Appendix D-4: Workshop Report

Development of Value-Added Products from the Artisanal Fisheries in Três Marias & Ibiai, MG, Brazil

December 3-21, 2005

WORLD FISHERIES TRUST
#204 – 1208 Wharf St.
Victoria, B.C. V8W 3B9

Contract: WFT-05-SP-1

Fishing boats wait out the rainy season along the Sâo Francisco River

Wm. Stephen Price, Ph.D.
Purnima Govindarajulu Price, Ph.D.

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A fishing boat motors up the swollen São Francisco River

Report prepared by

W. Stephen Price, B.Sc., M.Sc., PDPP, Ph.D.
Purnima Govindarajulu, M.Sc., Ph.D.
1742 Christmas Ave, Victoria, B.C., V8P 2X8
Tel: 250-383-6262 e-mail: wmsprice@shaw.ca

INTRODUCTION

This contract addresses the development of value-added fisheries products of the CIDA project, 'Peixes, Pessoas, e Água (PPA)'. This joint Brazilian-Canadian effort is to preserve the Sâo Francisco River fisheries through augmentation of the value of the fisheries products without increasing the catch or catch effort. Prior to the field trip a report reviewed the processing of fish, development of by-products such as fish leather, production of marketable compost, and production of smoked fish. In December 2005, Dr. Wm. Stephen Price and Dr. Purnima Govindarajulu Price worked as a consulting team to transfer appropriate technologies in these fields to the artisanal fisheries in Ibiai, Três Marias, GM Brazil. These workshops were headed by Dr. Yogi Carolsfeld, the Project Director, and his assistant Jason Emmert, who translated documents and presentations as well as facilitated logistics.

This report*, Development of Value-Added Products from the Artisanal Fisheries in Três Marias and Ibiai Area of Brazil,* describes the work and training carried out during this period (December 3rd to 21st, 2005) and the response of the communities to this technology.

The Três Marias introductory workshop, where Yogi and Stephen demonstrate the small Bradley smoker.

D-4: Executive Summary

Workshop Report

Development of Value-Added Products from the Artisanal Fisheries in Três Marias & Ibiai, MG, Brazil

The objectives of this contract were to increase the value of landed fish though improving handling and holding, to demonstrate the processes of fish smoking, fish drying and fish waste composting, and to evaluate fish leather tanning and market possibilities. WFT transferred the technology through the organization of workshops in the communities of Ibiai and Três Marias.

There were specific objectives:

- Review the current processing procedures and marketing of fish
- Evaluate the possibility of pinbone removal from filleted and value-added smoked or dried fish
- Demonstrate the procedures for hot-smoking fish, including the principles of preparation of fish for smoking and construction of small scale smokehouses
- Discuss health risks associated with improper storage
- Demonstrate some ways of packaging smoked fish, including vacuum-packaging
- Review the process of fish drying. Introduce the concept of a greenhouse solar dryer, and construct a working prototype using local materials
- Introduce the potential value of composting fish waste, as well as initiate a trial backyard composting system
- Review the hazards of chromium tanning of fish leather and explore the potential for marketing fish leather products globally and locally

Technology Transfer Activities

1. The **WFT Workshop Team** delivered two 3-day workshops in Três Marias and Ibiai. The Team, made up of Yogi Carolsfeld, Stephen Price, Purnima Govindarajulu, and Jason Emmert, gave formal presentations to interested fishermen and artisanal individuals from this Matto Grosso (MG) area. Stephen gave the presentations that covered the above topics, and Yogi provided simultaneous translation into Portuguese. Jason, who is fluent in Portuguese, helped immensely by explaining answers to questions and helping with logistics. Purnima recorded photographically, on paper and on computer, the activities, PowerPoint images, names, and questions. Participants, 10 in Ibiai and 18 in Três Marias, were given name tags and registered in a notebook.
2. **PowerPoint presentations** were used to introduce the objectives of value-added products in both workshops. The current market status of these products in Canada and internationally were reviewed, in addition to the techniques used and the potential for local development. This was followed by a question/answer period.

3. **Samples of smoked fish** from Canada were displayed during the presentations**.** To introduce the taste and concept of smoked fish, samples from St. Jean's BC Cannery and Smokehouse and a sockeye salmon from the Tsarlip First Nations were served to the participants.
4. **Fish Smoking.** This included the filleting of the fish and the removing of all bones, the preparation of marinades, and the smoking of the fish. Five species of local fish were cleaned and filleted by the WFT Team and participants. Using local spices, two generic marinades were made up, one sweet and the other savoury. While the fish was marinating, there was a demonstration of the working of the Bradley Smoker (Model BTISI, Bradley Technologies Canada Inc.) with its automated smoke pellet feeder. Following the presentation, the marinated fish were air-dried and placed in the smoker, with participants recording smoking temperature and duration of smoking at each temperature. At this point a simpler alternate smoker source was demonstrated so that the participants realized that an automated unit was not necessary and that the actual smoking box could be made from any enclosure - such as a 55-gallon drum. The participants also evaluated alternative smoke and heat sources using local materials. In Ibiai, largely due to the enthusiasm and skill of Josémar Alves, a steel drum was converted to a smoker.
5. **Refreshments** and food were provided midway through the workshops by the Brazilian partners. This helped greatly in developing group cohesion and rapport with the WFY Team. It facilitated the transfer of information on a more informal level. Participants were soon involved in all aspects of the workshop and demonstrations.
6. **Dried fish** as a potential value-added product was discussed. However, the continuous rainy weather did not permit carrying out the actual procedure for drying fish. A prototype solar dryer was constructed using local materials in Três Marias.
7. **Product evaluation.** During the final workshops, participants evaluated the smoked fish. This was done by a blind taste test comparison to the Canadian products. Two batches of fish were smoked at each location and the final products were evaluated for texture, presentation and taste. The local fish Curimba (*Prochilodus spp.)* and Dourado (*Pellona castelnaeana*) were selected at both locations as the best smoked fish.
8. **Packaging and marketing of** smoked and dried fish was discussed and the advantages and techniques of vacuum-packaging discussed in terms of health safety concerns and marketing advantages. Vacuum-packing of the smoked fish was successfully demonstrated using a small domestic unit (FoodSaver™-Vac300). Closure of the workshops was a discussion of the home smoker inventions and of marketing possibilities of this new product.
9. **Fish waste composting** principles and commercial operations were described, and a small sample of commercial compost from British Columbia was exhibited. A trial demonstration was initiated using a simple local plastic barrel. Sawdust and woodchips were collected from local sources and the composter was started with the waste from the fish that had been bought and cleaned for the fish smoking. A thermometer was inserted into the compost and the temperature monitored over the

days of the workshop. This lead to discussion about optimal conditions for 0developing compost and the benefits of compost, although the final product could not be evaluated due to the long duration required for the composting procedure.

10. **Health and environmental hazards** from using chromium tanning methods were reviewed and safe-handling procedures discussed.

11. **Fish leather products** made by the Três Marias participants were evaluated. The leather products manufactured by the group were photographed and a CD of these images produced to assist them in marketing. Pricing, potential sales outlets and marketing plans were discussed This group of artisans, who were primarily women from an artisan craft society, had taken part in an earlier workshop given by Centro Tecnológico do Couro.

RECOMMENDATIONS

The workshop period was short, but the response of the participants very positive. They were receptive to the information and rose to the challenge of assimilating these new technologies into their livelihoods. The recommendations are specific to each of the five areas of focus and are detailed in each section of the report. The following is a brief summary of the principal recommendations in the five areas.

