
REPORT: SPC/IFREMER SEMINAR ON FISH WASTE UTILIZATION

June 11, 2012
Noumea, New Caledonia



Report prepared by:
Catherine Mariojouis¹ and Michael Sharp²

¹ AgroParisTech

² Secretariat of the Pacific Community

In June 2012, the Secretariat of the Pacific Community -SPC- (Michel Blanc, Tim Pickering and Michael Sharp) and the French Research Institute for Exploration of the Sea -IFREMER- (Jean-Pascal Bergé, Liet Chim) with Catherine Mariojouis – AgroParisTech- organized a seminar that focused on the problem of under-utilization of fish waste and the potential uses of the waste in the region.

SUMMARY

The seminar provided opportunity for dissemination of information on fish waste utilisation through a series of presentations, which can be accessed on:

http://www.spc.int/DigitalLibrary/Events/Fish_Waste_2012.

Session 1 focused on the problem of underutilization of fish waste and the potential uses of the waste, and it introduced a general framework to when considering waste utilisation. There was also a summary of fish waste production in the Pacific region, which introduced a typology for categorising producers of fish waste in the region. The typology adopts the following definitions:

- i. **Category A:** remote countries or areas that do not produce a lot of waste;
- ii. **Category B:** countries and areas that interact with industrial fishing and processing sectors that produce a lot of waste, but generally utilise it (at least some of it); and
- iii. **Category C:** countries and areas that interact with industrial fishing and processing sectors that produce a lot of waste, but generally do not utilise it.

These categories are used throughout this report.

Session 2 focused on private sector exploitation of fish waste utilization. Examples of small-scale and large scale utilisers of fish waste were presented along with presentations based on market opportunities for fish waste, including feed for aquaculture and food for human consumption.

The seminar agenda can be found in appendix 1, with a summary of the key points from each presentation in appendix 3.

The afternoon sessions provided opportunity for exchange of ideas and brainstorming among participants. Working groups discussed and documented the present situation and possible future for fish waste utilisation in their countries, while considering the constraints for utilisation of fish waste.

These discussions led to developing some recommendations (action items) for improving the situation of fish wastes utilization in the Pacific Island Countries and Territories. The four key recommendations are:

- i. preparation of a brief about fish waste and its potential uses;
- ii. conducting a regional survey to determine the special distribution of fish waste currently produced in the region;
- iii. establish a multi-product mobile fish waste processing plant to demonstrate processing techniques throughout the region and to gather data for research and development programmes; and
- iv. research the potential for utilisation of fish waste in aquafeed.

The role of public policies was underlined as an important factor to achieving better utilisation of waste (or reduced waste) in the region.

PARTICIPANTS

The one-day seminar was organized following a week of meetings with Heads of Fisheries (HOF) of PICTs at the Secretariat of the Pacific Community (SPC) in Noumea, New Caledonia. This gave opportunity to have an international audience of around 50 people from numerous countries, gathering representative from public and private sectors. HOF and representatives from fishing associations from numerous PICTs, regional stakeholders, private sector, government and non-government organizations and experts in fish waste utilization all attended and contributed to the recommendations herein. A full list of participants is provided in appendix 2.

SUMMARY OF PRESENTATIONS

130 million tons of fish waste is produced globally on an annual basis (from capture and aquaculture industries). This consists of by-catch, waste-on-board, home waste and industrial waste. The waste is often disposed in landfill or dumped at sea, however there are alternative uses that add economic value.

Mass transformation is one form of utilisation. Some examples of products include: fish meal, oil, fertilizer and conversion into hydrolysate.

Sorting is another way for adding value to fish waste. Some examples of products produced by processing after sorting include: liver oil, gelatine, omega 3, protein sports food/drinks, calcium, cosmetics, biotechnology and pharmaceuticals.

When considering how to manage fish waste, the following framework can be adopted:

- i. identify the availability (or production) of fish waste;
- ii. assess the current use of this fish waste;
- iii. identify the potential application for this by-product; and
- iv. develop a strategy for exploiting the by-product for environmental and economic gain.

In the Pacific, there are many producers of fish waste at the industrial and artisanal level. Some examples of producers include canneries, longliners, purse seiners, small-scale fishers and processing operations, fish markets and commercial processing companies. In addition to many producers, there are also many potential utilisers, which range from human consumption to aquaculture to further refining (sorting) for international marketing.

Generally, the production in the Pacific is not well documented, however it is recognised that there is a need to find ways to better utilise fish waste for environmental and economic reasons.

AFTERNOON WORKING GROUPS AND DISCUSSION

The participants were assigned to three working groups to discuss and document three general areas in relation to fish waste in the Pacific. This aimed to gather a 'snapshot' of fish waste availability, current use, potential use, and to identify constraints and strategy for utilizing waste more effectively in the Pacific region. The groups were guided to discuss and report on the following areas for their respective PICT:

- i. fish waste availability and present uses;
- ii. potential uses of fish waste; and
- iii. constraints and strategies for future developments.

