SUB-REGIONAL OFFICE FOR THE PACIFIC ISLANDS

TCP/TUV/3301

DEVELOPMENT OF COMMUNITY-BASED AQUACULTURE SYSTEM AND MANAGEMENT OF INSHORE FISHERIES FOR FOOD SECURITY IN TUVALU

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Prepared by

John Eric Basco

(FAO Consultant – TCDC Expert in Milkfish Farming)

Table of Contents

List of Figures

List of Annexes

Introduction

The FAO Sub-regional Office in the Pacific Islands (FAO/SAP) in coordination with the Government of Tuvalu conducted a mission to render technical assistance in milkfish farming. The mission was implemented in close collaboration with staff of the Tuvalu Fisheries Department under the technical supervision of the Fishery Officer of the FAO/SAP and the overall supervision of the FAO Sub-Regional Representative for the Pacific Islands.

The project was specifically aimed to:

1. Review and extract information on what has been implemented locally in milkfish (and other species) farming in Tuvalu for the past ten or so years;
2. Define, prepare and formulate a development and management plan for the milkfish farming for Vaitupu Island;
3. Conduct consultations and site visits with the Fisheries Department and the *Kaupule* of Vaitupu on suitable sites for grow-up ponds, etc.;
4. Liaise with the Fisheries Department on possible options of engaging the Vaitupu community in the consultation process;
5. Provide an assessment of the current stock status of milkfish resources there on Vaitupu base on past and current exploitation levels;
6. Undertake a survey of milkfish fry and demonstrate milkfish fry collections in Vaitupu;
7. Provide a detailed guidance on how to manage the activities of post fry collections in Vaitupu;
8. Report findings of the consultation directly to the Vaitupu *Kaupule*, the government and FAO;
9. Assist in any other work that may be required by the department of fisheries from time to time; and
10. Prepare and submit a mission report to FAO/SAP.

Discussions, analysis and results herein were made based on reports/write-ups, survey, electronic communications, interviews, and personal discussions with key persons involved in aquaculture. List of key persons met that have significantly contributed to the

completion of this mission is provided in Annex 1. Detailed list of activities during the mission is provided in Annex 2.

The consultant was able to work closely with the staff of the Tuvalu Fisheries Department to gather relevant information for this mission. Site visits to potential aquaculture facilities, actual milkfish fry survey, interview with private and interested individuals, and discussions with the relevant government officials were all undertaken to contribute to this mission.

Aquaculture and Milkfish Farming in Tuvalu

There are only two aquaculture commodities that have been introduced to Tuvalu namely, milkfish and Giant clam. Of these two commodities, only milkfish is still presently farmed and is continuously developed to meet with the needed fish protein requirement of Tuvaluan especially during adverse weather conditions where fishing is difficult.

Clam culture was introduced and funded by Secretariat of the Pacific Community (SPC) in 2004 (as per. comm. Ms. Moeo Finauga) and hired an expert from Fiji. The consultant was able to set-up 2 circular fiberglass tanks at the Funafuti Fisheries area and achieved successful spawning. However, the day after spawning, there was a power failure that lasted for one week in the Island that caused the project to be aborted.

Several trials for the culture of milkfish have been attempted since 1970's in Vaitupu. This was done by digging-out small backyard ponds stocked with milkfish but wasn't successful due to limited knowledge of the biology and appropriate culture techniques of milkfish. Culture of milkfish eventually was able to set foot its foundation in Tuvalu when a demonstration project in Vaitupu was conducted in October 1995 to February 1996 by the FAO South Pacific Aquaculture Development Project. Aquaculture Expert (Mr. Esteban de la Cruz) was dispatched to conduct a milkfish fry survey, pond construction and design and trainings on the culture and management of milkfish in ponds (Taiwan International Cooperation and Development Fund (ICDF), Status Report on Milkfish Pond Construction Project in Tuvalu, Oct. 2006). This project resulted that the Vaitupu Kaupule and the community became aware of the proper techniques of collection, handling, transfer, care and management of stocks. After the project has been terminated, Kaupule management of the fishpond wasn't flourishing and some private ponds were left abandoned.

With the strong interest to revive the milkfish aquaculture project and recognizing the value of milkfish in the Vaitupu community, the Vaitupu Kaupule requested the Tuvalu Fisheries Department for technical assistance and financial support to continue the milkfish project. As a response to the request of the Vaitupu Kaupule, the Fisheries Department requested the Taiwan ICDF for its financial assistance and technical support. A 2-year project was formulated in 2008 where a Taiwanese aquaculture expert was deployed to Vaitupu from 2008 to 2010 to start the work. The existing two ponds, both the nursery and grow-out ponds with an estimated area of 200 sq. meters and 1200 sq. meters respectively were upgraded by deepening the ponds and construction of concrete main gates to allow bigger volume of water to be introduced and hold during low tide. They have also constructed the perimeter fence to discourage pouching and installed nylon lines on top of the ponds to prevent birds from preying on the milkfish stocks. After a year of the demonstration of milkfish culture in the ponds, the milkfish expert introduced a milkfish cage culture in the north-eastern part of the lagoon to allow more space for the milkfish

grow-out and production increase. One module of 4 units 5m x 5m floating cage was built and placed at around 15 meters away from the land at approximately 4-5 meters water depth. Trainings on cage construction and net construction were conducted by the aquaculture specialist including feeds preparation using the combination of locally available materials (seaweed, tuna, etc.) and imported raw materials (mill mix, flour, soya oil, etc.) for the cultured stocks.

On the last quarter of 2010, the project has been terminated and turned-over to the Vaitupu Kaupule for their operation and management. Since then, the Fisheries Department has been regularly visiting the Vaitupu aquaculture project twice a year.

In January 2011, another milkfish farming demonstration project was opened in Funafuti by the ICDF. The demonstration project that will last for 3 years showcased a tank culture of milkfish from the fingerlings (2-3" size) to the marketable size (600 kgs). The specialist in-charge for the project, Mr. Marc Lee, demonstrated a close recirculating and partial-discharge system of milkfish culture in tanks. The project is mainly for educational and training purposes for interested stakeholders and Fisheries staff on the culture and management of milkfish from fingerlings to marketable size that also includes training on feeds preparation using the combination of imported and locally available raw materials. Subsequent chapters below will discuss further on the existing milkfish project in Tuvalu.

