pago Pago, Fiji, and New Zealand	US$28.83/10 kg,
Tuvalu					
Vanuatu					
Wallis and Futuna					

APPENDIX 3. TUNA LONGLINE VESSELS AND CATCH IN THE WESTERN CENTRAL PACIFIC (SPC, 2002).

Year	Longline Vessels Active in WCPO	Albacore	Bigeye	Yellowfin
1970	3,401	32,590	33,987	53,080
1971	3,478	34,708	34,659	49,674
1972	3,471	33,842	45,329	51,090
1973	3,884	37,649	35,478	56,828
1974	3,772	30,985	39,029	54,102
1975	3,910	26,131	52,779	60,554
1976	4,023	24,106	64,513	70,735
1977	3,948	34,849	62,934	87,974
1978	4,231	34,858	49,394	109,384
1979	4,375	28,739	56,748	104,950
1980	4,658	31,027	54,045	117,423
1981	4,518	32,632	41,239	92,541
1982	4,236	28,339	44,739	83,824
1983	3,968	24,303	41,144	83,588
1984	4,013	20,340	46,156	69,752
1985	4,315	27,138	51,064	73,559
1986	4,243	32,641	46,485	62,080
1987	4,598	26,877	60,646	74,000
1988	4,242	31,531	50,166	81,081
1989	4,108	22,238	51,182	64,031
1990	3,709	22,624	66,807	72,335
1991	3,447	24,706	51,456	61,323
1992	4,633	30,248	63,431	71,651
1993	5,182	29,987	57,108	65,029
1994	5,432	33,235	66,976	73,318
1995	5,181	25,653	54,830	80,583
1996	4,717	24,120	48,772	77,013
1997	5,120	32,392	56,816	69,171
1998	4,983	40,141	72,050	65,967
1999	4,898	36,023	63,635	60,154
2000	4,879	39,838	59,833	76,425
2001	5,039	45,886	62,978	74,516
2002	5,076	45,969	81,701	80,039

APPENDIX 4. ASSUMPTIONS FOR CALCULATION OF BREAK-EVEN POINT TO OFFSET ADDITIONAL COST OF LIVE MILKFISH

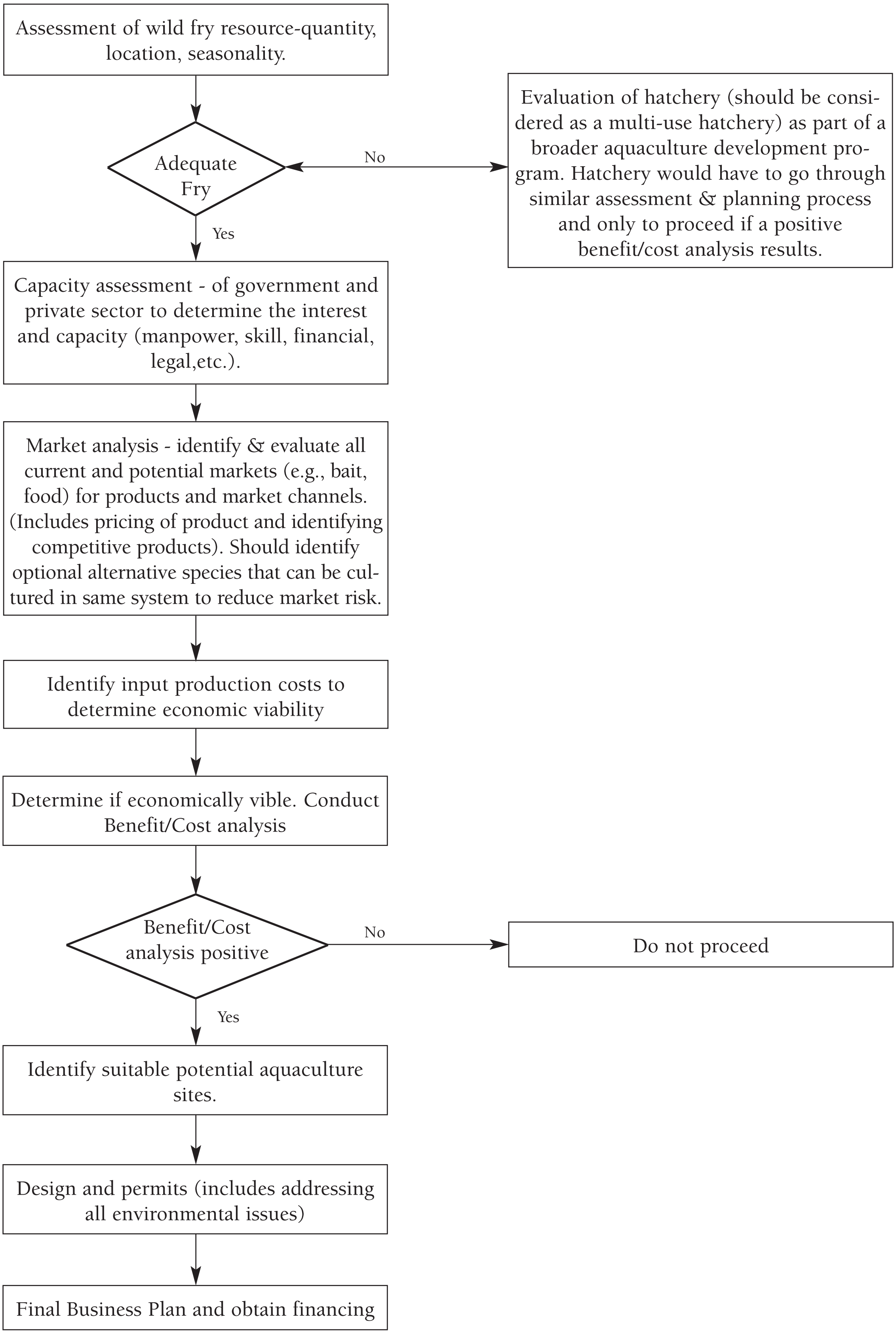
ASSUMPTIONS FOR CALCULATION OF BREAK-EVEN POINT
TO OFFSET ADDITIONAL COST OF LIVE MILKFISH