Then the results were presented to the plenary with open discussion on the future actions that are needed to improve fish waste utilization in the Pacific.

A summary of the working group outputs is provided below, with detailed outputs for areas 1, 2 and 3 provided in appendix 4, 5 and 6 respectively.

WORK-GROUPS OUTPUT

At the outset, it must be acknowledged that the outputs from the working groups, which are summarized in this section and detailed in appendix 4, 5 and 6, are the views of the seminar participants and they do not necessarily represent the actual situation. Although the data cannot be fully relied upon, the seminar gave opportunity to collate information from industry experts and present a snapshot of the current status of waste and its' utilization in the Pacific.

SNAPSHOT 1: AVAILABILITY AND PRESENT USES OF FISH WASTE IN THE PACIFIC

The reports of the working-groups give a first snapshot of the situation in the PICTs, with contributions from the different participants on the situation for artisanal / subsistence fisheries, industrial fisheries, and industrial processing.

The information gathered, which is presented in appendix 3, shows the situation for the different countries. Again, it must be underlined that the presented data were collected during informal

working groups, often with estimations and uncertainty, and cannot be regarded as accurate and exhaustive. Additionally, the table displays the missing data and the need for detailed fish waste surveys.

The typology proposed in the morning by Mr Michel Blanc (SPC) (refer appendix 3, S1P4) is pertinent to characterize the main types of situation. The typology is summarized as follows:

Context A – atoll (insignificant waste and almost fully utilized)

Description	<ul style="list-style-type: none">• Small communities with artisanal fisheries, where all fish byproducts are used• Generally little or no waste
Geography	<ul style="list-style-type: none">• Atolls, small islands, remote coastlines of larger islands
Production	<ul style="list-style-type: none">• Limited and scattered production of waste
Uses	<ul style="list-style-type: none">• Human food, animal feed (pigs or pets), or to make fertilizers
Opportunity	<ul style="list-style-type: none">• Limited commercial value adding potential

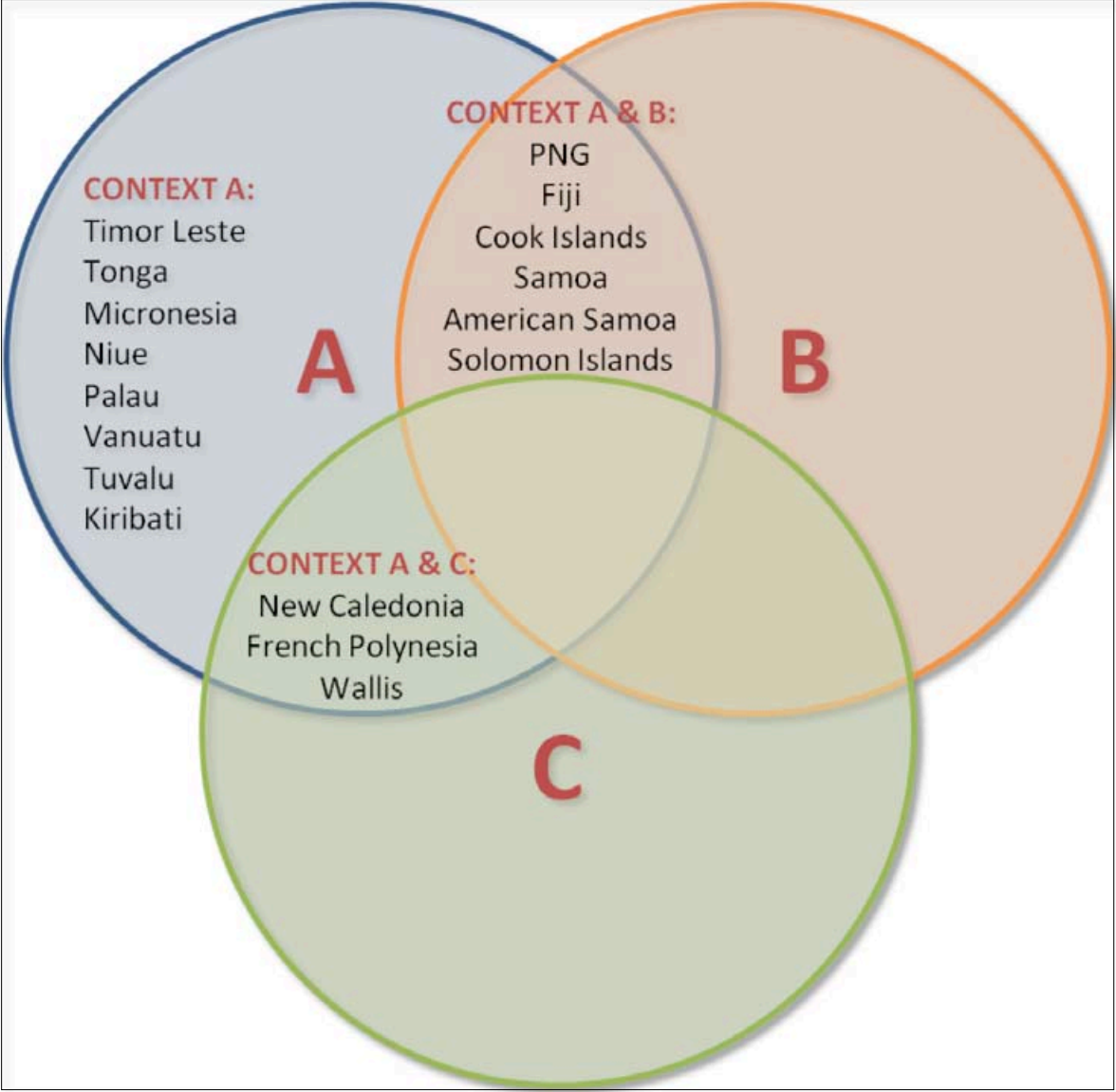
Context B – better (moderate waste being used, but not everything)