A. Fish Processing and Marketing

The presentation of fish is important in developing a market for a higher-priced food commodity, which requires consistent processing and often packaging.

Handling

1. Icing of fish with smaller pieces of crushed ice would ensure that the fish on display remain frozen longer and that the chances of bruising be reduced. Use of the ice chipper is recommended.

2. Hygiene concerns. The body cavities of fish should be carefully cleaned, especially for long-term freezer storage. Consideration was given to using smooth surfaced plastic lined Styrofoam coolers. These coolers are more expensive, but are more durable, have a bottom drain to remove contaminated water and can be cleaned more easily. The fish processing tables should be regularly sterilized using cut limes or bleach.

3. Filleted and frozen fish could be vacuum-packed at the Três Marias market should it be considered as a market for traveling customers, as well as for distribution to regional retail stores.

Packaging

4. The convenience and low cost of vacuum-packaging is especially appealing to a product such as fish that tends to spoil easily, is odorous, and is difficult for the consumer to transport.
   - Introduce participants to locally available vacuum-sealing units
   - Reinforce the need for refrigerating/freezing the vacuum-sealed fish until consumption.
   - Introduce vacuum-smoked fish to the local market at a festival, or public event

B. Fish Smoking

This value-added procedure seems to hold the most promise for success. All participants unanimously enjoyed the product. It has the convenient market appeal of a "fast food snack" and a unique dish for special events. In addition, it is a process that can start with a very small investment and grow into a large-scale operation.

1. Josémar Alves should be visited by WFT personnel in Ibiai to see if he has been able to develop the barrel smoker to the point that it functions predictably in terms of smoke concentration and heat control
2. A "home smoker" system should be perfected and followed up by a simple instruction manual or kit that can be made available to individual fisher families
3. Various marinades and local wood should be tested to develop a unique taste and smoke flavour
4. A market plan should be developed and instigated

C. Solar Greenhouse Fish/Food Dryer

The WFT prototype unit should be tested during dry weather for variables such as initial and final moisture content of fish, drying time, and drying rate. Should the unit prove successful in the testing, it could have several uses:

1. Expansion of a variety of dried products into fruit, beef, spices, and even medical plants
2. Development of a pre-fabricated ready-to-use kit and training/building manual

D. Composting Fish Waste

Producing compost from fish waste as a value-added product has potential, but needs further testing. The compost unit also needs further trials. The use of fish compost on local domestic vegetable gardens is an option. Once the system is established, further markets could be investigated.

E. Fish Leather – Health Concerns and Marketing

The health hazards of tanning fish skins using the highly toxic chromium tanning agents, especially Chromium(VI), should be reviewed. Issues of safe handling and discarding of waste to a central facility should be considered if tanning is to be continued. There has been a shift in the tanning industry to use only Chromium(III) and, if this is the case, there is less of a health and environmental issue.

The cost effective production of small leather items is limited by the capabilities of the small artisanal group using only hand sewing. Access to a professional or industrial sewing machine with capability for sewing leather and handling decorative sewing patterns may increase production capacity and efficiency. Currently the products are being sold at local craft shows. The potential for selling specialty souvenirs to the sport-fishing tourists and to tourists visiting highway rest stops should be explored. The potential for developing a larger regional market and for export to the international handicraft market could be assessed once efficient production capacity has been established.

Appendix D-4: Section A

Fish Processing and Marketing

Três Marias highway fish market – December 2005

PROCESSING AND MARKETING

Although this field trip did not take place during the open fishing season, some species of fish were still landed (Photos 1, 2). Most of the fish species, however, are stockpiled in freezers to be sold over the rainy closed season. These fish are sold directly by individuals along roadsides, in markets, and in urban grocery stores.

1. Ibiai fisherman and morning catch

2. Fishing in a swollen Sao Francisco River

Belo Horizonte city market. In Belo Horizonte we visited two meat markets that also sold fish. These fish were either heavily salted Portuguese salt cod, most likely from the Grand Banks off Canada, or previously frozen Brazilian fish. The smaller Brazilian ones - Bran, Quinha, Cacalinha, Sardinha, and Telaphia - were sold ungutted and whole, while the larger, such as *Dorado*, were marketed gutted and beheaded, but whole.

Três Marias roadside fish market. Because of the closed season, it was not possible to personally observe the handling of fish prior to arrival at the local fish market. However, we did purchase fish from roadside fish vendors at the Três Marias fish market. There we observed the later stages of processing - the holding facilities and the cleaning of the fish for customers.

At this time of year (December) the frozen and stockpiled fish are removed from large freezers on demand each day. They are immediately washed in ice water in a wheelbarrow. Assortments are then packed in ice and held by fisherman in their own large Styrofoam™ coolers. The customers select their fish individually. The fish is then weighed and sold, whole or cleaned, and transported wrapped in paper or plastic.

A large commercial ice-making unit is part of the fish market where ice and new Styrofoam™ coolers are available for sale to the fishermen. There is also a very sturdy and functional ice chipper, although it appears that the fishermen purchase the ice in large blocks and break it into smaller chunks to ice their fish simply by hitting it with a hardwood club. Consequently there are large chunks - up to 10 cm in dimension - that no doubt bruise the fish.

PINBONES REMOVAL

The possibility of developing a market for filleted fish, or smoked fish, with all bones removed was considered. Pinbones are generally removed by automated machines in large processing plants. However, in smaller operations, such as the St. Jean's Cannery and Smokehouse in B.C., manual removal using pliers is economically viable and would apply to the artisanal fisheries along the Sâo Francisco River. We were reasonably successful in removing pinbones form the larger fish we purchased at the Três Marias fish market. However, the bones of the smaller fish species are very fine, with a diameter generally less then the pliers' friction ridges. This made it difficult and time consuming to grasp them firmly enough to pull them out of the flesh. Because of this, the process was abandoned.

However, after the fish were smoked, the proximal ends of the pinbones generally extended from the dried flesh by 1-3 mm and were no longer firmly attached to the muscle connective tissue. These bones could then be easily and quickly removed.

RECOMMENDATIONS

Fish is an extremely perishable food, and in the tropics spoilage happens particularly quickly due to rapid growth of naturally occurring bacteria. Spoilage begins as soon as the fish dies. Processing should therefore be done quickly to prevent the growth of spoilage bacteria. Fish is a low acid food and is therefore very susceptible to the growth of food poisoning bacteria. The fishermen and vendors in this cool season were generally keeping their fish for sale in coolers and packed in ice, and there was no visible or olfactory indication that any had started to spoil. However, it is believed that there could be improvement in this procedure, especially in the warmer seasons, without undue financial hardship to the fishermen.

1. In the larger commercial operations in Belo Horizonte, it is suspected that the length of time that the fish are in the display cases where icing is inconsistent results in the fish being in less than optimal condition. However, market pressure apparently does not demand the higher quality as yet.
2. For the roadside fish market of Três Marias, the ice used in the Styrofoam™ coolers should be chipped rather than broken into the small chunks with a wooden mallet. In December the ambient temperature was not particularly warm (high 15-20°C). During the summer dry season, it is believed that chunks of ice would be inadequate for uniform and safe cooling of the fish flesh. The ice chipper, if used, would help to alleviate this problem.
3. The body cavities of fish should be more carefully cleaned if the fish have extended travel, or storage, time, before reaching the consumer.
4. There is concern that the wooden tables used for the dressing of the fish were not kept up to hygienic standards required for safe distribution of products. Regular washing with fresh lime juice (or cut limes) or bleach would reduce chance of bacterial contamination becoming an issue.
5. Fish seemed to be over packed relative to ice in the storage Styrofoam™ coolers.