Average Size of Tuna Caught (kg)	AST	35
Average Price of Tuna Caught (US$/kg)	APT	$2.75
Hooks per set	HS	1500
Number of Sets per Trip	ST	15
Cost of Frozen Bait (per MT)	CFB	$1,000
Cost of Live Milkfish (per MT)	CLM	$4,000
Size of Frozen Bait (g/fish)	SFB	120
Size of Live Milkfish (g/fish)	SLM	60

CPUE Scenario	CPUE with Frozen Bait	Catch (kg)	Value	Value of catch*	Catch* (kg)	Break-even CPUE with live milkfish	Percent increase in CPUE to offset Additional cost of live Milkfish
1	0.75%	5,906	$16,242.19	$18,942.19	6,888	0.87%	16.62%
2	1.00%	7,875	$21,656.25	$24,356.25	8,857	1.12%	12.47%
3	1.25%	9,844	$27,070.31	$29,770.31	10,826	1.37%	9.97%
4	1.50%	11,813	$32,484.38	$35,184.38	12,794	1.62%	8.31%
5	1.75%	13,781	$37,898.44	$40,598.44	14,763	1.87%	7.12%

* Required to offset additional cost of live Milkfish

APPENDIX 5. ASSESSMENT & PLANNING MILKFISH AQUACULTURE



APPENDIX 6. NARRATIVE OF FINANCIAL & ECONOMIC ANALYSIS: MILKFISH IN SPC REGION

SCENARIOS

There are five scenarios that address hypothesized production scenarios that could potentially occur with the development of milkfish aquaculture in the SPC region.

Scenario I - Extensive – This is the most likely scenario for initial pond production. The extensive system will rely totally on the enhanced productivity (through commercial fertilizers) to support the growth of the milkfish.

Scenarios II - Extensive Plus – This represents an optional scenario that could be applied to moderately improved management over the entire system would allow greater management control and operational efficiency. It represents a progressive increase in stocking density up to 5 milkfish/m^2. The natural productivity of the ponds would be supplemented with a moderate quality feed (chicken grower).

Scenario III - Semi-intensive – This represents a scenario that could be applied to ponds that provide adequate physical controls and have experienced management. The use of high quality supplemental feed would allow for the increased stocking density and increase in the number of crops per year.

Scenario IV - Intensive – Represents a further progression of pond culture; however, this requires very knowledgeable and experienced management to be successful.

Scenario V - Net/Pen culture – These represents production scenarios that move from the land leased pond culture to production along the coast and in protected waters. A net or pen culture is an area immediately along the coast or in shallow waters < 4 m deep (tidal range dependent) that a net is used to enclose an area forming an enclosed pond.

Scenario VI - Cage – This scenario culture method could be carried out at the highest stocking density. Fine mesh nets forming cages would be suspended in marine waters that are protected from waves and storm surge along with being away from boat traffic channels. This would require sophisticated management and labor force similar to an intensive system. Even though this eliminates the costs associated with pond construction, other costs of watercraft and cage support facilities (e.g., walkway, dockage, and security watch facility) are incurred. The fish are totally depended on an artificial feed of the highest quality.

ASSUMPTIONS

BIOLOGICAL

Stocking Rate (fry/m^2)

This is the number of fry that are stocked per area. It should be noted that the stocking density for raising the milkfish to the live bait size (40-60 g/piece) allows for a higher stocking density than that used for grow-out to food size (250-300 g/piece), since the fish are harvested after approximately 40-60 days of culture and to maintain biomass the stocking density is increased. In an extensive system this ranges from 10,000-30,000 per ha. In an "extensive plus" system (with some supplemented feeding with modest grade feed) this ranges from 30,000-50,000 per ha. In a semi-intensive system this ranges from 100,000 to 250,000 per ha. Intensive and net/pond systems range from 300,000 to 500,000 per ha. In the case of cages, it would be the 50 to 100- fry/m^3 area. This will be influenced by site-specific conditions. Note – this will depend on the targeted product harvest size (i.e., larger size will require a reduction in stocking rate).

Survival Rate

This is survival from stocking to harvest. This can range from 60-80% under pond grow-out systems depending on the physical condition, control of the ponds and predators, and quality of management. A value of 70% is used in all the scenarios, which represents a moderately good survival.