Description	<ul style="list-style-type: none">• Low income urban centers and islands that interact with industrial fisheries• Intermediate situation with both artisanal and industrial fisheries• Generally already having a specialized plant for processing waste into fish meal and fish oil• Some use of waste, but not entire use
Geography	<ul style="list-style-type: none">• Urban centers and islands that interact with industrial fisheries (onshore processing, transshipments)
Production	<ul style="list-style-type: none">• Medium-to-high volumes of waste, geographically concentrated
Uses	<ul style="list-style-type: none">• Industrial use when economy of scale allows (e.g. fish meal)• Some types of waste being used as human food for food security (e.g. heads, tail trunks, belly flaps)• Some waste not-utilized
Opportunity	<ul style="list-style-type: none">• Moderate value adding potential

Context C – complete (no use of waste – completely wasted)

Description	<ul style="list-style-type: none">• High income urban centers and islands that interact with industrial fisheries• Disposal of waste at sea or landfill• Disposal costs (financial and opportunity cost)
Geography	<ul style="list-style-type: none">• Urban centers and islands that interact with industrial fisheries (onshore processing, transshipments)
Production	<ul style="list-style-type: none">• Medium-to-high volumes of waste, geographically concentrated
Uses	<ul style="list-style-type: none">• Entirely wasted – no use
Opportunity	<ul style="list-style-type: none">• Increasing awareness on waste issue, driving policy for better use• High cost of discards providing economic incentive for value adding

The situation of each country and/or sub-part of a country has been characterized by the reporters in appendix 4 using these typologies. As a summary of the findings, the figure below represents the general context for all participating PICTs.



SNAPSHOT 2: POTENTIAL USES OF FISH WASTE IN THE PACIFIC

It was highlighted that, in some countries (e.g. context A), there is a very small amount of fish waste and no change is required due to entire use of fish byproducts.

Concerning the potential uses in context B and C, the question has been treated through a general discussion and not at country level. Appendix 4 summarize the potential uses that were identified by each working group, which followed the applications that were proposed in Mr. Jean-Pascal Bergé's (Ifremer) presentation (refer appendix 3, S1.P1).

Below is a summary of the potential uses of fish waste in the Pacific, as identified by the working groups.

Application	Potential uses of fish waste
Agricultural	<ul style="list-style-type: none"> • Production of fertilizer, fish silage or compost (organic potential) • Production of pesticide (insects)
Animal feed	<ul style="list-style-type: none"> • Produce fish meal and oil for agricultural and aquaculture feeds • Use of 'stickwater' from fish meal process, which can be added to fish meal or in the production of hydrolysates
Food (human)	<ul style="list-style-type: none"> • Utilize at-sea discards from tuna transshipment for human consumption (food security) • Produce gelatin with fish waste • Produce tuna 'stock' from fish dust – this is similar to beef and vegetable stocks and is commonly used in Japanese cuisine
Pharmaceutical	<ul style="list-style-type: none"> • Produce collagen for micro-encapsulated medicines in aquaculture (improves palatability)
Other	<ul style="list-style-type: none"> • Utilize pearl and crustacean shells (e.g. jewelry, calcium) • Bycatch is being used for low-value add activities and should be allocated to areas that derive higher economic value add (e.g. fish cakes, jerky) • Potential to explore the use of fish waste for bait for longliners or game-fishers

SNAPSHOT 3: CONSTRAINING FACTORS TO FULL UTILISATION OF FISH WASTE

Participants were asked to identify the constraints to efficient and profitable utilization of fish waste and bundle these constraints into the following categories: economics, extension and development, commercial, supply chain organization, fisheries sector, public policies, and administrative organization.

Appendix 5 provides a full list of the identified constraints for each working group, with the below presenting a summary of the discussions.