6. There is some concern that the older Styrofoam™ coolers could be vectors for pathogenic bacteria as the surfaces were often pitted and suspiciously discoloured on the inner surfaces.
7. The use of power or automated pinboners was deemed inappropriate due to their high cost and very probable ineffectiveness.
8. Pinbone removal from smoked fish fillets before packaging with simple needle-nosed pliers is quick and would add to the value of the product, especially if packaged.
9. Once the smoking and packaging has been sorted out, local markets, especially in the highway rest-stop restaurants should be approached for potential outlets for this new local product. As in British Columbia, these outlets could also carry fresh frozen fillets or whole fish.

PHOTOGRAPHS OF FISH MARKETING AND PROCESSING

2. Fishermen selling fish along highway

3. Small fish in a Belo Horizonte city market

4. Três Marias fisherman's highway market

5. WFT team discussion with fisherman

6. Ice maker and storage freezer

7. Fisherman loading block ice from freezer

8. Ice chipper beside freezer

9. Block of ice and frozen fish removed from freezer

10. Fish are rinsed and washed before placing in the vendor display boxes

11. Ice and fish are placed individually in display boxes

12. Manual breaking of ice with mallet

13. Fish are stacked with minimal ice

14. Relatively large ice chunks.

15. Small and large fish are gutted

16. Frozen Dorado & Tucunare

17. Tubanare

18. Filleting of fish at TM market

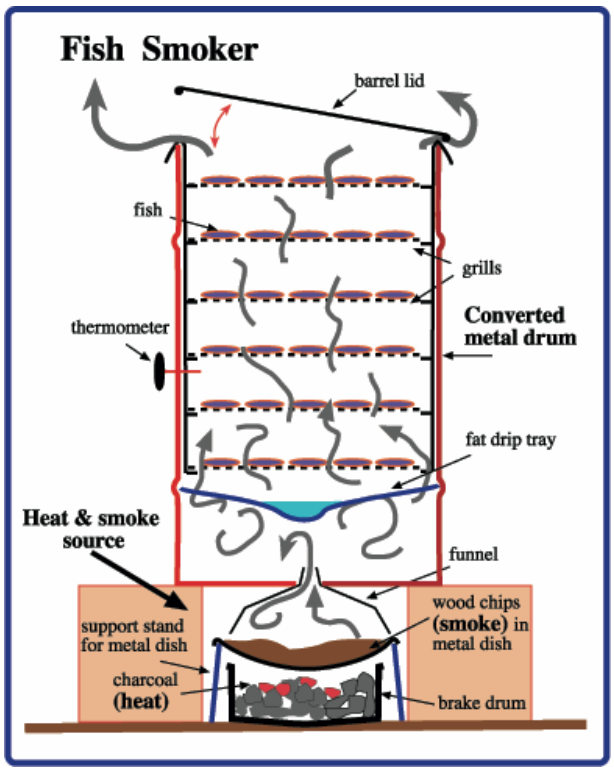
19. Cutting stakes from Surubim

20. Pliers used for pinbone removal.

21. Pinboning is difficult on small fish.

Appendix D-4: Section B

Fish Smoking



Creative adaptation of technology - inspiration and success

FISH SMOKING

The objective of this section was to introduce the taste of smoked fish, a novel product, to the fishing communities of Ibiai and Três Marias. We included presentations of the methodologies for the construction of fish smokers and the production of smoked fish. As with the other projects, the workshop started with a Power Point presentation followed by prototype production and testing.

TECHNOLOGY TRANSFER ACTIVITIES

The presentations initially described 'cold' and 'hot' smoking and health concerns. During these talks, samples of 'cold' and 'hot' smoked salmon from Canada's west coast, were given to the participants to taste. Both the regular smoked and the candied fish were considered delicious. The participants were particularly impressed by both the presentation and the taste of the First Nation's sockeye salmon. It immediately became the standard of perfection they aspired to for their smoked products.

We then discussed the issues of marketing this new product, high-financial return per weight, and the need for attractive packaging. We used the packaging of the St. Jean's Cannery Nanaimo, British Columbia to exemplify excellence and variety of presentation.

A. SMOKED FISH PREPARATION

- Fish were purchased from the market in Três Marias. They included both high and lower value small fish, including Surubim (R$13/kg), Dourado (R$10/kg), Tucanare (R$7/kg),Corimba (R$7/kg), Majeen (R$6/kg), Piau (R$3/kg).
- The fish were cleaned and fillet by the participants.
- The participants recorded all the procedures in a logbook. The importance of maintaining meticulous records in the development of a consistent product was emphasized.
- Based on quantities from recipes used in Canada (pre-trip report), the participants made two marinades, one savoury and the other sweet.

Marinade – Savoury		Marinade – Sweet	
Water	2 l	Water	2 l
Rock salt	250 ml	Brown sugar	250 ml
Limes	2	Rock salt (no iodine)	250 ml
Cloves	24	Honey	5 ml
Bay leaves	1.5	Pepper	To taste
Brown sugar	150 ml		
Onion (chopped)	1 (cooking)		
Soy Sauce	1 ml		
Garlic salt	5 ml		

- The fish were marinated for 1- 2 hours and then rinsed and air dried until a pellicle was formed.
- The fish were then smoked in the small semi-commercial Canadian made Bradley smoker. The Bradley smoker uses electricity for heating and the temperature is easily

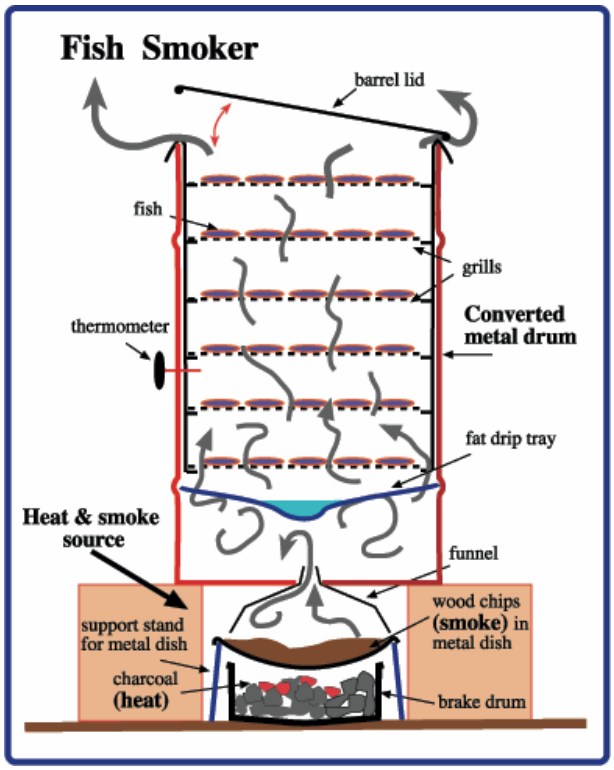
controlled using a thermostat dial. The smoke is created using patented wood chip biscuits made of cherry wood. Throughout the whole process these wood chip biscuits are fed on to a heating element automatically.

- The fish were smoked for approximately 18 hours. The temperature was slowly ramped up from about 40°C to about 100°C for two hours. It was then ramped down for the full development of the smoked flavour. This ensured that all potentially harmful bacteria were killed and the final product was safe to eat.