Crops Per Year

This is the number of complete grow-out cycles per year (from stocking to total harvest).

Feed Conversion Rate

This is the weight ratio of supplemental feed to milkfish produced. There is no supplemental feed in scenario I so it has a value of zero. Scenarios II & III utilize a moderate quality supplemental feed and are progressively dependent on this feed for nutrition as the stocking density increases. Scenarios IV & V utilize a high quality milkfish feed that will serve as the main nutritional source.

Harvest Body Weight (kg)

The average harvest body weight of 40-60 g/milkfish is the target at harvest for live bait. For frozen bait and food, it would be 125-200 g/fish; however, for this size product it would require a reduction in stocking rate.

PHYSICAL

Farm Pond Area (ha)

This is actual pond area under water or in the case of pens it is the area at mean low tide. For cages it would be the 10,000 m^3 area.

Labor Requirement (people/ha)

This is the number of full-time equivalent positions that are required per given area of ponds. This will vary with the intensity of culture system and the management skill level.

FINANCIAL

Sale Price of Product - Farm-Gate ($/kg)

Local Market

This is the median price the farm (on farm price) receives for product sold in the local market.

Export Market

This is the median price the farm (on farm price) receives for product sold for the export market.

Market Share (%)

Local Market

This is the portion (%) of the total production that enters the local market. This is considered the priority market, since a higher price is received in the local market (does not incur all the costs associated with participating in international markets).

Export Market

This is the portion (%) of the total production that enters the export market.

Fry Cost ($/Fry)

This is the cost per fry delivered to the farm (shipping, packing, handling costs included). It would be the cost of obtaining the fry from the wild or a hatchery. Generally wild fry collection costs will be lower than the cost to produce the fry in a hatchery and is the value assumed.

Feed Cost ($/kg)

This is the price of the supplemental feed utilized. A medium grade feed (chicken grower) is used as a supplement in Scenarios II & III. A high-grade nutritionally balanced commercial milkfish feed is used in Scenarios IV, V, and VI, since there is a greater dependence on the feed as the main source of nutrition.

Electrical Power Rate ($/kW hr)

This is the cost of electricity per unit.

Electric Power Demand (kW hr/ha/year)

This is the total annual electrical demand per unit area of ponds. This will increase with the stocking density at semi-intensive with the use of pond aerators. It will also increase with the use of commercial pelleted milkfish feed, since it needs refrigerated storage to maintain the nutritional quality.

Chemical costs ($/ha/year)

This is the total annual cost of chemicals per unit area of ponds. This includes lime, fertilizers, rotenone, piscacides (e.g., teaseed cake), etc. For example, these chemicals are applied depending on the conditions in the ponds to maximize natural productivity, while controlling pests (e.g., 12 g teaseed cake/m^3 of water, rotenone 1-2 liters/ha (applied in shallow pond 5 cm), 500 kg lime/ha, fertilizer 25 kg urea/ha plus 12.5 kg triple superphosphate/ha per application). In the pen and cage scenarios, chemical use is modified to reflect the culture method (e.g., chemical cleaning of net material between culture periods as needed).

Miscellaneous Costs ($/ha/year)

This includes all supplies (including fuel) and materials that are consumed or have a useful life of less than 1-year. It also includes repairs of equipment.

License Fee Costs

No costs are used in the scenarios, since it is considered a government operation or fees are waved as a new industry. This normally consists of fees for licenses to conduct business and would be part of annual cost of doing business for a private entity.

Management Cost

Base Salary (up to 5 ha)

This is a set amount in all of the scenarios with the exception of extensive, extensive plus, and semi-intensive, since labor will fill the function of manager/owner. Since labor required for these three scenarios is only part-time, a separate management cost is not incurred in these 1 ha farm scenarios. However, it should increase with technical requirements of the production system and scale of operation. In addition, costs for assistant manager and administrative staff will be incurred in larger farms and ones with greater technical requirements.

Incremental Salary (>5 ha: $/ha)

An incremental salary is not utilized in the current scenarios. However, in private enterprises it often increases with responsibility associated with the size of the farm (can also be tied into a salary bonus above a certain base production goal).

Wage ($/hr)

This is the wage rate paid to farm staff (non-management).

Lease ($/ha/year)

No cost is assigned to the scenarios, since it is assumed to be on government owned land. Normally, a private entity would incur an annual cost for the lease of land utilized by the farm.

Fixed Assets

Pond construction Cost ($/ha)

A cost is assigned for the construction of the ponds or culture system.

Building Cost (Initial)

This is for building structures for the storage of equipment, processing area, security, and on-farm housing as needed.

Land Cost ($/ha)

No cost is assigned, since it is assumed to be on government owned land. Normally, a private entity would either buy the land or lease it; therefore, this provides for that option.

Equipment Cost

Equipment needs (e.g., pumps, refrigeration, vehicles, etc.) to be replaced and an allowance to purchase new equipment is provided. In addition, pond aerators along with electrical lines to the ponds will be needed.