Application	Constraints
Economics	<ul style="list-style-type: none"> • Upfront investment for efficient use of waste is large • Large scale is needed to be competitive • Operational costs for producing a low value product are high • There is uncertainty about the production costs and market (price) for by-products • Public sector subsidies may inhibit private sector investment
Extension and development	<ul style="list-style-type: none"> • Technical expertise for high-technology waste utilization is lacking in the region • Support and awareness around the potential uses for waste in the region is also lacking
Commercial	<ul style="list-style-type: none"> • People are generally unaware of the potential applications for fish waste • Few market data are available
Supply chain organization	<ul style="list-style-type: none"> • Collaboration and cooperation is required to get sufficient supplies to warrant fish waste utilization – this is especially the case for small scale players who have small volume, wide spread geographic distribution of fish waste • Efficient collection mechanisms are not available
Fisheries sector	<ul style="list-style-type: none"> • Policy required to encourages landing of by-catch and incentive to land the guts (for fish silage)
Facilities	<ul style="list-style-type: none"> • Infrastructure for large scale value adding is lacking in the region
Administrative organization	<ul style="list-style-type: none"> • Separate regional administrations resulting in a lack of global strategy
Public policies	<ul style="list-style-type: none"> • Public policy and legislation hinder use of fish waste (e.g. HACCP, policies that restrict landing of fish guts, etc)

STRATEGY FOR FUTURE DEVELOPMENTS

The aim was to formulate strategies to overcome constraints, however only one working group addressed this component. The following ideas were expressed:

- i. Most PICTs are small-scale waste producers;
- ii. Technical: SPC, Ifremer and others can facilitate the development of this sector via introducing network contacts and gathering, reviewing and disseminating information;
- iii. Economic analyses is required to decide on the most suitable products that suit the scale of each location;
- iv. A summary of the main regional producers, user groups and opportunities for fish waste utilization is required; and
- v. Develop and implement pilot public-private partnerships (public science, private expertise) to test ideas.

DISCUSSION AND FOLLOW-UP ACTIONS

Discussions were held about how best to utilize fish waste in the region and the following follow-up actions display the identified priorities to achieve this. The follow-up actions are summarized below:

1. Improve information about the potential applications for fish waste and develop a decision tool to assist companies (or countries) to compare various waste utilization alternatives and decide on the most appropriate option

It is proposed that SPC and Ifremer will prepare a short note (e.g. policy brief) gathering the main information about possible uses, technologies, application sectors, and the main conditions to consider for the choice of wastes utilization route. This will incorporate the decision making framework for utilization of this waste.

2. Conduct a regional survey about fish waste

Beyond the first round of information gathering which has been held in this seminar, it is considered a priority to paint a picture (as precise as possible) of the fish waste situation in the PICTs. This should cover: availability (quantity, quality, mapping), present uses, potential uses and needs and identify opportunities & constraints.

3. Develop a mobile pilot processing plant for testing and demonstrating different technologies leading to different products

The choice of a technology for using fish wastes relies on tests for obtaining accurate data to determine the technical and economic feasibility. It is proposed that a mobile technological platform is developed at pilot scale, with a series of machines allowing the testing of different technologies.

The machines could be installed in a shipping container allowing making it available in different places, countries and contexts. It would be a first tool for research and development programs and provide a location to demonstrate different fish waste utilization techniques to major producers of fish waste in the region. It is expected that this facility would provide data for research and a means to demonstrate fish waste utilizing technologies that can be adopted by the private sector.

4. Aquaculture feed (aquafeed) production projects from fish waste

Aquaculture development in the region offers market opportunities for the utilization of fish waste in aquaculture feed applications. Experimental studies are needed to set up adequate aquafeed.

CONCLUSION

The role of public policy was highlighted as a major step towards better fish waste utilization. There is a need for research and extension programs that target private sector development for sustained wholly encompassing fish waste utilization.

Several representatives declared that holding this seminar on “fish wastes” was welcomed as opportunities to act for lowering this spoilage of valuable resources are now offered, especially in an environment of increased fish catch and processing in many Pacific Island Countries and Territories.

APPENDIX 1: SEMINAR PROGRAM

SESSION 1: 8h30 – 10h00

Introduction: Seminar objectives and programme, Michel Blanc

1/ Seafood waste and possible utilizations: “Everything is good in fish!”

Jean-Pascal BERGE, IFREMER, France - 45 mn

2/ General framework to think about fish waste utilization: a multistep procedure

Catherine MARIOJOULS, AgroParisTech, France – 15 mn

3/ Fish waste production and utilization in the Pacific Islands – information gathered from pre-seminar questionnaires.

Michel BLANC

*** Coffee break ***

SESSION 2: 10h30 – 12h00

4/ Examples of fish waste processing and value adding: 1h30

- Small-scale unit: fish silage - Bio Agri NC , M. et Mme Gontard
- Large-scale unit: a cooperative creating different uses for byproducts: Copalis - JP. Bergé
- Feed for Aquaculture: Liet Chim and Tim Pickering
- Human feed – Fiji case: Tim Pickering
- Cannery waste – PAFCO: Bhan Singh, CEO
- Waste from fresh chilled tuna exports – Kiribati Fishing Venture: Li Chang Hong, GM

*** Lunch***

SESSION 3: 13h30 – 15h00

5/ Working groups: 1h30

Objective: putting together the knowledge of participants (even without detailed data) in order to build a complete snapshot of the situation starting with the availability of the raw material, matching this with demand for its possible uses and identifying strategies to overcome the constraints.