B. CONSTRUCTION OF A PROTOTYPE FISH SMOKER

Once the principle of cooking and smoke flavouring was demonstrated, we explained, using a series of photographs, how any smoke or heating source could be used instead of the automated Bradley system. We explained that the actual form of a "smokehouse" is dependant on the amount of fish to be smoked at one time, the availability of local materials (pre-trip report), and imagination. The following are the steps taken during the workshop in Ibiai.

- The participants collaborated to make a functional smoker as drawn in Figure 1 below.



- Josémar Alves provided a 55-gallon steel drum, which served as the oven/smoke house. The metal drum had a clamp lid, which could be closed completely for retention of smoke and heat or left ajar to moderate the smoke and heat. In the bottom of the barrel a central 5-10 cm diameter hole was cut. This allowed the smoke to enter through a funnel.
- After some discussion, charcoal was chosen as the best source of heat, and a truck brake drum was used to safely contain the charcoal while it burned.

- A metal rack was configured to hold a heavy metal pan above the charcoal. This pan held the wood chip and sawdust which when heated by the charcoal below generated the smoke. A large inverted funnel was inserted into the base of the drum to divert the smoke into the barrel. We used wood chips from the Mirenjeeba tree, collected from a local woodworking shop.
- Three building blocks were then placed around the charcoal brazier to support the metal drum about 30 cm above the charcoal fire.
- A drip dish was fashioned out of aluminium foil and suspended just above the bottom of the drum. This was made strong enough to hold a small amount of water. This water not only prevented any of the fish drippings from igniting and smoking, but also maintained moisture in the smoking chamber. This prevented the surface of the smoked fish from drying out completely.
- A system of tiered racks were made and suspended from the lip of the drum. The fish were placed on these racks at different heights. As well, some of the fish were suspended vertically from hooks to assess if this provided better all around smoking of the filets.
- A spike oven thermometer was inserted into the side of the metal drum to monitor the smoker temperature. Participants followed the time and modulated the temperature as shown in Figure 2.

C. EVALUATION OF THE SMOKED FISH

After the successful smoking of the local fish, participants in both Ibiai and Três Marias were eager to explore market acceptance and market value of this product. We therefore set up a blind taste test demonstration using both the samples brought from Canada and the smoked fish produced during the workshop.

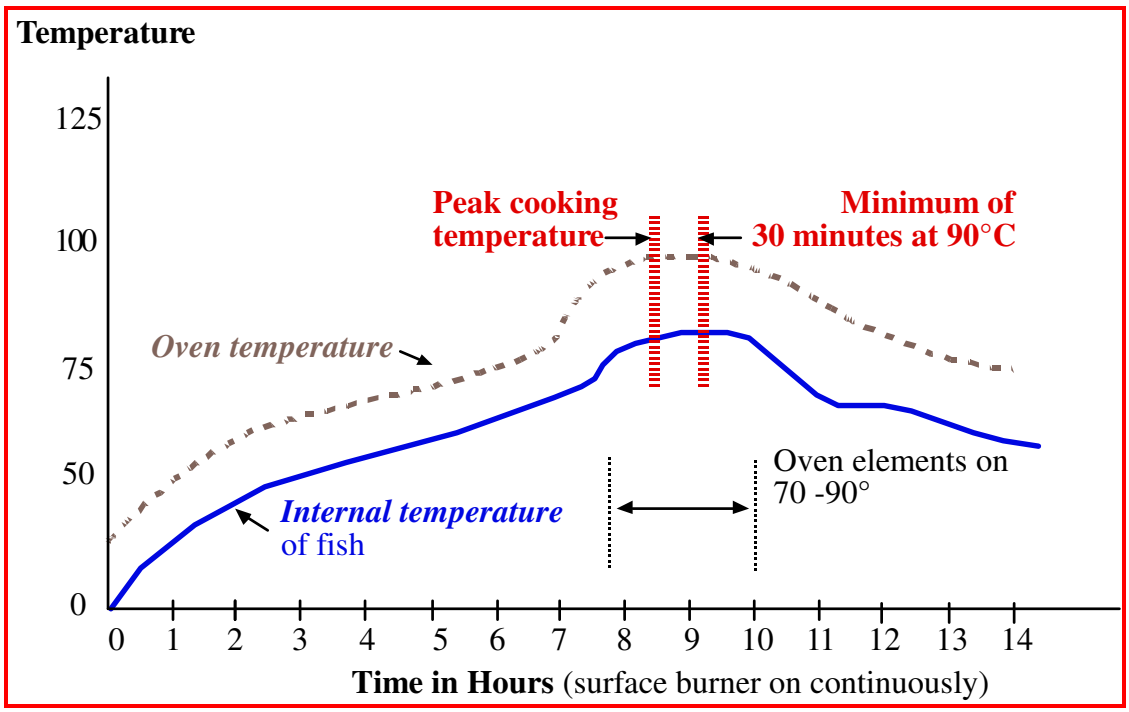
The different species and flavours of the smoked fish were placed individually on plates with only numbers identifying them. The participants were then asked to sample the fish and assess flavour in terms of both taste (salty, too salty, not sweet enough etc), and texture (too soft, too dry, burnt etc). Their evaluations were marked onto large poster size sheets of paper and summarized. This was followed by a discussion about how the product could be improved.

The results of this taste test are subjective but the pattern of likes and dislikes was the same at both Ibiai and Três Marias. The relative ranking was interesting: 1st Canadian sockeye; 2nd Curimba, 3rd Dourado, 4th Tucanaré and Surubim. Piau was disliked at both locations. At both locations the savoury marinade was preferred to the sweet.

The smoked fish that was prepared at the workshop was also tested on a random selection of individuals from the community in Três Marias. Although a little dubious at first, all of the people who tasted a sample found the taste intriguing and quite delicious.

This testing procedure not only showed what flavours were potentially most successful, but also gave the participants a model to develop their own specific flavour and texture prior to marketing their new product.

SMOKER (OVEN) TEMPERATURES AND TIME FOR *HOT*-SMOKING



Hour	Temperature Range	
1	35-45°C	≈
2	55-60°C	≈
3	60-65°C	≈
4	65-75°C	≈
5	75-80°C	≈
6	80-85°C	≈
7	80-85°C	≈
8	80-95°C	≈
9*	95-100°C	≈
10*	100-95°C	≈
11	90-85°C	≈
12	85-75°C	≈
13	75-10°C	≈
14	70-65°C	≈
15*	65-75°C	≤
16*	65-75°C	≤
17*	65-75°C	≤
18*	65-75°C	≤
19*	65-75°C	≤
20*	65-75°C	≤

Figure 2. Graph of the temperatures and time required for safe hot-smoking of fish.
*Absolute minimum of 90°C for 30 minutes to kill potential pathogens
* Optional length of time varies for fish texture and flavour

D. PACKAGING

The taste test was followed by a discussion about packaging this new product for marketing and sale. Some of the smoked samples that were brought down from Canada by the WFT team had been sealed in packages that did not require refrigeration. This packaging is done using a process that is similar to canning: heating both the product and packaging to very high temperatures using a commercial canning/sealing unit (retort vacuum-sealing and/or nitrogen flushing). Machines used in this process are very expensive and not appropriate for small-scale operations. However, it was important to distinguish between this 'hot' vacuum-sealing and the more commonly used domestic vacuum-sealing where the products need to be refrigerated or frozen for long term storage.