Site Visits for Potential Milkfish Sites in Vaitupu

Several sites have been visited in Vaitupu with the Kaupule during the survey on 21 to 27 July, 2012. Both operational and abandoned ponds were visited including the desired location for the milkfish pond expansion situated in Potu Fukagamua, adjacent to the Te Loto Lagoon with an estimated area of 20 hectares. Please see attached photos for reference. Below table summarizes the sites visited and its descriptions / observations and recommendations.

Site and Location	Description	Observations and Recommendations
1. Kaupule Fishpond (Situated at Tomasi causeway adjacent to the eastern part of the Te Namo Lagoon) Please see Annex 5 for photos of the ponds.	This site has nursery ponds at 200 sq. m. and grow-out ponds with an area of 1, 200 sq.m. These ponds have been dug out below sea level with present estimated water depth during low tide for nursery and grow-out pond at 0.20 and 1 meter respectively. This fishpond	Nursery and grow-out ponds are located in an ideal location where there is good water exchange during low tide. However, the nursery pond is too shallow for the milkfish fry/fingerlings to be in good environmental conditions. The nursery pond could be excavated deeper to at least 0.40 meters to achieve good water condition for milkfish fry/fingerlings especially

	has been improved (deeper excavation, concrete gate construction and fenced the area) by the Taiwan ICDF in 2008-2010 to demonstrate milkfish culture and management in ponds from fingerlings to marketable size.	during low tide.
2. Kaupule Floating Cages (Located in the north-eastern part of Te Namo Lagoon) Please see Annex 5 for photos of the cages.	In 2009, the Taiwanese ICDC milkfish expert introduced milkfish cage culture in the north-eastern part of the lagoon to allow more space for the milkfish grow-out and aim for increasing in production. One module of 4 units 5m x 5m floating cage was built and placed at around 15 meters away from the land at approximately 5-8 meters water depth.	- Out of 4 units of netcages, only 2 units were stocked with milkfish of 400 pcs. each with varying sizes (1 unit is a mixture of 5-10 inches milkfish size and the other unit is a mixture of 3-7 inches size). There are available stocks in the grow-out ponds to maximize the stocks in the floating cages, but due to unavailability of good/usable nets, the Kaupule management decided to let the milkfish stay in the grow-out ponds. - It was observed that the milkfish stocks were not properly sorted according to size during the stocking that resulted to uneven sizes of the stocked milkfish. - Sorting should be done within 2 months after stocking of milkfish to give chance for the smaller sized milkfish to grow and attain a uniform size during harvest. - The ideal stocking size for the milkfish in the cages should be 5-6 inches or 30-40 grams for faster growth and shorter culture period (4-5months). - It was also observed that only single net is used for the culture of milkfish. This is deemed to be disadvantageous since milkfish stocks can easily escape outside when predators like turtles, pufferfish and barracudas break nets. It is recommended to have

			double net in cage culture to prevent escape of stocks. - The net mesh size used is small for grow-out cages (7 mm.) where fouling organisms could easily blocked the net which would slow down the water flow that provides dissolved oxygen to the milkfish. - Recommended mesh size should be at least 12 mm size polyethylene net (PE net, no. 12) both for inner and outer netcage for easy maintenance/cleaning and for a good water circulation and higher dissolved oxygen concentration on the cultured milkfish that will result to faster growth of the cultured milkfish. - Another observation that is crucial for the growth and improvement of the existing floating cage project is the depth of their net cage which is only at 1.5 meters which is too shallow for fishcage culture. Sinking feeds would have a big chance to get outside the net and will not be converted into fish weight. Recommended depth of netcage should at least be 3-3.5 meters to allow milkfish to eat feeds before it touches the bottom of the net. - It is also recommended that the location of the floating cage be moved further in the middle portion of the lagoon about 15 meters away from the original location where there is a good water circulation. This desired area is the deeper part of the lagoon of about 7-8 meters where tidal current flows. - It was also observed that the wooden cage frame of the floating cage is not constructed completely. Presently only the plastic floater

			with inside foam holds the cages together. It is important to immediately fix the cage frame because of this is the backbone of the floating cage. - The combination of 2" x 3", 2" x 2" and 1" x 8" timber will make the floating cage stronger and will last longer (please see Annex 3 for detailed design and cost estimates of materials needed for reconstruction of Vaitupu Kaupule floating cage project). - It was also found out that the upper layer of the net is almost leveled to the water surface and the net cage cover is not completely sealed. It is vital for culture of milkfish in cages to completely seal the cover of the net because milkfish has a jerking behavior when disturbed by big predator fish and as a result, some milkfish stocks would have a chance to escape through the surface. - The upper part of the net should be at least 1 foot higher to prevent touching of net cover on the water surface that would prevent attachment of fouling organisms that blocks the entry of feeds to the milkfish stocks. - Based on the interview with the caretaker, feeding of milkfish both in fishpond and cages is only done twice a day. The regular feeding of milkfish must be at least 4x per day where the computed total daily feeds for the day needs to be divided into 4 feeding rations. - It is important to compute the total daily feeds of milkfish based on the average body weight of the stocks after bi-weekly sampling to attain the ideal growth rate of the

		milkfish stocks. (Please see Annex 4 for milkfish feeding guide and sample computation). - In this type of culture system where the milkfish stocks depend mainly on the artificial feeds, the crude protein content of the feeds should be at least 24% to achieve the ideal growth rate of the fish. - Locally available raw materials (e.g. grated coconut and tuna mill) in combination with imported raw materials (e.g. flour, mill mix, soy bean oil, etc.) would reach this required protein requirement of the feeds.
3. Abandoned Fishponds (Adjacent to the north-eastern and northern parts of Te Namo Lagoon) Please see Annex 5 for photos of the ponds.	During the tenure of Taiwan ICDF project, they assisted in the construction of the concrete gates of all these 3 ponds with an area of 50-100 sq. meters adjacent to Te Namo Lagoon. One is on the north-eastern part and the 2 small ponds are situated in the northern part of the lagoon. These three ponds were abandoned and few fingerlings of milkfish (2-3 inches) and mullets are found inside these ponds. Water depth of the pond during low tide is about 1 foot high.	These small ponds can be restocked with milkfish fingerlings of about 3-4 inches in length from the Kaupule fishpond at the stocking rate of 1 pc/sq. meter and feed with left over household foods and grated coconuts.
4. Preferred site of Kaupule for fishpond expansion (located at Potu Fakagamua Village adjacent to the southern part Te Loto Lagoon)	The desired location of the Kaupule for future expansion of the fishpond is situated adjacent to the southern part of Te Loto Lagoon and is estimated to be around 5-6 hectares for fishpond development.	- During this early stage of milkfish development in Vaitupu, present culture system utilizing one nursery, one grow-out pond and floating cages is enough since milkfish are still presently harvested in the lagoon on a regular basis. Establishment of the abundance of milkfish fry in the

Please see Annex 5 for photos of the site.		Island before expansion needs to be prioritized at its pioneer stage of culture. The desired location of the Kaupule has been found ideal for fishpond construction and development but would require big investment during the construction where heavy equipments are needed during the excavation and dike construction. Also, the corners of the dikes would require large volume of cement including gate constructions.