- a- State of fish waste availability in countries (waste forms, quantities, locations, current disposal) – RAW MATERIAL – PRODUCTION LED DRIVERS;
Moderators: Catherine Mariojouis and Lindsay Chapman
- b- State of local demand for fish byproducts derivatives (human food, animal feed, agriculture products e.g. fertilizers, fine chemicals) – MARKETS – DEMAND LED DRIVERS
Moderators: Jean Pascal Bergé, Liet Chim, Aliti Vunisea
- c- Identify constraints (15') to efficient and profitable utilization fish waste processing and formulate strategies to overcome constraints (15') – MATCHING PRODUCTION TO DEMAND - TECHNICAL SUPPORT
Moderators: Tim Pickering and Michel Blanc

*** Coffee break ***

SESSION 4: 15h30 – 16h0

6/ Plenary session:

- Synthesis of sub-workshops: 30 mn

Discussion on outcomes from working groups: 1h00

Brainstorming for follow-up actions (e.g. what are the priority issues and development needs to address immediately?)

Interest in a collaborative approach between enterprises to provide scale for improved utilization of fish waste?

APPENDIX 2: SEMINAR PARTICIPANTS FROM PICTS, PARTNER ORGANISATIONS AND SPC

Country representatives

Name	Organisation	Country
Ray Tulafono	Department of Marine and Wildlife Resources	American Samoa
Koroa Raumea	Ministry of Marine Resources	Cook Islands
Shalendra Singh	Ministry of Fisheries and Forests	Fiji
Josyane Couratier	Délégation de la France auprès de la CPS	France
Catherine Mariojouis	AgroParisTech	France
Mainui Tanetoa	Direction des Ressources Marines (DRM)	French Polynesia
Tim Adams	Nauru Fisheries and Marine Resources Authority	Nauru
Monte Depaune	Nauru Fisheries and Marine Resources Authority	Nauru
Abel Cica	Confédération des pêcheurs de NC	New Caledonia
Nathaniel Cornuet	Province Nord – Direction du Développement	New Caledonia
Régis Etaix-Bonnin	Service de la Marine Marchande et des Pêches Maritimes	New Caledonia
Bernard Fao	Province Sud – Direction du Développement Rural	New Caledonia
Régis Pidjot	Province Nord	New Caledonia
Christophe Puntonet	Province Nord	New Caledonia
David Orrukem	Bureau of Marine Resources	Palau
Weti Zozingao	Division of Fisheries & Marine Resources	Papua New Guinea
Joyce Samuelu Ah-Leong	Ministry of Agriculture and Fisheries	Samoa
James Teri	Ministry of Fisheries and Marine Resources	Solomon Islands
Augusto Fernandes	National Directorate of Fisheries and Aquaculture	Timor-Leste
Rui Pires	National Directorate Environment	Timor-Leste
Vilimo Fakalolo	Fisheries Division of Ministry of Agriculture & Food, Forests and Fisheries	Tonga
Samasoni Finikaso	Ministry of Communication, Transport and Fisheries	Tuvalu
Sompert Gereva	Department of Fisheries Fisheries Research & Aquaculture Division	Vanuatu
Graham Nimoho	Fisheries Department	Vanuatu
Bruno Mugneret	Service des Affaires Rurales et de la Pêche	Wallis and Futuna

Partner organisations

Name	Organisation	Country
Poroaiti Arokapiti	Arama & Associates	Cook Islands
Hardyson Lekolo Maenu'u	Artisanal Fishermen's Association of the Solomon Islands	Solomon Islands
Nicolas Guillemot	Fisheries and Marine Environments	New Caledonia
Nicole Franz	Food and Agriculture Organization of the United Nations (FAO)	Italy
Carlos Fuentesvilla	Food and Agriculture Organization of the United Nations (FAO)	Italy
Florence Poulain	Food and Agriculture Organization of the United Nations (FAO)	Italy
Masanami Izumi	Food and Agriculture Organization of the United Nations (FAO)	Samoa
Li Chang Hong	Golden Ocean Fish Limited	Fiji
Prasert Charoensuk Ravadee	International Collective in Support of Fishworkers (ICSF)	Thailand
Kazuo Udagawa	Japan International Cooperation Agency (JICA)	Suva
Jimmy Langley	KANGO Association	Kiribati
Catherine Kila	Madang Fisheries Cooperative Society	Papua New Guinea
Tupou Naitilima	Pacific Islands Tuna Industry Association	Tonga
Andrew Smith	The Nature Conservancy	Australia
Sikela Ulumutu	Tuvalu Fishermen's Association	Tuvalu
Helene Jacot des Combes	University of the South Pacific (USP)	Fiji
Eric Festa	Vanuatu Sport Fishing Association	Vanuatu
Graham Marsh	Wahoo Enterprises Ltd	Niue