The WFT consulting team had brought with them from Canada a small FoodSaver (Model V300) vacuum-sealer designed for home use so that the workshop smoked fish could be packaged. The major drawback was that the vacuum bags for this FoodSaver unit are specific, very costly (Re $3.00 per bag), and not available in Brazil. This prompted a search for similar vacuum-sealers available in Brazil. As a temporary solution, through the ingenuity of the participants and the WFT team, a technique was devised that could seal locally available plastic bags. To do this a small strip of plastic mosquito netting was first partially inserted into the open bag before the vacuum and heat was applied.

The vacuum-packaging seemed to be a potentially ideal format for local and regional distribution to run trials on marketing this new food item. To assess market acceptance of the smoked fish and packaging, trial marketing should be attempted at the local market, in roadside rest stops and stores, and at festivals.

We stressed that the smoked fish that are vacuum-packaged this way need to be refrigerated for short-term storage and frozen for long-term storage. Vacuum-packaging with the domestic FoodSaver unit is done at room temperature, and although it may slow down bacterial growth due to lack of oxygen, it does not kill the bacteria. Of particular health concern is the bacteria *Clostridium botulinum,* which causes botulism. This bacterium is anaerobic, and, when freed from competition with aerobic spoilage bacteria, can multiply to lethal high levels.

RECOMMENDATIONS

The workshop participants enthusiastically accepted the smoked fish value-added products. However, further follow-up is necessary to ensure successful product production and marketing.

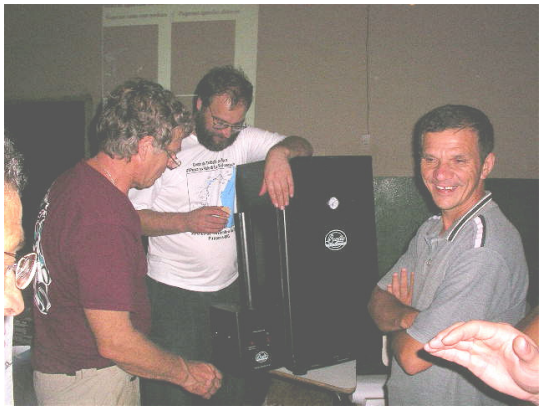
1. In Ibiai, Josémar Alves should be visited by WFT personnel to see if he has been able to develop the drum smoker to the point that it functions predictably in terms of smoke concentration and heat control. Should the drum smoker prove successful, WFT could develop this technology effectively by either developing a pre-fabricated ready to use kit, and/or a training/building manual.

Smoker - Kit Materials
1. One 55 gallon metal drum with a band clamp lid and a 5-10 cm hole in the bottom and a 8 mm hole drilled into the side for the thermometer
2. Simple wooden handle attached to lid
3. Spike metal thermometer
4. Truck brake drum to hold charcoal used as the heat source
5. A shallow metal bowl and 15 cm “rebar” stand to hold it above the charcoal
6. A funnel to direct the smoke from the pan into the drum.
7. Drip tray that can hold some water inside the drum.
8. A removable set of racks that can be easily cleaned

2. In Três Marias, Vincente took charge of the Bradley smoker and plans to set it up in the CAPI facilities. A follow-up workshop may be necessary to build a prototype drum smoker as in Ibiai and to get further participation from the fishing community. Consideration should be given to alternative “smokers”, such as adapting the home oven or even commercially available barbeques.
3. It is important to develop a distinctive smoked fish product that is consistent in flavour and texture and that is unique to the region. Different marinades should be made and tested for local acceptance, and various types of hardwoods should be tried for different flavours. Records must be kept of details of species of fish used, marinade recipes, kind of wood chips used, marination and smoking duration and temperature, until a consistent and unique product is created. Once developed these procedures could become trade secrets.
4. A workshop may be convened to introduce participants to the locally available vacuum-sealing units. At this time, health concerns of proper storage of smoked fish vacuum-sealed using a domestic unit should be strongly emphasized. All such vacuum-sealed smoked fish need to be refrigerated (maximum 2 - 5 days), or frozen until they are sold. An information notice should be included with the package so that the consumers understand the need for refrigeration or freezing of the product if not immediately consumed.
5. Local health regulations for the production of food-for-sale should be reviewed.
6. Once a consistent product has been developed, a marketing strategy needs to be outlined including the development of attractive packaging, pricing structure and venues for sale.

PHOTOGRAPHS OF FISH SMOKING

1. Power Point presentations at the start of the workshop.



2. Demonstration of the principles of a commercial Bradley Smoker

3. Sampling some of Canadian West Coast smoked fish

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

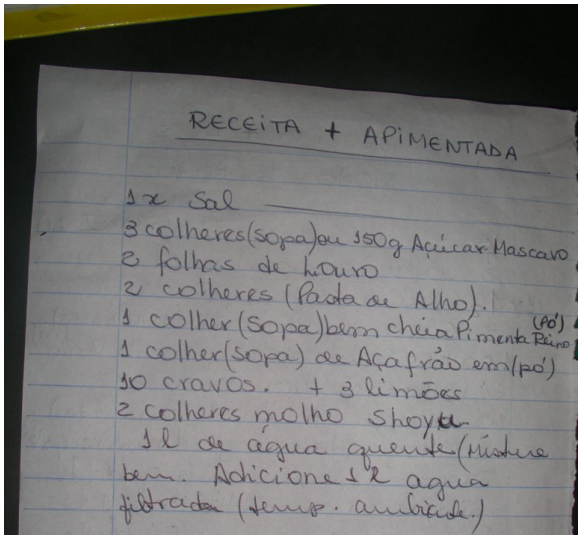
4. Canadian First Nations smoked sockeye salmon still on smoking sticks

5. Participants clean and fillet local fish

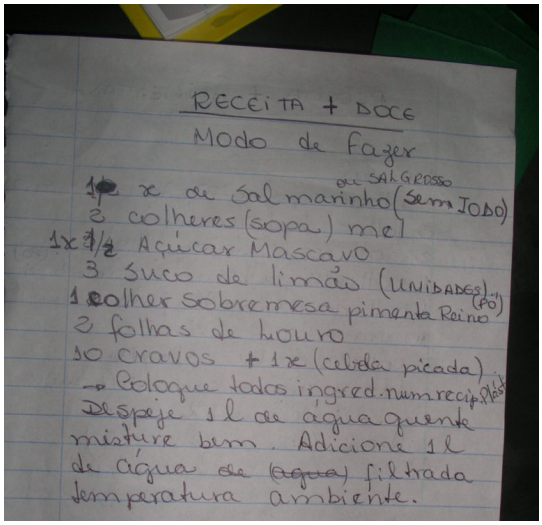
6. Participants all prepare marinades

7. Participants keep accurate records of ingredients used in marinade preparation

8. The fish are soaked in the marinades for 1 to 2 hours in a refrigerator



9. The recipe for savoury marinade



10. The recipe for sweet marinade

11. The fish slices are removed from the marinade and rinsed to remove whole spices adhering to the surface

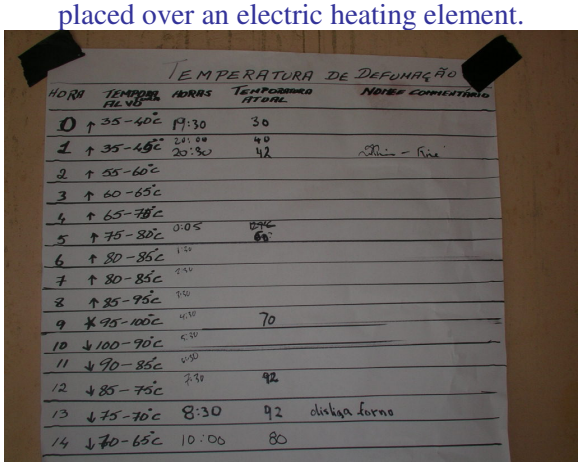
12. The fish slices are air dried for about an hour. The fan kept flies away and helped in the development of a pellicle

13. The fish are then loaded into the semi automated Bradley smoker that the WFT team had taken down from Canada

14. The Bradley smoker is fitted with an automatic smoke generator, which uses customized woodchip pellets.

15. The automated smoke generator was adapted to local conditions using a pan of woodchips placed over an electric heating element.