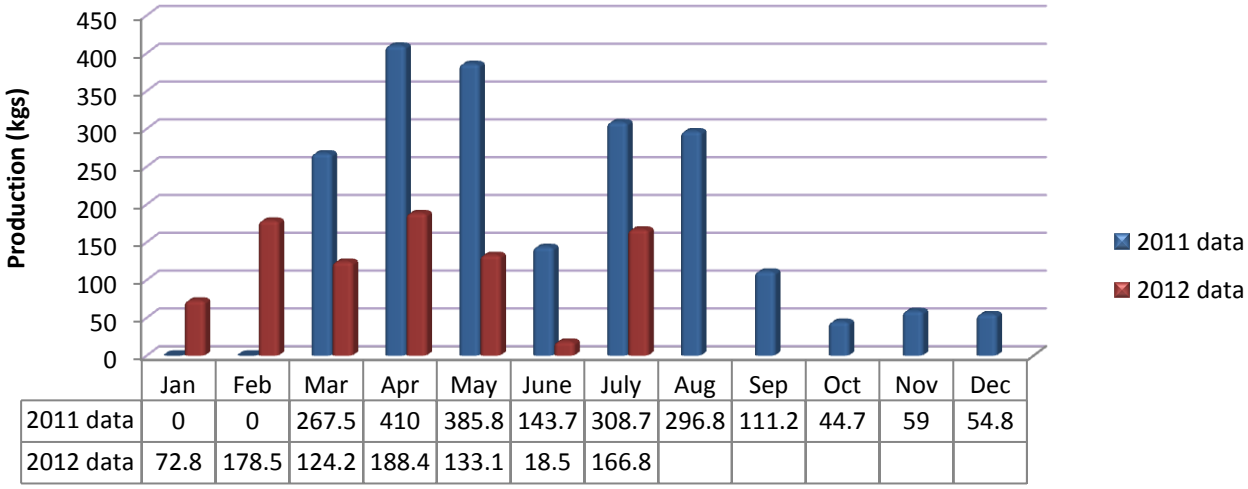
Assessment of the Current Status of Milkfish Resources in Vaitupu Based on Past and Current Exploitation Levels

A. Marketable Size Milkfish Resources

Milkfish has always been a preferred fish for the Vaitupu community because of its distinct taste. There are two (2) sources where milkfish marketable size is regularly taken; from the lagoon and from the aquaculture facility run by the Kaupule. Milkfish fingerlings are commonly seen as fish school in the shallow areas of the lagoon even during the Consultant's visit. Fishing of milkfish inside the Te Namo lagoon where there are abundant milkfish is only allowed for the community if they use a hook and line. Strictly no fishing using gillnets are allowed for the community to preserve the fishery resources of the lagoon. Only the Kaupule can fish using gillnets with 2.5-3.0" size inside the lagoon and sell to the community for consumption. Normally, the price for the milkfish and mullets caught by the Kaupule inside the lagoon is cheap at AUD1.50/kg, which is same as the price of reef fishes and tuna caught from inside and outside the reef.

Based on the interview from one of the Vaitupu residents, milkfish sizes nowadays are smaller in size and in volume (400-500 grams) compared to what they were catching 10 years ago that could reach up to 3-5 kgs. in size and with much larger quantity. During the visit, it was witnessed that the Vaitupu Kaupule fishermen are catching milkfish inside the lagoon using gillnet and about 25 pieces of milkfish were caught with the size ranging (350-400 grams). Together with the milkfish catch are few mullets (6 pcs.) and other small pelagic fishes. The milkfish caught inside the lagoon were observed to be fat indicating abundance of natural foods on the substrate of the lagoon.

Figure 1 below indicates the production of captured milkfish inside the lagoon by the Kaupule in 2011 and 2012. From this data, the decline of captured milkfish can be seen in the March-July 2011 productions compared to the March-July 2012 productions. This is the major reason why the Vaitupu Kaupule and the community are serious in the development of their milkfish aquaculture to meet the demand for milkfish by the Vaitupu community and Funafuti.



	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2011 data	0	0	267.5	410	385.8	143.7	308.7	296.8	111.2	44.7	59	54.8
2012 data	72.8	178.5	124.2	188.4	133.1	18.5	166.8					

Figure 1. Captured Milkfish Production inside the Lagoon

Based on the data collected by the Fisheries staff, Lotokufaki Paka from Vaitupu Kaupule, there were four harvests done in the floating cage project which started in February 2011 with the total volume of 236.1 kgs, followed by May 2011, September 2011 and April 2012 with the total volume of 260.8 kgs, 200.5 kgs and 125.6 kgs respectively. Please see Figure 2 below for detailed information of floating cage production.

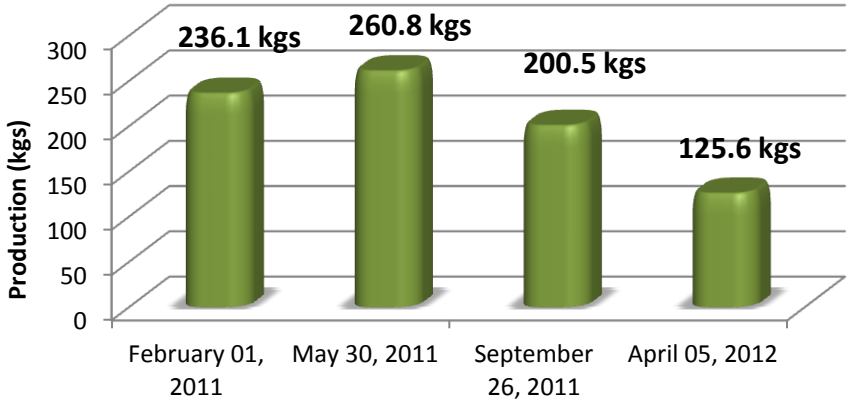


Figure 2. Milkfish Production in Vaitupu Floating Cages

The harvested milkfish from the floating netcages are sold for AUD4.00/kg and were easily sold out to the community. Presently, there are two more cages with estimated stocks of 400 pieces per net cage with varying sizes (1 unit are mixture of 5-10 inches milkfish size and the other unit are mixture of 3-7 inches size). Estimated harvest date for the bigger sized milkfish is in October 2012 with the target size of 500 grams per fish.