Working Capital Rate (% TVC)

Working capital is calculated as 50% of the total annual costs minus depreciation. This is based on the assumption that it would take six months for the cash inflow from harvest sales to meet or exceed the cash outflow. Working capital needs vary slightly between the species and management practices. For example, cost and revenue differences depend on growth rates of the species, stocking rates and schedules, feeding practices and feed quality, pond design and size, and the degree of automation.

Total Equity

Total equity reflects the portion of the total investment in the farm that is provided by the owners (shareholders) capital investment. In this case it is assumed with a government funded and operated facility, the total equity will be the same as the total invested.

Total Investment

This is the total investment in the farm.

Depreciation Schedule (years)

Ponds

A 20-year depreciation schedule is used.

Building

Since no cost is assigned to the fully depreciated buildings there is no depreciation schedule.

Equipment

An average 5-year depreciation schedule is used.

Size of Loan

There is no loan applied in the scenarios. However, under private operation a loan is usually utilized.

Loan Terms (years)

This does not apply in the current scenarios, since there is no loan. However, it would normally be the years of the loan.

Interest Rate

This does not apply in the current scenarios, since there is no loan.

Insurance Premium Rate (%)

There is no insurance premium, since it is assumed in the case of government operations they are usually considered self-insured.

Property Tax Rate (%)

No property tax is applied, since it is assumed in this case the government owns it and the government does not assess property tax on itself.

Corporate Tax Rate

No corporate tax rate is paid, since it is assumed to be a government operation.

Inflation Rate on Lease (Annual)

This does not apply, since there is no lease of property. However, there is usually an inflation clause in private leases that account for increase in the lease fee over the term of the lease.

Inflation Rate on Operations

The rate utilized is 2.5%. However, the current scenarios only look at a single year operation and not over an extended period so this inflation rate does not influence the scenarios based on a single year of operation.

SPECIES: *CHANOS CHANOS* - TUNA BAITFISH (40-60 g/fish)		AQUACULTURE PRODUCTION SCENARIOS (VALUES IN US$)					
		1	2	3	4	5	6
ASSUMPTIONS		**EXTENSIVE**	**EXTENSIVE PLUS**	**SEMI-INTENSIVE**	**INTENSIVE**	**PENS**	**CAGES**
BIOLOGICAL							
Stocking Rate (PL's/sq m)	SR	3	5	10	30	30	50
Survival Rate	SUR	70,00%	70,00%	70,00%	70,00%	70,00%	70,00%
Crops Per Year	CPY	5	5	5	5	5	5
Feed Conversion Rate	FCR	2	2	2	2	2	2
Harvest Body Weight (kg)	HBW	0,06	0,06	0,06	0,06	0,06	0,06
PHYSICAL							
Farm Pond Area (ha or 10,000 cu m for cages)	FPA	1	1	1	1	1	1
Labor Requirement (people/ha)	LR	1	1	1,5	2	2	10
FINANCIAL							
Sale Price of Product - Farm-Gate ($/kg)							
Local Market	SPLM	$4,00	$4,00	$4,00	$4,00	$4,00	$4,00
Export Market	SPEM	$4,00	$4,00	$4,00	$4,00	$4,00	$4,00
Market Share (%)							
Local Market	MSLM	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
Export Market	MSEM	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Fry Cost ($/Fry)	PLC	0,05	0,05	0,05	0,05	0,05	0,05
Feed Cost ($/kg)	FC	$0,00	$0,20	$0,40	$0,40	$0,40	$0,40
Electrical Power Rate ($/kw hr)	EPR	$0,20	$0,20	$0,20	$0,20	$0,20	$0,20
Electric Power Demand (kw hr/ha/year)	EPD	100	200	500	1000	100	100
Chemical Costs ($/ha/year)	CC	$100,00	$100,00	$100,00	$250,00	$100,00	$250,00
Miscellaneous Costs ($/ha/year)	MC	$100,00	$100,00	$100,00	$200,00	$200,00	$2 000,00
License Fee Costs	LFC	$0,00	$0,00	$0,00	$0,00	$0,00	$0,00
Management Cost							
Base Salary (upto 5ha)	MCBS	$3 000,00	$3 500,00	$8 000,00	$10 000,00	$10 000,00	$10 000,00
Incremental Salary (>5ha: $/ha)	MCIS	$0,00	$0,00	$0,00	$0,00	$0,00	$0,00
Wage ($/hr)	W	$2,50	$2,50	$2,50	$2,50	$2,50	$2,50
Lease ($/ha/year)	L	$0,00	$0,00	$0,00	$0,00	$0,00	$0,00
Fixed Assets							
Pond Construction Cost ($/ha)	PCC	$15 000,00	$15 000,00	$15 000,00	$15 000,00	$2 000,00	$55 000,00
Building Cost (Initial)	BC	$5 000,00	$10 000,00	$25 000,00	$25 000,00	$5 000,00	$25 000,00
Land Cost ($/ha)	LC	$0,00	$0,00	$0,00	$0,00	$0,00	$0,00
Equipment Cost	EC	$2 000,00	$5 000,00	$5 000,00	$10 000,00	$2 000,00	$15 000,00
Working Capital Rate (% TVC)	WCR	40,00%	40,00%	40,00%	40,00%	40,00%	40,00%
Total Equity	TE	$27 968,00	$40 520,00	$67 456,00	$116 028,00	$73 112,00	$210 308,00
Total Investment	TI	$27 968,00	$40 520,00	$67 456,00	$116 028,00	$73 112,00	$210 308,00
Depreciation Schedule (years)							
Ponds	DSP	20	20	20	20	20	20
Building	DSB	20	20	20	20	20	20
Equipment	DSE	5	5	5	5	5	5
Size of Loan	SL	$0,00	$0,00	$0,00	$0,00	$0,00	$0,00
Loan Term (years)	LT	15	15	15	15	15	15
Interest Rate	IR	10,00%	10,00%	10,00%	10,00%	10,00%	10,00%
Insurance Premium Rate (%)	IPR	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Property Tax Rate (%)	PTR	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Corporate Tax Rate	CTR	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Inflation Rate on Lease (Annual)	IRL	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Inflation Rate on Operations	IRO	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%