16. The smoke generated was piped into the Bradley smoker unit using an air duct.

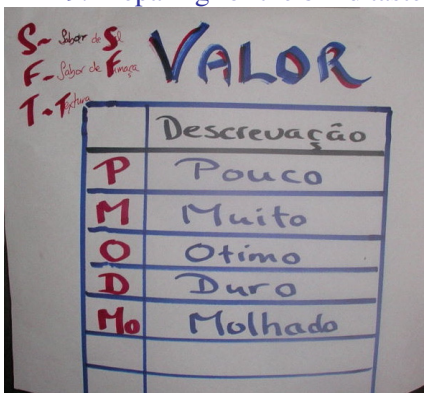


17. A chart specifying the cooking temperatures and duration at each temperature was posted

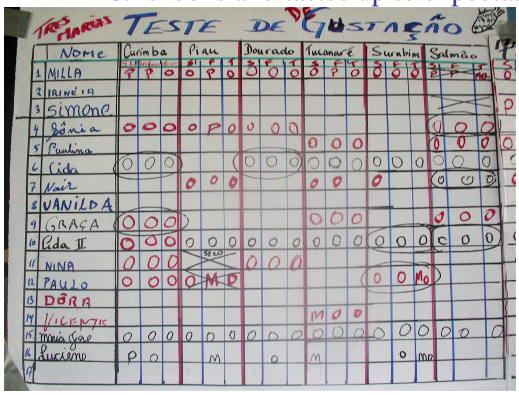
18. The participants were all involved in maintaining and recording these cooking temperatures.

19. Preparing for the blind taste testing

20. It looks and tastes up to expectation



21. Taste descriptors



22. Taste test poster board

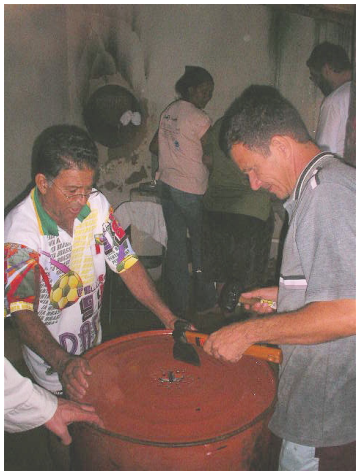
23. Reaction of participants to success

24. Bia proclaiming the aphrodisiac power of smoked fish

25. The smoked fish got a thumbs-up when taste-tested at the local fish market.

26. The product was met with some scepticism in town but enthusiastically accepted once the people tasted the product.

PROTOTYPE CONSTRUCTION OF DRUM FISH SMOKER

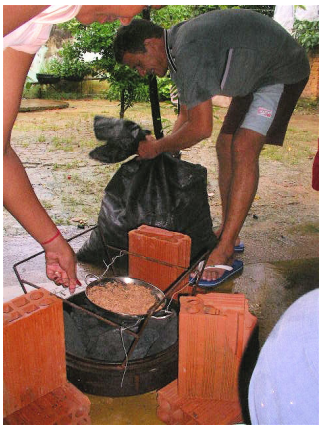


27. Josémar Alves implements his plans to transform an steel drum into a smoker

28. Installation of the Bradley thermometer

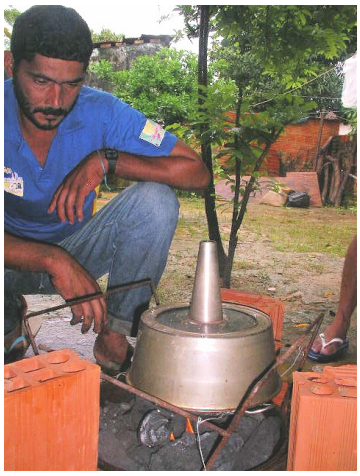
29. Jose tries a hot-plate element for generating smoke

30. An alternative smoke source



31. A bag of wood mango woodchips are placed in smoke dish

32. Dish of specific hardwood ships and sawdust gives the flavour.



33. Marcâo ponders a smoke funnel made from an angle cake tin

34. A truck wheel rim is used to hold the charcoal to generate heat and smoke

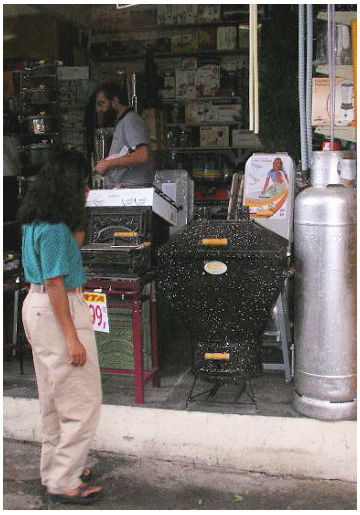
35. Marcâo hanging fillets vertically in smoker

36. A drip tray is fashioned from aluminium foil below the fish

37. Reducing the heat in the smoker

39. A successful smoking batch

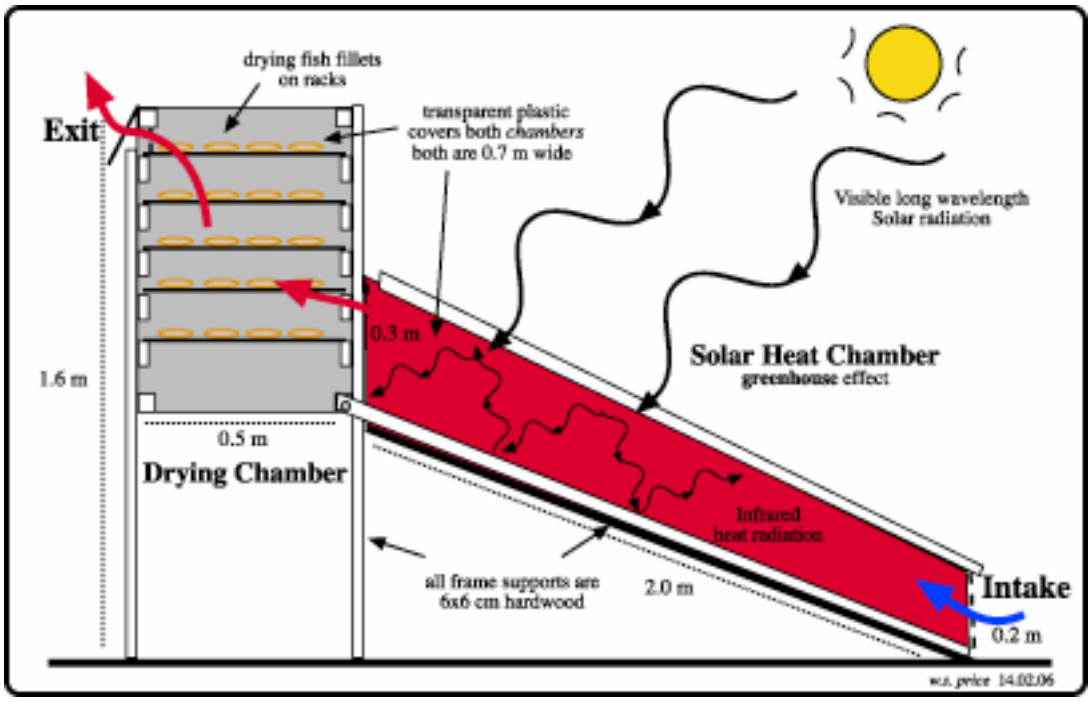
39. Can these ovens be transformed into smoke ovens?