Looking on the big difference or uneven sizes of the milkfish stocks, if the milkfish stocks will not be sorted, not even 50% of the stocks will reach the target size of harvest. Stocking of milkfish with even sizes is vital for milkfish cage culture coupled with sorting of stocks 2 months before target date of harvest to separate the smaller size of fish and placement in the cages where its size fits.

B. Milkfish Fry and Fingerling Resources

Milkfish fingerlings (2-5" size) are commonly seen to go in school in the shallow portion or near the opening of the Te Namo lagoon and the Te Loto lagoon. Most of the fingerlings stocked in the nursery pond project of the Kaupule are harvested using scoop nets, skimming nets and seines nets either in the opening of the lagoon, in the shallow part of the lagoon or in the mangrove areas where small pools with remaining water during low tide. Only few locals know how to identify/distinguish milkfish fry from other species during its 14^{th}-21^{st} days old from the time of spawning (10-12 mm. size).

Based on the interview with the locals involved in the collection of milkfish fry/fingerlings, they said that milkfish fry and/or fingerlings are not that abundant anymore compared to previous years where they could be found in abundance inside the usual areas they are collecting. According to them, milkfish fingerlings are abundant during the first quarter of the year or during the wet season. There are several surveys done for milkfish fry but mostly are done inside the lagoons and mangrove areas. The highest average number of fingerlings captured during the peak season are 200-300 pieces per day (per comm.; Paitela).

Based on the milkfish fry survey done during the visit to Vaitupu, 21-26 July, 2012, there is a big potential for collection of milkfish fry outside the lagoon and in the sandy shore of the Island. A method used during the collection trial was the light method (night time method; used during new moon) using rechargeable lights and the fry dozer method at the Motofua sandy beach area. During the first night of the fry survey (21 July) which was the second day after the new moon, trial collection had been done near the gate opening of the pond adjacent to the lagoon and the mangrove areas. With 1 hour lighting, no milkfish fry were attracted to the light, which indicates absence of milkfish fry in the area. Normally, if milkfish fry are present in the area or near the area where the light can accommodate, milkfish fry will be attracted to the lights for they prey to the zooplanktons attracted to the lights. On the third night after the new moon (22 July), trial collection was done near the

wharf area and after 1 hour of lighting of the two areas, there was no species of milkfish fry that were attracted to the lights but there were some shrimp fry and other unidentified fish fry attracted to the lights in abundance.

Fry dozer construction was done on the 3rd day of our visit (23 July) and tested on the next day at the Motufua Secondary School sandy beach. Due to the absence of bamboos to be used as frame of the fry dozer gear, the only option left was the use of local wood that could float in the sea. During the trial, no milkfish fry were collected and the survey was not reliable since the frame could not withstand the wave action and the opening of the fry dozer was quite narrow and short (2.5 meters). The ideal opening of fry dozer should be at least 3.5 meters for wider range of collection and six (6) meters length.

During the site visits conducted, there were three ideal sites identified where milkfish fry could be collected using a fry dozer gear namely Motufua Beach, Motu o Sina (near the opening of the Te Namo lagoon) and in the sandy beach of the wharf area both on the left and the right side of it. (Please see photo plates below for the sites of fry collection). It is believed that milkfish fry can be collected in this area in a larger quantity during high tide, three (3) days before and after new moon and full moon.

Management Plan for Milkfish Farming in Vaitupu

Milkfish farming in Vaitupu has a potential for growth and development if proper management and utilization of resources are employed. The donor agency like the Taiwan ICDF has done a great work in the training and development of the milkfish fishpond facility including the introduction of floating cage culture. As recommended earlier, if these recommendations are followed, there will be a significant impact on the production from the current practices.

As mentioned above, the planned expansion of the fishpond in the Te Loto lagoon can later be considered if reliable and continuous supply of milkfish fry is established on the Island. Below are the detailed guidelines on milkfish fry identification, collection, storage, transport, acclimatization and stocking to aide the Vaitupu Kaupule on the proper management of their aquaculture project.

Milkfish Fry Identification, Collection, Storage, Transport, Acclimatization and Stocking

Milkfish Fry Identification

A trial collection should be made to help Fisheries staff and Vaitupu fishermen to recognize and become familiar with the fry and collecting methods. It requires good

eyesight and practice to differentiate and identify milkfish fry (Figures 3 and 4). A good description was made by Villaluz et al. (1983) as follows:

"Milkfish fry are late postlarvae 10–17 mm in total length (average about 14 mm) which is caught from shore waters when they are about 2–3 weeks old from the time of spawning. Upon capture from the shore waters, milkfish fry have transparent, elongated bodies like those of larval anchovy and sardines and some gobies. In the collector's basin, milkfish fry can be readily picked out by their energetic movements and their conspicuous eyes. They swim together and circle continuously in the same direction. They are able to stay alive where the fry of most other fish species in the same catch have died. Under the microscope, milkfish fry can be seen to have a straight gut without transverse folding of the intestine. A single line of pigments runs along the lower edge of the abdomen from the throat almost to the anus. The liver is large and sometimes looks like a yolk, which is why the fry have been mistaken to be newly hatched when they are in fact 2–3 weeks old."

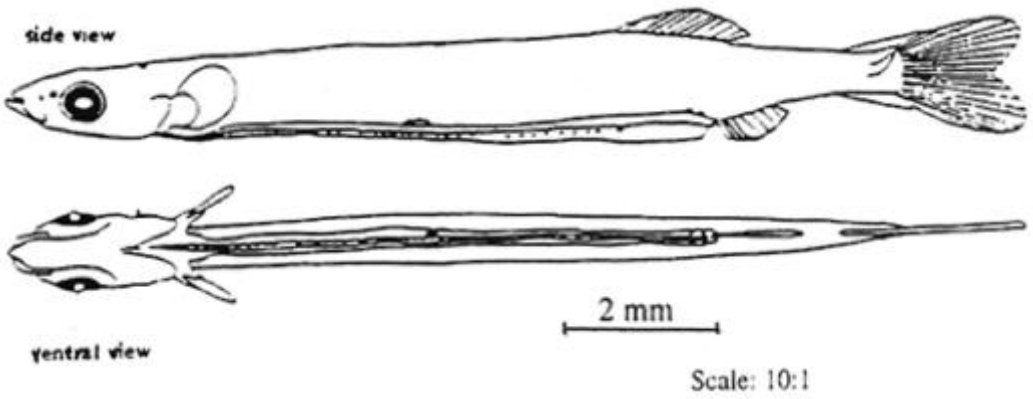


Figure 3. Milkfish Fry
(Source: Bagarinao et al.)