The Secretariat of the Pacific Community

Name	Organisation	Country
Mike Batty	SPC	New Caledonia
Roy Benyon	SPC	New Caledonia
Patrick Delhayé	SPC	New Caledonia
Ian Bertram	SPC	New Caledonia
Colette Wabnitz	SPC	New Caledonia
Michel Blanc	SPC	New Caledonia
Michael Sharp	SPC	New Caledonia
Jonathan Manieva	SPC	New Caledonia
William Sokimi	SPC	New Caledonia
Thimoty Numilengi	SPC	New Caledonia
Aymeric Desurmont	SPC	New Caledonia

APPENDIX 3: KEY POINTS FROM SEMINAR PRESENTATIONS (SESSIONS 1 & 2)

SESSION 1

S1.P1: Seafood waste and possible utilizations: “Everything is good in fish!”

- 130 million tons of fish waste is produced on an annual basis from capture and aquaculture industries.
- What is wasted:
 - By-catch: 7-8 million tons is discarded every year
 - Waste-on-board: gills, guts, heads, fins
 - Home waste: fillets make up only 50% of total weight of fish
 - Industrial waste: off cuts, sorting, grading
- What we do with our waste:
 - Landfill (worst solution)
 - Mass transformation:
 - production of fish meal and fish oil
 - 5.6 million tons of fish meal (from 33 million tons of raw material) are produced each year (17% of total waste)
 - artisanal fish oil is made in Africa – simple processing
 - composting and production of silage (fertilizer)
 - fish sauce
 - conversion into hydrolysate
 - Sorting (to add more value):
 - cod liver oil; gelatine; omega 3; sports food/drinks; calcium; cosmetics; biotechnology; pharmaceuticals
- 100% of the biomass must be used.

S1.P2: General framework to think about fish waste utilisation: a multistep procedure

- Availability of fish by-products:
 - fresh finfish
 - fresh shellfish
 - fish canneries
 - fish smoking factories
 - fish frozen products
 - other fish processing units
 - Current use of by-products:
 - food on local markets
 - feed on local markets
 - processing into fish meal / fish oil / other
 - disposal on land or at sea (noting that this activity has costs associated with it)
 - Identifying potential uses for fish by-product requires consideration of:
 - markets
 - legislation
 - environmental aspects
 - Basic economics of by-product utilization:
 - profit maximization objective influencing the decision to add value
 - large scale is required to cover the investment costs (high capital cost/low per unit price)
 - Developing a strategy:
- } Who has the product?
} When is it available?
} Where is it available?

- conduct a survey of by-product availability
- conduct research and development
- identify stakeholders
- project planning, evaluation and comparison of options

S1.P3: Fish waste production and utilization in the Pacific Islands

- Context A:
 - remote islands and atolls
 - small and scattered production of waste
 - most waste is used (food/animal feed/fertilizer)
 - generally, no value adding opportunity
- Context B:
 - low income urban areas and islands that interact with industrial fisheries
 - medium-high volumes of waste that is geographically concentrated
 - potential for industrial use where economies of scale are achievable
- Context C:
 - high income urban centres / islands that interact with industrialized fisheries
 - medium to high volume of waste that is geographically concentrated
 - potential for industrial use where economies of scale are achievable
- Cost of the disposal of industrial waste in selected countries:
 - Fiji: USD 30/MT
 - New Caledonia: USD 100/MT
 - French Polynesia: USD 75/MT
 - Marshall Islands: USD 27f/MT (mainly fuel for ocean dumping)

S1.COMMENTS:

American Samoa has two canneries, which produce pet food and fish meal from their by-product with very little being dumped into the ocean. The small scale sector doesn't have a lot of waste, but the small amount is not processed and it is thought that majority is fed to pigs.

American Samoa requested advice on cost of developing fish silage at the artisanal level. In addition to this, it is viewed that the canneries can add more value to their by-product by raising protein value.

SESSION 2:

S2.P1: Small-scale unit: fish silage (BioAgri-NC).

- Small scale production unit.
- Source raw material for free from local tuna processing companies.
- Simple production that is reliant on availability of cheap raw materials.
- Heavy competition with inorganic imports.

Comments/questions:

- How much was the investment? Close to CFP 10 million. A new grinder costs CFP 2.5 to 3.5 million (depending on import duty).
- Consideration of operating cost (electricity) is required when planning what size grinder is required. Low power technology can be adapted to improve energy efficiency.
- Women play an important role in this business.
- Flies and rats are not a problem due to the addition of formic acid, which stabilizes the product.
- Would like to make sausage/fish cakes if legislation permitted.
- Can't use fish guts to replace the formic acid due to legislation that fish guts must be discarded at sea.