40. Can commercially available barbeques be used as smokers?

Appendix D-4: Section C

Dried Fish
Solar Greenhouse Fish/Food Dryer



Solar greenhouse fish/food dryer concept introduced to Três Marias

DRIED FISH - SOLAR GREENHOUSE FISH/FOOD DRYERS

The objective of this section is to assess current methods of drying fish, as well as to review the concept of solar dryers that have been developed and adapted in various parts of the world. Historically, drying has been used as a means of preserving fish in times of plenty for use or sale during times of limited fish availability. However, dried and salted fish are also considered a delicacy in some parts of the world and thus the potential exists for developing value-added dried fish products with this low capital investment. Using direct sunlight for drying fish is an ancient technology and certainly not a novel concept to the fishermen in Brazil.

Drying fish is a common method of preserving fish because drying takes less energy pound per pound than freezing, especially in areas where ambient temperatures and solar radiation are high. Dried food products have the advantage of greatly improving the preservation of a food item without adding preservatives, resulting in a product that requires little or no refrigeration to store, transport, or display. Thus, in some situations, drying is considered as an alternative to freezing, and is suitable for small communities where electricity is unavailable, costly, or interrupted. The Três Marias region has a stable supply of hydroelectric power, but there are significant capital costs in keeping fish frozen, recurring costs of daily electrical consumption, and a need for refrigerated transportation to reach regional markets. Conversely, the low cost of solar drying could provide an economic advantage to artisanal fishers by allowing them to sell fish throughout the year, especially during closed fishing seasons. The relative advantage of these two methods would depend to a large extent on the market demand for frozen or dried fish.

Although the global market for dried fish products is expanding, it still only accounts for about 5% of the world's fishery exports (FAO source). In Brazil, imported dried salt cod (*bacalhau*) is very highly priced in the markets in Belo Horizonte. The price per kilogram of bacalhau ranged from R$29.90 to R$79.90 depending on the source and quality. There already seems to be a well-developed market and cultural acceptance for salted dried fish as a value-added product.

TECHNOLOGY TRANSFER ACTIVITIES

A. CONCEPT INTRODUCTION

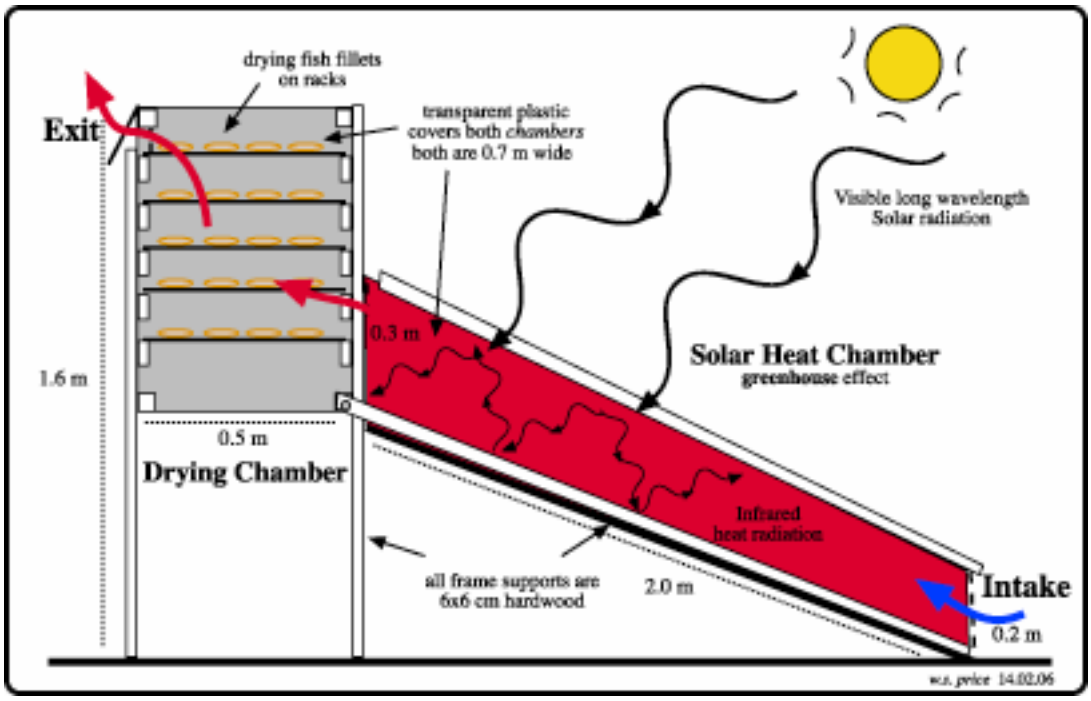
The potential for developing dried fish as a value-added product and the design of a 'greenhouse' solar dryer were discussed during the presentations in the workshops. Since the site visit was during the rainy season, direct observation and demonstration of a dryer was not feasible. We did, however, find a collapsed fish drying rack beside the fish market. It was well designed, approximately 2.5 m x 3 m, and elevated 1.25 m off the ground to allow for air movement and protection of the fish against rats, cats and dogs. It was also completely enclosed by insect netting. We were told that small fish, or split large fish, dry within 2-3 days during the dry season. However, since the concept of using a greenhouse chamber to generate hot dry air for drying fish or food products had apparently not been considered, we fabricated a prototype for demonstration purposes.

Because of the low technology and costs, fish are commercially dried using the greenhouse effect in many countries. A greenhouse solar dryer consist of two parts: a heat collection chamber and a drying chamber. Air is heated in the heat collection

chamber where a black-coated surface increases heat absorption and the transparent plastic cover prevents the escape of heat radiation. The hot air from this collection chamber then moves by simple convection upwards. It is directed into a drying chamber where it moves across the food surfaces and then out through the exit vent on top of the drying chamber. Since the capacity to hold moisture greatly increases when air is heated, the warmer air quickly removes up to 80 - 90% of the moisture from the fish.

B. PROTOTYPE SOLAR DRYER CONSTRUCTION

For the WFT prototype, all materials and tools were purchased locally in a Três Marias hardware store. Due to the hardness of the wood, an electric drill was used to pre-drill the fastening screw holes to prevent the wood from splitting. The other useful tool was a heavy-duty stapler to attach the plastic sheeting and mosquito netting. Design and construction took approximately two days due to drying times of the paint and time needed to collect materials. However, with the design plans and kit (see below), one person should be able to build a unit in approximately 7 hours.