Figure 4. Photo of milkfish fry caught from wild. (By: John Eric Basco)

Milkfish Fry Collection

Milkfish fry can be found and collected in almost all the coastal waters of the tropical Indo-Pacific region. In regions affected by monsoon or trade winds, the peak fry season typically coincides with one or both of the biannual wind shifts. These seasonal peaks are more or less predictable, but fry abundance may vary from year to year (Vilaluz**,** A.C.). In the Pacific region, normally fry collection is done 3 days before and after new moon and full moon where milkfish fry are abundant**.**

Milkfish fry are pelagic fishes, meaning they only stay on the surface even if disturbed. This characteristic makes their collection easier. Design, construction and area of operation of milkfish catching gear are primarily dictated by the topography of the fry ground, wind direction, current patterns and tidal fluctuations (Villaluz, A.C.). Collection gear and methods are modified to suit the convenience of fry collectors as well as the availability and cost of materials. There are two types of gear recommended that may be efficiently used in the collection of milkfish fry in Vaitupu Island. These are push net or "fry dozer" and barrier nets. Collection of fry should be done during high tide to take advantage of the concentration of the fry near the shore cause by the push of tidal currents. Below is the description for the different types of fry collecting gear that is applicable in Vaitupu.

Push net

This gear usually needs a two-man team wherein one pushes the gear and at the same time scooping the fry from the end bag net while the other one is leading the flow of the fry and sorting it. A v-shaped bamboo/ 4" dia. PVC pipe serves as the main framework making shape like the end of a scissor. It has detachable fine mess nylon netting (0.3 to 1.3 mm) and a catch/bag net at the narrow end of the gear. During the process, milkfish fry are concentrated at the bag net thus abaca cloth is usually sewn over the nylon netting. If abaca cloth is not available, the nylon netting could be double-layered to prevent sticking of fry creating ease in the process. Lead sinkers are used as weights attached to the wings of the gear as well as in the bag net. (Bagarinao et al.)

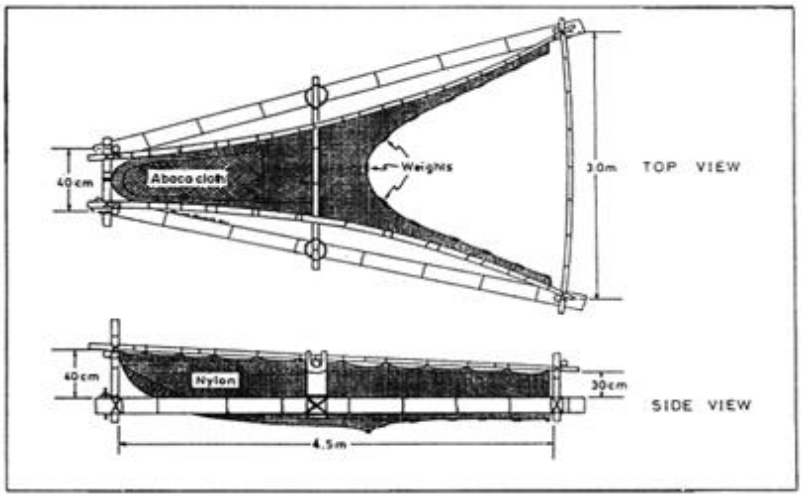


Figure 5. Push net, basic type, its structure and dimensions (Villaluz A.C.)

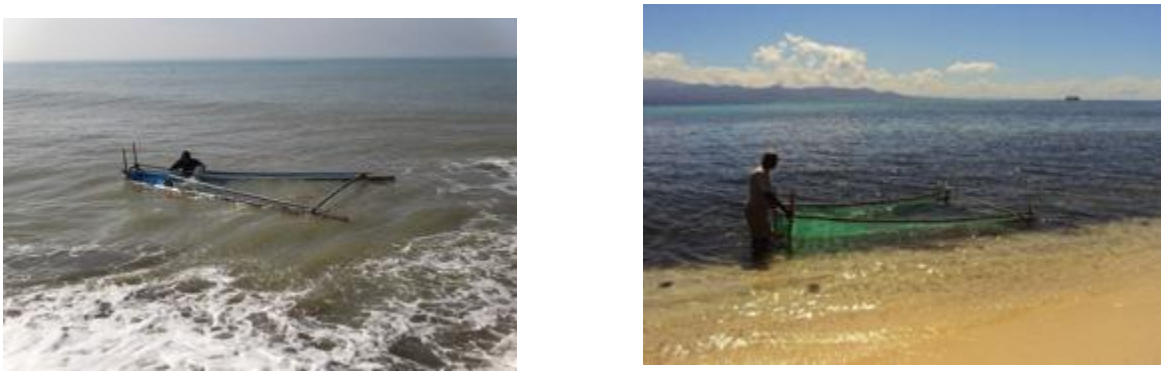


Figure 6. Push net (left: sandy beach of Philippines; right: Solomon Islands)

Storage of Fry

Collected fry, which may include other species, are placed in a white plastic for sorting and counting using a small white bowl. The counted fry are placed in another container for storage while debris, dead fry and unwanted species are discarded.

Careful observation should be noted with Tarpon fry (*Megalopscyprinoides*) and ten-pounder (*Elopsmachnata*) which may look very similar to milkfish larvae. They are voracious predators of milkfish fry and fingerlings in the nursery pond. Both can be distinguished from the milkfish from their longer and wider bodies, swimming movements and light amber color (Villaluz, A.C).