		AQUACULTURE PRODUCTION SCENARIOS (VALUES IN US$)					
		1 EXTENSIVE	2 EXTENSIVE PLUS	3 SEMI-INTENSIVE	4 INTENSIVE	5 PENS	6 CAGE
PRODUCTION							
Unit Production (kg/ha/crop)	UP	1 260	2 100	4 200	12 600	12 600	21 000
Total Production (kg/farm/year)	TP	6 300	10 500	21 000	63 000	63 000	105 000
REVENUE (R)		$25 200,00	$42 000,00	$84 000,00	$252 000,00	$252 000,00	$420 000,00
OPERATING EXPENSES (ANNUAL)							
VARIABLE COSTS							
Labor							
Full Time Staff		5 200,00	5 200,00	7 800,00	10 400,00	10 400,00	52 000,00
Occasional Labor		2 000,00	4 160,00	6 240,00	8 620,00	4 160,00	5 000,00
Feed		0,00	4 200,00	16 800,00	50 400,00	50 400,00	84 000,00
Fry		7 500,00	12 500,00	25 000,00	75 000,00	75 000,00	125 000,00
Electricity		20,00	40,00	100,00	200,00	20,00	20,00
Chemicals		100,00	100,00	100,00	250,00	100,00	250,00
Miscellaneous		100,00	100,00	100,00	200,00	200,00	2 000,00
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TOTAL VARIABLE COSTS (TVC)		14 920,00	26 300,00	56 140,00	145 070,00	140 280,00	268 270,00
FIXED COSTS							
Salary Personnel							
Manager/Owner		0,00	0,00	0,00	10 000,00	10 000,00	10 000,00
Assist Manager		0,00	0,00	0,00	5 000,00	5 000,00	5 000,00
Admin Staff		0,00	0,00	0,00	5 000,00	5 000,00	5 000,00
Land Rent		0,00	0,00	0,00	0,00	0,00	0,00
Interest on Loan		0,00	0,00	0,00	0,00	0,00	0,00
Loan Principal		0,00	0,00	0,00	0,00	0,00	0,00
Depreciation							
Ponds		750,00	750,00	750,00	750,00	100,00	2 750,00
Building		250,00	500,00	1 250,00	1 250,00	250,00	1 250,00
Equipment		400,00	1 000,00	1 000,00	2 000,00	400,00	3 000,00
License Fee		0,00	0,00	0,00	0,00	0,00	0,00
Insurance		0,00	0,00	0,00	0,00	0,00	0,00
Property Tax		0,00	0,00	0,00	0,00	0,00	0,00
		----------------	----------------	----------------	----------------	----------------	----------------
TOTAL FIXED COSTS (TFC)		1 400,00	2 250,00	3 000,00	24 000,00	20 750,00	27 000,00
TOTAL OPERATING COST (TOC)		$16 320,00	$28 550,00	$59 140,00	$169 070,00	$161 030,00	$295 270,00
OPERATING PROFIT (OP)		$8 880,00	$13 450,00	$24 860,00	$82 930,00	$90 970,00	$124 730,00
CORPORATE TAX (CT)		$0,00	$0,00	$0,00	$0,00	$0,00	$0,00
NET PROFIT (NP)		$8 880,00	$13 450,00	$24 860,00	$82 930,00	$90 970,00	$124 730,00
RETURN ON EQUITY (ROE)		31,75%	33,19%	36,85%	71,47%	124,43%	59,31%
RETURN ON INVESTMENT (ROI)		31,75%	33,19%	36,85%	71,47%	124,43%	59,31%
BREAK EVEN (PRICE $UNIT)		$2,59	$2,72	$2,82	$2,68	$2,56	$2,81
BREAK EVEN (PRODUCTION KG/HA/YR) LOCAL MKT		4 080,00	7 137,50	14 785,00	42 267,50	40 257,50	73 817,50
BREAK EVEN (PRODUCTION KG/HA/YR) EXPORT MKT		4 080,00	7 137,50	14 785,00	42 267,50	40 257,50	73 817,50
Unit Variable Cost ($/kg)		$2,37	$2,50	$2,67	$2,30	$2,23	$2,55
Total Fixed Cost/ha		$1 400,00	$2 250,00	$3 000,00	$24 000,00	$20 750,00	$27 000,00
Total Variable Costs/ha		$14 920,00	$26 300,00	$56 140,00	$145 070,00	$140 280,00	$268 270,00
Total Cost/ha		$16 320,00	$28 550,00	$59 140,00	$169 070,00	$161 030,00	$295 270,00
Unit Total Cost ($/kg)		$2,59	$2,72	$2,82	$2,68	$2,56	$2,81