S2.P2: Large-scale unit: a cooperative creating different uses for by-products.

- Cooperative developed between two processors, which eventually grew to 50 members.
- Initially produced fish meal and fish oil.
- Quality control boosted profits.
- The co-op diversified into the nutritional market and began to separate all inputs.
- Now, the coop (company) has two target markets for their products:
 - i. Mass transformation
 - ii. Niche production

Comments/questions:

- Diversification achieved by R&D and investment that improved quality and achieved economies of scale.
- The niche market was created by this company, which took significant risk.

S2.P3: Feed for aquaculture

- Feed for aquaculture is provided in many forms:
 - as fresh fish
 - as fish meal and fish oil
 - as processing or other waste (trimmings, off cuts, offal)
 - FIFO (fish-in fish-out) ratio is used to determine the quantity of whole fish needed to produce sufficient quantity to achieve desired production levels for farmed fish based on predetermined feed conversion ratios (FCRs). Average of 650kg of fresh fish to produce 1MT of farmed fish was quoted.

Comments/questions:

- Above quoted FIFO average of 650kg seems optimistic.

S2.P4: Human feed – Fiji case

- Fish waste is not a waste, so it should be referred to as a by-product or a co-product.
- There are increasing levels of oceanic catch being landed and consumed domestically in the Pacific (PNA – no discards rule).
- Tuna frames (heads/skeleton) are sold in Suva (FJD 2.50), however there are presentation, cold chain and sanitary issues with this.
- Fish dust from canneries/frozen exporters is being sold as a pet food.
- “Soltfish” in the Solomon Islands are fish that do not meet cannery specification and are soaked in salt brine and stored on-board for sale to the local market.

Comments/questions:

- There is room for improvement in this area, especially in regards to meeting sanitary requirements for human consumed by-product.

S2.P5: Cannery waste – PAFCO

- Fish waste is used to make meal (poultry and fish feed – 55-58% protein content) and oil, with 90% of the meal going to Malaysia and 10% being sold locally (in Fiji).
- 18MT fish meal is produced each month.
- 800L fish oil is produced per day.
- The fish oil investment was FJD 0.7m (USD 0.38m), which was done in partnership with Solander Pacific.

S2.P6: Waste from fresh chilled tuna exports – Kiribati Fishing Venture (Golden Ocean)

- Fish sawdust and bones are given away to pig farmers, with the remainder going to landfill.
- There is interest in:
 - Silage production
 - Gelatine production
 - Fish meal and fish oil production
- For this to occur, there is a need for:
 - Technical advice
 - Investment assistance
 - Logistical support

APPENDIX 4: AVAILABILITY AND PRESENT USE OF FISH WASTE IN THE PACIFIC

COUNTRY	FISHERY TYPE		PROCESSING ACTIVITY	AMOUNT OF WASTE		CURRENT USE OF WASTE	CONTEXT		
	Artisanal / subsistence	Industrial		Artisanal / subsistence	Industrial		A	B	C
Group 1:									
American Samoa	Y		2 x canneries	No waste (by-products consumed in communities)	Large	<i>Fish market:</i> guts, skin, and bones – disposal / ocean. <i>Industrial:</i> Fish meal & oil, pet food (red meat), human food (heads) and some dumped at sea	X	X	
Cook Islands (North)	Y	longline landings in American Samoa canneries			No waste	Pig feed	X		
Cook Islands (South)	Y					Pig feed, fertilizers	X		
Fiji	Y	longline processing companies	1 x cannery	Est. 2500 MT per annum	Est. 5000 MT from longliners; and cannery?	<i>Artisanal:</i> Feed to pigs and dogs, probably guts dumped at sea <i>Longline:</i> Heads for local and home consumption; fish feed <i>Cannery:</i> Fish meal and oil	X	X	
Kiribati	Y		Project to establish an industrial processing facility	Est. 1000 MT		<i>Artisanal (bones, guts, skin):</i> bones mostly dumped at sea; guts and skins fed to pigs, with some used for fertilizer <i>Industrial:</i> to be determined	X	X	
Timor Leste	Y		Tuna export company, just starting	Very small		<i>Artisanal:</i> no waste, bones fed to pigs <i>Industrial:</i> to be determined	X	?	