Certain considerations to understand about milkfish fry:

- The fry are not fed during overnight storage after captivity. The storage water (20 to 30 liters capacity) generally is diluted with water again at ratios of one part seawater to one part freshwater to approximate 20 to 25 ppt salinity. The purpose is to reduce stress from osmotic pressure differences.
- For feeding, food such as the yolk of hard-boiled eggs, pulverized rice, or dried wheat flour, is given to the fry daily.
- Daily inspection of the storage containers is done every morning and afternoon; the excess food, feces and dead fry are removed by swirling by hand to concentrate the unwanted materials at the center. A bowl is then used to scoop out these potentially toxic wastes.
- During water change, the salinity is gradually reduced or increased to 3-5 ppt per day until the salinity is the same with the receiving ponds/lagoon to avoid stress.
- To ensure uniformity in size and transport, the collected milkfish fry may be stored in a plastic basin, bucket or in coolers that can hold water about 10-15 liters. The fry containers are then covered to minimize fry activity and to prevent dirt from entering the containers.
- Keep the fry in shaded and cool place to minimize the stress.
- About 3,000 milkfish fry may be stocked in this container without aeration for 2 weeks as long as the fry are fed daily with egg yolk or flour, regular siphoning of excess feeds and wastes, and daily change of at least 50% of water volume.
- Avoid storage of fry for more than 15 days to prevent weakness and mortalities.

Fry Transport

- Milkfish fry are not fed a day before transport to avoid polluting the transport water that would cause fish stress and mortalities.

- The storage containers are cleaned and the water is completely replaced with premix water of the desired salinity.
- The fry are normally contained in double-lined oxygenated plastic bags (20" x 30") with salinity ranging from 15 to 25 ppt. The plastic bag may hold 4 liters of water in which 1 liter may hold up to 1,500 to 2,000 pieces of milkfish fry (10-12 mm size). The oxygen to water proportion during packing procedure is 1/3 water to 2/3 oxygen. This method is proven to be effective up to 10-13 hours transport time. Normally, the water temperature is lowered down to 26°C to minimize fish metabolism by placing iced-plastic bottled water (600 ml) wrapped by an old newspaper and placed in between 2 transport bags inside the styrofoam.

Acclimation and Stocking of Fry

- It is always best to determine the salinity of the receiving pond so that necessary adjustment on the salinity would be during holding of fry to have a very good survival upon stocking
- Upon arrival to the site, the fry are usually emptied into plastic basin to sort out predators. The fry are stocked in the pond in the early morning or late afternoon when the temperature is cool to prevent temperature shock
- Upon arrival in fishpond, the salinity and temperature is normally checked to determine the difference of the transport water and the receiving water.
- It is best to count the fry to prevent under or over stocking. One or two plastic bags are randomly selected and placed in the white basin for counting and would serve as basis of count for each plastic bag.
- The water in the conditioning container is diluted about 10% with pond water while sorting and counting is done. If the salinity of the receiving water and the transport water is less than 5 ppt., 25 to 30 minutes of acclimation would be enough by adding half liter of pond water to the container every 5 minutes until the equilibrium is achieved. Then, the milkfish fry are released in the ponds or nursery cages.

Figure 7. Manual counting of milkfish fry and acclimation of milkfish fry prior to stocking

Sites Visited in Funafuti

After the Taiwan ICDF turned-over the aquaculture project of both fishpond and floating cages at Vaitupu to the Kaupule during the last quarter of 2010, they again did the demonstration project on milkfish in concrete tanks at Funafuti that will last for 3 years. The project will mainly focus on management training of Fisheries Department staff, demonstration of milkfish culture, feed production and its guidelines and training workshop in aquaculture. (Second Quarter Report by Lotokufaki Paka)

There are 4 tanks with varying dimensions. Tank 1 with the dimension of 6 m x 19 m x 1.4 m stocked with 300 pieces milkfish with an average body weight of 300 grams. This is the same pond where they did the first harvest of 75 kgs. In April 2012, they sold to the community for AUD5.00/kg. They are planning to have the second harvest in November 2012 when the stocks reach 500 grams average body weight. Tank 2 with the dimension of 4 m x 8 m x 1.4 m is stocked with 400 pieces, 30 grams milkfish. Tanks 3 and 4 both with the dimension of 4m x 4 m x 1.4 m are stocked with 600 pieces per tank with an average body weight of 3 grams and 5 grams respectively.

The milkfish stocks are fed 4 times daily by both farm made formulated feeds and imported milkfish feeds from Fiji. According to the Expert in-charge, Mr. Marc Lee, it is more cheaper to import feeds from Fiji rather than making feeds in Funafuti because most of the raw materials used like flour, mill mix, eel powder and soybean oil are also imported plus the labor fee for preparation of feeds (e.g. mixing, grinding, drying etc.).

All the tanks are equipped a life support system (e.g. aerators, pumps) and have good closed re-circulating system and filter system that minimize the effluent discharge to the environment.

There are two local workers that have been hired in a contractual basis and one Fisheries counterpart to undertake a training on milkfish culture and management.

Recommendations and Steps for Follow-up Actions:

1.) There is a need for a follow-up action to further evaluate the distribution and occurrences of milkfish fry in Vaitupu Island. A milkfish fry survey for a year would yield a better understanding of the occurrence of milkfish fry, seasonality and other environmental conditions associated with its distribution and frequency in the region. This survey could also be used as a training opportunity involving Tuvalu Fisheries Department staff and Vaitupu fishermen, especially in the demonstration of the methods of fry collection in the sandy beach of the Island.

    If possible, hiring one worker from Vaitupu to conduct 1-year milkfish fry collection in the identified sandy beach area under the expense of the TCP project would be very helpful to carry out the objective of the assistance. Once the abundance and season of milkfish fry is identified, then plans for future expansion of fishpond can be considered.

2.) Training in the methods of milkfish fry collection, identification, sorting, handling, transport, acclimatization and management of milkfish fry needs to be established.

3.) Vaitupu Kaupule should be educated on the biology of milkfish and the negative effects of capturing milkfish breeders on the fry industry. They should be taught that these breeders are the ones producing eggs that developed into milkfish fry that may become an industry in the future. It is recommended that the Kaupule should take into consideration of imposing restriction in capturing 40-50 cm size (3.5- 5 kgs.) milkfish adults for the sustainability of milkfish fry industry of the country since there is no present restrictions or Fishery Law about size limits of milkfish capture.

4.) Workshops on milkfish collection of fry and culture management should be conducted to different interested stakeholders to booster the interest and acceptability of milkfish as a major species of culture in the country. Training in site selection, pond construction, fry collection, pond preparation, fertilization, feeding management, harvesting and post harvest activities including a training on value added products of milkfish such as deboning, stuffing and smoking needs to be considered.

5.) There is a need to establish connections in the neighboring countries for supplies of netting materials, feeds and other aquaculture equipment needed for improvement of aquaculture project in the country. Please see Annex 6 for possible aquaculture suppliers from Australia, Fiji and Taiwan.