APPENDIX 8. EVALUATION PROCESS OF ESTABLISHING A COMMERCIAL BAITFISH FARM

I. FRY SUPPLY
- A. Availability
  - 1. Size of fry available
  - 2. Seasonality
- B. Cost
  - 1. Cost by size
  - 2. Cost by month
- C. Quantity/Quality
- D. Shipping process and cost options
  - 1. Shipping quantity in a box at different sizes of fry
  - 2. How much in container?
  - 3. Is it cheaper per container?

II. GROW-OUT PRODUCTION
- A. Procedure
  - 1. Pond steps
    - a) Fry
    - b) Holding
    - c) Grow-out
    - d) Transfer
  - 2. Stocking density
    - a) Phase I - fry
    - b) Phase II - holding
    - c) Phase III - grow-out
    - d) Phase IV - acclimatization
  - 3. Feed
    - a) Rate
      - (1) Maintenance diet (stunting growth)
      - (2) Growth diet
    - b) Type
    - c) Frequency
- B. Growth rate
  - 1. Phase I - fry
  - 2. Phase II - holding
  - 3. Phase III - grow-out
  - 4. Phase IV - acclimatization
- C. Mortality at each phase
  - 1. Phase I - fry
  - 2. Phase II - holding
  - 3. Phase III - grow-out
  - 4. Phase IV - acclimatization

III. TRANSFER PROCESS TO LONGLINE VESSELS
- A. Equipment
  - 1. Live pumps
  - 2. Transport tank I truck a) Oxygen
  - 3. Monitoring system
- B. Process

IV. EVALUATION OF MARKET DEMAND AND REQUIREMENTS FOR PRODUCT
- A. Longline tuna fleet
  - 1. Current
  - 2. Future

B. Breakdown of fleet composition
    1. Size of vessel bait wells
C. Market price
    1. Size
    2. Season by month

V. ALTERNATIVE PRODUCT PRODUCTION
A. Marine shrimp
B. Tilapia
    1. Natural coloration
    2. Red-hybrid

APPENDIX 9. PROCESS IN ESTABLISHING A COMMERCIAL AQUACULTURE OPERATION

I. PRELIMINARY ASSESSMENT

A. Identification of specific intent/purpose
B. Site assessment
C. Preliminary design
D. Preliminary Business Plan
E. Evaluation to proceed

II. DESIGN AND PERMITS

A. Design
   1. Design Documentation & Specs
B. Permits
   1. Environmental Impact Assessment/Statement
   2. Permit application process
      a) Non-wetland
      b) Wetland/Seashore Reserve/ or
   3. Permit issuance
C. Evaluation to proceed

III. FINALIZATION OF BUSINESS PLAN AND FINANCING

A. Business Plan
B. Financing
C. Evaluation to proceed

IV. CONSTRUCTION

A. Construction permits
B. Bid process
C. Construction contact
D. Implementation
E. Monitoring
F. Completion

V. PRE - OPERATION

A. Personnel recruitment
B. Equipment/supplies purchasing
C. Systems evaluation
D. Test operation of all facilities, equipment and verification of supplies

VI. COMMERCIAL OPERATION

A. Production strategy
   1. Production scheduling
   2. Stocking/harvest
   3. Alternate species
B. Production operations
C. Farm maintenance

APPENDIX 10. INTERNET SITES FOR SUPPLIERS OF FROZEN MILKFISH BAIT.

Growfish - Gippsland Aquaculture Industry Network (GAIN)... said. The bait quality milkfish comes from harvests that are deemed to be inferior in quality for human consumption. According to ...
www.growfish.com.au/content.asp?contentid=327 - 21k - Cached - Similar pages

Seafood Industry Contacts - Indonesia ... We are exporter of milkfish for bait and human consumption, we can supply about 300 MT/month. We have experience with milkfish export since 1995. ...
www.sea-ex.com/countryinfo/indonesia.htm - 75k - Cached - Similar pages

Seafood Industry Contacts Indonesia Q - Z ... Main product: milkfish for bait and human consumption. Other products: red snapper, yellow pike conger, grouper, hair tail, cuttlefish etc. ...
www.sea-ex.com/countryinfo/indonesia2.htm - 38k - Cached - Similar pages
[More results from www.sea-ex.com]

All ActionTrade Portal , Import Export Trade Leads, Business Trade ...
... We would like to offer you Frozen milkfish and Round Scad/Muroaji for
Tuna ... Category: Seafood. Sub Category: Bait. Its an Offer to: sell. ...
www.allactiontrade.com/tradeoffer/ offers1.asp?subcat=Bait&cat=Seafood - 62k - Cached - Similar pages