Solomon Islands	Y	Transshipment discards sold on local market	Tuna cannery	Est. 600 MT	25,000 MT (based on 100,000 MT catch)	<i>Artisanal:</i> heads consumed and other waste fed to pigs and pets <i>Industrial:</i> Fish meal, large bones and other wastes dumped at sea; undersized fish sold on local market	X	X	
Vanuatu	Y	1 export company: sashimi grade, fresh whole tuna		Very small	Small	<i>Artisanal:</i> fed to pigs and pets <i>Industrial:</i> fins only (fish gutted at sea)	X	?	
Palau	Y	3 processing plants: exporting fresh tuna		Very small	Small	<i>Artisanal:</i> fed to pigs and pets <i>Industrial:</i> fins only	X	?	
Group 2:									
Niue	Y	N		Very small		100% used, silage didn't work	X		
Tonga	Y	?		Very small		100% used	X		
Papua New Guinea	Y	Y	Canneries; huge industrial development		Large (industrial fishing bycatch) 40% of waste (4 x 13000m MT?)	Fishmeal (4 sites) produced by canneries for export to SE Asia and Australia			X
Fiji (Tripacific)		Gilled and gutted 1000T	Loining		320 MT waste (per 800 MT fish)	Fishmeal? - some projects			X
Cook Islands	Y	<i>Note:</i> foreign license with condition on food security	2 loining plants			Currently dumped at sea (noting foreign license condition)			X

Micronesia	Y	4 plants before, 1 now			?	Buried in landfill Fishermen complaints prevent free gift of byproducts (byproduct competing with fishers on the market)		X	
Samoa (western)			2 processors			Pig and tilapia feed, or dumped at sea	X	X	
Tuvalu	Y	N		No waste		Pig feed. Bycatch is dumped into the lagoon (est. 20-40 MT)	X		
Group 3:									
Wallis	Y	N	N	Est. 50 MT		Dumped at sea and landfill		X	
French Polynesia (Tahiti)	Y	Processing plants for sale on local and international markets	Y		Est. 3000-4000 MT	Dumped at sea and landfill			X
French Polynesia	Pearl farming				Abundant (shell, mantle, digestive gland)	Dumped at sea, some muscle consumed locally			X
New Caledonia	Y	Y	3 plants	300 MT	1000 MT	Dumped landfill; small silage production; small amount used as feed for aquaculture (lobster)			X

APPENDIX 5: POTENTIAL USES OF FISH WASTE IN THE PACIFIC

Application	Working group 1	Working group 2	Working group 3
Agriculture	<ul style="list-style-type: none"> Fertilizers Organic “pesticides” (ants) Silage from wastes or discards 	<ul style="list-style-type: none"> Fish silage, but it needs to be marketed (to convince people) 	<ul style="list-style-type: none"> New Caledonia : under study and development, fish silage production as organic fertilizer; trials currently carried out on composting Some current trials in Tahiti to produce silage as organic fertilizer and composting
Feed	<ul style="list-style-type: none"> Aquaculture feed 	<ul style="list-style-type: none"> Fish meal & fish oil PNG has big potential for production of fish feed, but fish meal is worth more for export Use of ‘stick water’ from meal process: add to fishmeal or make hydrolysates 	<ul style="list-style-type: none"> Scheduled trials in NC for mud crab culture
Food (human)	<ul style="list-style-type: none"> Discards from tuna transshipment for human consumption Gelatin 	<ul style="list-style-type: none"> Tuna “stock” (Japanese cuisine) from fish dust 	
Pharmacy (vet.)		<ul style="list-style-type: none"> Collagen for micro-encapsulated medicines for farmed fish (improves palatability) 	
Other	<ul style="list-style-type: none"> Shells (jewelry), crustaceann shells 	<ul style="list-style-type: none"> Bycatch is undervalued → fish cakes, jerky, etc Bait for longliners or game-fishing 	

APPENDIX 6: CONSTRAINTS FOR THE DEVELOPMENT OF BY-PRODUCT USE

Application	Working group 1	Working group 2	Working group 3
Economics	<ul style="list-style-type: none"> • Initial investment (large scale needed) • Operational costs • Scale of operation for viability 	<ul style="list-style-type: none"> • Accurate costing and scale of production • Scale of investments needed is unknown 	<ul style="list-style-type: none"> • Accurate costing according technologies available. • Public subsidies may refrain private initiatives
Extension and development	<ul style="list-style-type: none"> • Technical expertise 	<ul style="list-style-type: none"> • Technical support 	<ul style="list-style-type: none"> • Technical expertise for production of products other than silage
Commercial	<ul style="list-style-type: none"> • Markets 	<ul style="list-style-type: none"> • Familiarity with the possible products 	<ul style="list-style-type: none"> • Lack of market information
Supply chain organization	<ul style="list-style-type: none"> • Companies networking necessary for the supply of wastes, collaboration • Need collaboration for small scale actors: limited volume, spread out; how to collect to usable amount? • For aquaculture farms: how to get fish waste? 	<ul style="list-style-type: none"> • Continuity of supply (to give continuity) 	<ul style="list-style-type: none"> • Scattered sources of waste (e.g. 400 km from Nouméa to Koumac)
Fisheries sector	<ul style="list-style-type: none"> i. How to keep on boats and land the guts from fish (for silage) & discarded fish 		
Facilities	<ul style="list-style-type: none"> ii. Lacking infrastructure for large scale treatment 		
Administrative organization			<ul style="list-style-type: none"> iii. Separate regional administrations, lack of global strategy
Public policies	<ul style="list-style-type: none"> iv. Public policy and legislation eg HACCP 		