***References*:**

Bagarinao, T.U. 1999. Ecology and farming of milkfish. SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines. 171 pp.

Kumagai, S. and T. Bagarinao. 1981. Studies on the habitat and food of juvenile milkfish in the wild. Fish. Res. J. Phil. 6: 1–10.

Villaluz, A.C. 1984. Collection, storage, transport and acclimation of milkfish fry and fingerlings. In Advances in milkfish Biology and Culture. (J.V. Juario, Ferraris, R.P. and Benitez, L.V., Eds.). Island Publishing House, Manila, pp. 85–96.

Villaluz, A.C. and A.Unggui. 1983. Effects of temperature on behavior, growth, development and survival of young milkfish, Chanos chanos (Forskal). Aquaculture. 35: -321–330.

Paka, L. Aquaculture Project The Second Quarterly Report 2012. Taiwan Technical Mission in Funafuti

Annex 1. Key persons met in Tuvalu

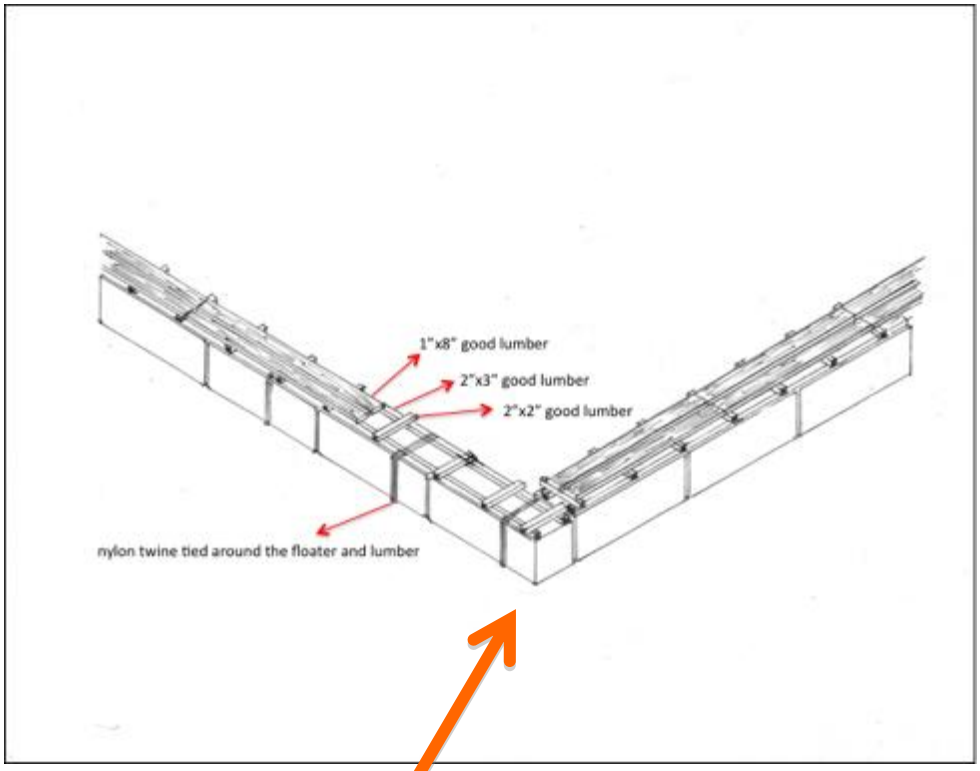
1. Sam Finikaso, Director, Fisheries Department (sfinikaso@yahoo.com)
2. Ms. Moeo Finauga, National Project coordinator, Fisheries Officer, Fisheries Department (mfinauga@gmail.com)
3. Marc Li, Aquaculture Specialist, Taiwan ICDF Tuvalu
4. Semese Alefaio, Research and Development Officer, Research Section, Tuvalu Research Section (semese@tautai.com)
5. Leti Pelesala, Secretary, Vaitupu Kaupule
6. Lilipa Lameko- Milkfish Project Caretaker, Vaitupu Kaupule Aquaculture Project
7. Lotokufaki Paka , Research Officer, Fisheries Department, Fisheries Counterpart for Taiwan ICDF Demonstration Project in Funafuti
8. Filipo Makolo, Research Officer, Fisheries Department
9. Teveia Lilipa, Taiwan ICDF Milkfish Project Coordinator for Niuta Island
10. Paitela Kelemene, Vaitupu resident presently working in Taiwan ICDF Milkfish Demonstration Project in Funafuti

Annex 2. Travel itinerary

13th July (Fri)	- Palau- Manila – Nadi- Suva
14th-17th July (Sat-Tue)	-Manila- Hong Kong- Nadi- Suva
17th July (Tue)	- arrived Funafuti, Tuvalu - met with Ms. Moeo Finauga, National Project coordinator, Fisheries Officer, Fisheries Department - visited Milkfish Demonstration Facility of Taiwan Agricultural Technical Mission
18th July (Wed)	- visited Milkfish Demonstration Facility of Taiwan Agricultural Technical Mission with Moeo Finauga and met Marc Li, ICDC Specialist - discussed plans to Vaitupu on how ICDC can help using their equipment sang packing materials - canvass and purchase rechargeable lights to be used in Vaitupu fry collection
19th July (Thu)	- at Milkfish Demonstration Facility of Taiwan Agricultural Technical Mission - assisted in milkfish feed preparation - preparation for Vaitupu trip
20th July (Fri)	- work in the office - left Funafuti to Vaitupu via Manaui's Skipper Boat
21st July (Sat)	- meeting with the Kaupule - visited Kaupule project sites (cages, ponds and the desired area for pond expansion) - conducted survey of milkfish fry at night using lights near the fishpond facility of Kaupule
22nd July (Sun)	- work in the guest house - conducted survey of milkfish fry at night using lights at the whaft
23rd July (Mon)	- fabrication of small fry dozer gear - visited possible sites for milkfish fry collection
24th July (Tue)	- fry collection on the sandy beach of Mutufua Secondary School - visited floating net cage and observe feeding of milkfish stocks
25th July (Wed)	- performed cleaning of nets by removal of fouling organisms clogging the nets - mending of holes in the netcage
26th July (Thu)	- meeting with the Kaupule Secretary on the findings of the mission and recommendations for improvement of the existing project and follow-up actions