Indonetwork.info - Search All keywords in Products Catalog. ... Frozen Milkfish for Tuna Bait. Frozen Milkfish for Tuna Bait [May. 29, 2003 19:08:16]. PT. ..Frozen milkfish for Tuna Bait. Frozen Mackerel for Tuna Bait. ...
www.indonetwork.info/prod/AgQ3/0.html - 37k - Cached - Similar pages

Aquafind ... 30/03 INDONESIA (0). OFFER MILKFISH FOR TUNA BAIT - Harijanto, Andri 22:42:14 10/30/03 INDONESIA (0). ***WTS Frozen Horse Mackerel ...
www.aquafind.com/boards/boards.php?name=comfish - 19k - Cached - Similar pages

Indonetwork.co.id - Mencari Semua Kata di Semua Pilihan. ... beku.... (Selengkapnya...). Frozen Milkfish for Tuna Bait. Jual: Frozen Milkfish for Tuna Bait [29 May. 2003, 19:08:16]. Harga: Fluktuatif. ...
www.indonetwork.co.id/all/AgQ3/60.html - 40k - Cached - Similar pages

Indonetwork.co.id - Mencari Semua Kata di Semua Pilihan. ... beku.... (Selengkapnya...). Frozen Milkfish for Tuna Bait. Jual: Frozen Milkfish for Tuna Bait [29 May. 2003, 19:08:16]. Harga: Fluktuatif. ...
www.indonetwork.co.id/all/AgQ3/60.html - 40k - Cached - Similar pages

Business Portal - Tpage.com ... CV. Samudra Intan Berlian [ID] Products : MILKFISH FOR TUNA BAIT & HUMAN CONSUMPTION CV. SAMUDRA INTAN BERLIAN IS SPECIALIST EXPORTER ...
dir.tpage.com/11/08/02/ - 25k - Cached - Similar pages

Indonetwork.co.id - Mencari Semua Kata di Katalog Produk. ... Selengkapnya...). Frozen Milkfish for Tuna Bait. Frozen Milkfish for Tuna Bait [29 May. 2003, 19:08:16]. PT. Lima Er [Indonesia]. Harga: Fluktuatif. ...
www.indonetwork.co.id/prod/Ag/110.html - 37k - Cached - Similar pages
[More results from www.indonetwork.co.id]

Trade Board 2003 ... MILKFISH TUNA BAIT Ms. Nien 05:17:10 10/30/03 (0): Exporters of Small Animals, Birds and Reptiles AMAZING LOOK 13:23:28 10/16/03 (2): ...
www.arab.de/etrade/trade6.html - 53k - Cached - Similar pages

Marine Food Supplies,Seafood Supplies,Wholesale Marine Food, ... Chanos Milkfish4 Tuna Bait Offering various tuna bait esp milkfish in almost end of season, we are still able to supply 7-9 containers 40' fcl reefer milkfish. ... trade.indiamart.com/offer/agro-farm/ marine-food-supplies/sell.html - 82k - Cached - Similar pages

Free trading board for fishing, aquaculture and seafood companies ... FILEFISH/LEATHER JACKET W/R AND H&G, PT. SAMUDRA KUALITA MINA 30-10-2003, MILKFISH
BAIT 4M INDONESIA, PT. SUKSES JAYA MAKMUR 30-10-2003, WTS/// FROZEN SEAFOOD, ...
www.seafoodboard.com/cgi-bin/ board.cgi?step=2&page_num=4 - 19k - Cached - Similar pages

Free trading board for fishing, aquaculture and seafood companies ... BASIS International 14-10-2003, WTS: Milkfish for tuna bait, de_kitchen 14-10-2003, WTS: Cuttlefish WR Uncleaned, de_kitchen 14-10-2003, WTS - IMITATION CRAB STICKS, ...
www.seafoodboard.com/cgi-bin/ board.cgi?step=2&page_num=1 - 18k - Cached - Similar pages

To SELL products or services. Offer to Sell and Post an Offer. Do ...
... Frozen Marine Product and Steering Wheel Company : Lima Roti Dua Ikan Products
Frozen Milkfish for Tuna Bait Frozen Round Scad (Muroaji) Dried ...
www.ariestrade.com/ ielist.cfm?startrow=4481&posttype=2 - 73k - Cached - Similar pages

SHRIMP SEMOGA JAYA : Shrimp Export from Indonesia Around The ... ... Chanos Chanos) In a separate building situated away from our Shrimp processing facilities, we have been producing frozen Milkfish for tuna bait since 1990. ... shrimp.semogajaya.com/product.htm - 16k - Cached - Similar pages

Chinawebs, B2B vertical international trade website... We supply Frozen fish as follows : 1. Milkfish for tuna bait 2. Muroaji for tuna bait 3. Ribbonfish 4. Yellow Croaker 5. Yellow Tilapia 6. leatherjacket If you ...
www.chinawebs.com/trade/list_sub2.php?sub2_id=107 - 11k - Cached - Similar pages

EXPO - EXPORT - Search result for:HUMAN - [Translate this page] ... Samudra Intan Berlian, Contact Samudra Intan Berlian. Productos : Milkfish for bait & Milkfish for HUMAN consumption. Gresik, Indonesia. ...
www.my-product.net/search.php3?terms=HUMAN - 56k - Cached - Similar pages