27th July (Fri)	- traveled back to Funafuti via Manaui Skipper Boat
28th July (Sat)	- work in the hotel
29th July (Sun)	- work in the hotel
30th July (Mon)	- work in the Fisheries office - canvass materials for Vaitupu floating netcages with Ms. Moeo Finauga - meeting with Mr. Sam Finikaso, Director, Fisheries Department and Discuss mission findings and recommendation and follow-up actions for 2nd mission
31st July (Tue)	- assisted in milkfish sorting and counting at Taiwanese Milkfish Demonstration Center - meeting with Ms. Moeo Finauga regarding plans for the next mission - work in the Fisheries office
1st Aug (Wed)	- work in the Fisheries office
2nd Aug (Thu)	- work in the Fisheries office - went to shipping company to inquire freight charges from neighboring countries to Funafuti
3rd Aug (Fri)	- work in the Fisheries Office - visited abandoned floating cage in Funafuti
4th Aug (Sat)	- work in the Hotel
5th Aug (Sun)	- work in the Hotel
6th Aug (Mon)	- work in the Hotel (National Holiday, Youth Day)
7th Aug (Tue)	- work in the Fisheries Office - check other Shipping Company for Freight Quotations
8th Aug (Wed)	- work in the hotel - preparation for departure in Funafuti
9th Aug (Thu)	- left Funafuti-Suva-Nadi
17th Aug (Sat)	- arrive Palau

Annex 3. Proposed Vaitupu Kaupule floating cage reconstruction



Materials Needed for Vaitupu Kaupule Fishcage Project
(1module of 4 units 5m x 5m floating cage)

A. Netting Materials (need to be purchase overseas)	Unit	Quantity	Estimated Amount (AUD)	Total Amount
1. Polyethylene net/PE net; (no. 12), 100 m/roll	rolls	10	$ 200.00	$ 2,000.00
2. Polyethelene rope/PE rope (no. 10),100 m/roll	rolls	8	$ 60.00	$ 480.00
3. Evelon cord (2mm diameter), 100 m/roll	rolls	50	$ 2.00	$ 100.00
4. Plastic sewing needle (6" length)	pcs.	20	$ 0.50	$ 10.00
			Sub-total	**$ 2,590.00**
B. Cage Frame Materials (locally available)				
1. Good lumber (2" x 3" x 12')	lengths	36	$ 18.50	$ 666.00
2. Good lumber (2" x 2" x 12')	lengths	15	$ 15.50	$ 232.50
3. Good lumber (1"x 8" x 12')	lengths	35	$ 29.40	$ 1,029.00
4. Common nails (2")	kgs.	5	$ 4.90	$ 24.50
5. Common nails (3")	kgs.	5	$ 4.80	$ 24.00
6. Monofilament twine (165 kgs; 1.8 mm x 1000 m)	rolls	2	$ 75.00	$ 150.00
			Sub-total	**$ 2,126.00**
C. Feed Requirements for Vaitupu Cages				
1. Starter Feeds (Sinking, 25 kgs.)	bags	10	25	$ 625.00
2. Grower Feeds (Sinking, 25 kgs.)	bags	30	25	$ 750.00
3. Finisher Feeds (Sinking, 25 kgs.)	bags	20	25	$ 500.00
			Sub-total	**$ 1,875.00**
			TOTAL	**$ 6,591.00**

Annex 4. Feeding guide for milkfish culture in ponds and cages

Feeding Guide for Milkfish Culture in Cages Using Formulated Feeds

Fish Weight (grams)	Feeding Rate (%)	Feeding Frequency	Feed Type
1	20	4-5x/day	Fry mash
2	15	4-5x/day	Fry mash
5	10	4-5x/day	Fry mash
10	8	4x /day	Fry mash/ Starter crumbles
15	7	4x/day	Starter crumbles
20	6.0	4x/day	Starter crumbles /starter pellets
30	5.0	4x/day	Starter pellets
60	4.5	4x/day	Starter pellets
100	4.0	4x/day	Starter pellets/ Grower pellets
175	3.5	4x/day	Grower pellets
300	3.0	4x/day	Finisher pellets
400+	2.5	3-4x/day	Finisher pellets

Example Computations:

Given:

1. Total Stocks (TS) = 2,000 pcs.
2. Percent Survival = 90 %
3. Average Body Weight (ABW) = 200 grams
4. Feed Rate (FR) = 3.5 %

Find: How much is the total daily feeds (TDF) for the stocks?

Formulas : TDF = Biomass x Feed Rate(FR)

Biomass = Total weight of the population

$$= \frac{\text{total stocks x \% survival x ABW}}{1000}$$

= 2,000 x 0.90 x 200/ 1000

= 360 kgs.

To compute for total daily feeds (TDF) = Biomass x Feed rate

= 360 kgs. x 0.035

= 12.6 kgs. of feed (divided into 4 rations)

Annex 5. Photo plates

Sites Visited in Vaitupu

Nursery Pond managed by Vaitupu Kaupule

Grow-out Pond managed by Vaitupu Kaupule

Floating Cage Managed by the Vaitupu Kaupule

Fry collection areas

1st Site Mutufua Secondary School (Sandy beach)

2nd Site, Motu o Sina (Near the Opening of the Big Lagoon)

3rd Site, Wharf Area, Asau Side (Sandy beach)

Construction of fry dozer

Meeting with Kaupule

Funafuti

ICDF Milkfish Culture in Tanks Demonstration Project

Annex 6. List of feeds and net suppliers in Fiji, Australia and Taiwan Province of China

Supplier	Products	Contact Information
I. Fiji		
1. Pacific Feeds LTD	Milkfish feeds	P.O.Box 182 Suva pacificfeeds@pacificfeeds.com.fj www.pacificfeeds.com.fj Tel no: +679 336 2258
2. Goodman Fielder International(Fiji)	Milkfish feeds	Private mail bag No.30 Suva, 30 Karsanji St. Tel no: +679 338 7777
II. Australia		
1. Aquaculture Supplies	Aerators / Anti-predator/ Cages/ General/ Hides/ Netting/ Pumps /Ropes & Floats /Tanks/ Feed	(e) aquasupplies@westnet.com.au (w) www.aquaculturesupplies.com
2. Australian Netmakers	Nets/ Netting/ Anti-predator/ Ropes & Floats/ Cages	(e) info@australiannetmakers.com (w) www.australiannetmakers.com
3. Primo Aquaculture	Feed/ Aerators/ Larval Feeds	(e) primo@primo.net.au (w) http://www.primo.net.au
III. Taiwan		
1. Chuan Kuan Enterprise	Aquaculture Supplies, equipments and materials	(e)chuankuan@seed.net.tw