Art und Weise Manufacturers - [Translate this page] ... Samudra Intan Berlian, Contact Samudra Intan Berlian. Produkte : Milkfish for bait & Milkfish for human consumption. Gresik, Indonesia. ...
world-product-expo.com/Textiles/Fashion/?from=276 - 89k - Cached - Similar pages

Fishing Monthly - Latest Fishing Reports - Updated Weekly... are some thumping Spanish mackerel present, as the bait schools are in ... doggie mackerel, broad barred Spanish mackerel, coral trout, milkfish, grinner, stripey ...
www.fishingmonthly.com.au/reports/Fishing-reports/ qld/2003/0825.html - 82k - Cached - Similar pages
[More results from www.fishingmonthly.com.au]

Business Portal - Tpage.com... items are frozen fish for human comsumption and some kinds of fish bait. ... PH] Go to Homepage Products : Bonuan Boneless Bangus(deboned milkfish) Bonuan Boneless ...
dir.tpage.com/21/14/06/ - 25k - Cached - Similar pages

Aquatic Network: Aquaculture Products & Services... mozcom.com Subcategory: Aquaculture--milkfish; Seafood Production/Processing Comments: Looking for buyers of milkfish--fry, fresh ... West Central Bait Co., Inc.
www.aquanet.com/products/dir_aq3a.htm - 43k - Cached - Similar pages

EXPO - EXPORT - Search result for:HUMAN - [Translate this page]... Samudra Intan Berlian, Contact Samudra Intan Berlian. Produits : Milkfish for bait & Milkfish for HUMAN consumption. Gresik, Indonesia.
www.expo-export.net/search.php3?terms=HUMAN - 54k - Cached - Similar pages

EXPO - EXPORT - Search result for:HUMAN - [Translate this page]... Samudra Intan Berlian, Contact Samudra Intan Berlian. Produkte : Milkfish for bait & Milkfish for HUMAN consumption. Gresik, Indonesia.
www.world-product-expo.com/search.php3?terms=HUMAN - 55k - Cached - Similar pages
[More results from www.world-product-expo.com]

Chinawebs, B2B vertical international trade website... We supply Frozen fish as follows : 1. Milkfish for tuna bait 2. Muroaji for tuna bait 3. Ribbonfish 4. Yellow Croaker 5. Yellow Tilapia 6. leatherjacket If you ...
www.chinawebs.com/trade/list_sub2.php?sub2_id=107 - 11k - Cached - Similar pages

Trade Leads - Hop Cones - Fresh Dried - buy, sell, agents, ...
... Besides, we also could supply live lobster, any dried fish, kerapu and Tuna fish
bait (muroaji and milkfish). Details / Contact. Buy Seafood dried fish shrimp. ...
www.afacerionline.com/index.php/ TradeLeads/showProducts/11704 - 33k - Cached - Similar pages

export offers directory, export offers guide Bizeurope.com... Size 100 Grams above 2)Frozen Ribbon Fish Size 200~700 Grams 3)Frozen Muroaji (Scad)for tuna bait 4)Frozen Milkfish for tuna bait and consumer good 5)Baby ...
www.bizeurope2.com/export/sept2003.htm - 101k - Cached - Similar pages

seafood directory exporters and manufacturers - Bizeurope.com... Bait Products: herring, imported and domestic illex squid, loligo squid, sardines ... of deboning processing and distribution of Bonuan Boneless Bangus (milkfish). ...
www.bizeurope.com/bsr/sourcing/seafood/001.htm - 101k - Cached - Similar pages

Taiwan Product Online: Agricultural & Food Products : Taiwan ... ... tool & supply/ supplies- (1) fishing hook, fish hook- bait holder hook ... mossambicus, tilapia fillet (ixumidai) oreochromis niloticus, milkfish, catfish, large ...
www.manufacture.com.tw/tpo4/product-category/ products/z411800e.htm - 42k - Cached - Similar pages

Trade Leads - Fishing - Industrial - buy, sell, agents, ... Besides, we also could supply live lobster, any dried fish, kerapu and Tuna fish bait (muroaji and milkfish). Details / Contact. ...
www.afacerionline.com/index.php/ TradeLeads/showProducts/10801/4 - 34k - Cached - Similar pages
[More results from www.afacerionline.com]

Interbirja... 60367 OFFER: [ID] We sell Milkfish for Tuna Bait and fish feed Posted by Mr. Heru cahyono from Erozone Global Logistics, Indonesia, on 2/24/2003 1:50:44 AM. ...
www.interbirja.net.md/adverte.php?s=1&type=102 - 21k - Cached - Similar pages

Best Trade Site... and exporter of seafood in Taiwan.Such as illex squid,mackerel,milkfish,muroaji,pacific ... 07-24 Message: Our product have Illex Squid for human and for bait. ...
portugaltrade.org/site/best_site.htm - 70k - Cached - Similar pages

export offers directory, export offers guide Bizeurope.com ... Description: Specialist of milkfish exporter.
Quantity: 300 mt/month
Brand: sib Size: all size For tuna bait, and human consumption. ...
www.bizeurope2.com/export/july4.htm - 101k - Cached - Similar pages