Solar Dryer - Kit Materials	Tools
1. 3.5 m of polyester clear plastic 2. 10 pieces (6 x 6 cm); 6 (2 m), and 4 (3 m), hardwood 3. 2 x 1 m sheet of galvanized tin 4. 0.25 m piece of mosquito netting 5. 2 dozen screws for fastening 6. 1 litre of primer and black metal paint 7. Material for shelves	1. Handsaw 2. Electric drill and 2 (3 mm, 8 mm) bits 3. Hand workshop stapler 4. Paint brush

- Solar Heat Collector (approx. 3 m long x 0.7 m wide x 0.25 m tall). This section is an inclined rectangular box with a black metal floor to absorb heat. Above this is the greenhouse frame covered in clear plastic.
- Drying Chamber (approx. 0.5 m long x 0.7 m wide x 0.7m tall; volume, 0.3 m^3). This is the solar "oven". It has four potential rack rails, upon which we placed thin bamboo rack sticks. Although designed primarily for fish drying, this dryer has the potential to be used for other produce such as dried fruit. We estimate this unit has a capacity of 40-50 kg fresh fish per batch, which should be suitable for adaptation by fisherman-processor families in the area.

  These two units are simply held together by two 6 mm 8 cm long bolts.

Unfortunately, the weather was overcast and very wet (rainy season). Power, airflow, and drying temperatures could not be tested.

The solar heat collector should preferably be covered with UV-stabilized polyethylene plastic with a transpassivity of 92% for visible radiation (in general, the transparent plastic can be used for one or two years before being damaged by UV radiation and mechanical stress). No specifications were available for the plastic used.

RECOMMENDATIONS

A. SOLAR DRYING TECHNOLOGY

The WFT prototype unit should be tested during dry weather to find out the effectiveness of the solar collector and drying unit. Variables should be tested: initial moisture content, final moisture content, drying time, and drying rate.

Considerations in testing a solar dryer

1. Fish should dry within 2 days, but trials should be run as to types of fish (oil content), and thickness of the fillets. Time and moisture content should be compared between the passive and greenhouse drying systems
2. Drying time will also depend on sun, air movement, humidity, quantity, and type of food
3. Once the drying process has started it should not be interrupted
4. Direct sunlight is not recommended
5. Temperature ranges of (37.2°C - 71.2°C) will effectively kill bacteria and inactivate enzymes, although temperatures around (43.2°C) are recommended for solar dryers
6. Too much heat, especially early in the process, will prevent complete drying
7. Food should be cut into thin slices, less than 1.25 cm thick and spread out on trays to allow free air movement
8. Fish should be rotate 180 degrees daily for uniform drying
9. Drying tray materials to consider are stainless steel, wood, or bamboo slats

Should the unit prove successful in the testing, WFT should consider the development of expanding the variety of dried products to fruit, beef, spices, and even medical plants. It is possible that the WFT could transfer this technology effectively if it were to develop a pre-fabricated ready-to-use kit and a training/building manual. A kit would contain the items listed in the table below:

B. General Market Guidelines

1. Develop and produce dried fish, fruit, and vegetable prototype products utilizing fish, especially those that are underutilized
2. Make prototype target products in sufficient quantities to adequately carry out marketing testing
3. Process the target products with attention paid to moisture, salt content, and seasoning levels so that the end product has the greatest chance of success
4. Introduce product prototype and subsequent market analysis to determine viability
5. Analyse foreign dried fish products
6. Measure consumer willingness to try new products
7. Estimate market size and value
8. Carry out a cost-benefit analysis and compare the dried fish with other products – local and foreign

PHOTOGRAPHS OF WFT SOLAR GREENHOUSE FISH/FOOD DRYER

1. Collapsed Três Marias fish drying rack. Fish were dried in 2-3 days

2. High price of bacalhau (R$79,90 in Bela Horizonte market

3. Attaching sheet metal to base frame of solar chamber

4. Painting primer on metal floor of solar chamber

5. Painting metal floor black to absorb heat

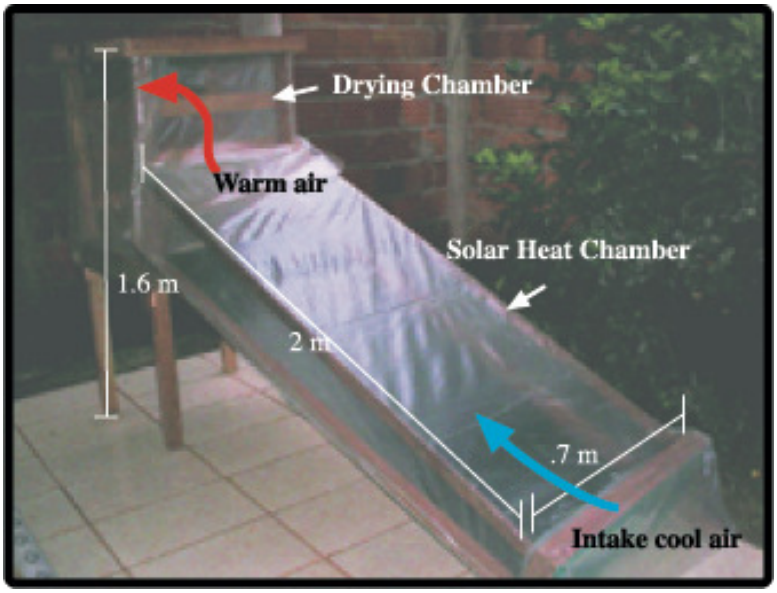
6. Assembly of drying racks. A “door” access is simply a weighted plastic sheet

7. Drying racks can be made of stainless steel or a wood that can be hygienically cleaned

8. The air intake is protected by mosquito netting from entry of insects

9. Toggle closures of dryer 'door'

10. Only two bolts connect the solar chamber and the drying chamber



11. Finished prototype WFT Solar Greenhouse Dryer

Appendix D-4: Section D

Composting Fish Waste

José Alves adding fish and kitchen waste to the WFT compost barrel
in back yard of his father's (Josémar) home in Ibiai

COMPOSTING OF FISH WASTE

The primary objective of this section of the workshop was to assess the feasibility of producing high-value compost from fish waste as well as evaluate the potential market for the sale of this compost to generate additional income. The first step in this process was to assess the amount of fish waste that is generated. During the December workshop period the WFT team purchased the most common fish that was being caught and sold in the markets: Corimba, Dourado, Tucanaré, and Piau. The fish were gutted and filleted primarily by participants. In observing the end-products, it became very apparent that there is very little fish waste. The participants clearly indicated that the heads and backbone would be saved and added to soup. They also indicated that some of the other waste would be fed to chickens and pigs, although too much would cause the meat to taste fishy. Therefore, there is not a large amount of fish waste generated by individual families, and there are no apparent home problems with disposal of fish waste.

At the roadside fish market of Três Marias, the fish are generally sold whole. However, the fisherman will clean the fish and cut them into stakes or fillets, for no extra charge. The collection of fish entrails, blood, and bones in a central collection bin at these fish markets could generate sufficient fish waste to produce compost in quantities large enough for sale as a value-added product.

Technology Transfer Activities

Given the limited amount of fish waste available, only small 'back-yard' compost bins were set up at Ibiai and at Trés Marias as demonstration models. According to a compost specialist (Victoria Compost Education Centre), a minimum of a cubic meter is required for composting animal protein. However, there was not sufficient time to build the recommended 1 m^3, aerated, vermin resistant compost bin. Consequently we initiated trials composting using two commonly available large 150-litre plastic barrels. These barrels are convenient, low cost (Re$25), easy to clean, vermin resistant, humidity controllable, waterproof, small enough to be easily turned, and non-obtrusive in a backyard. They are in principle very similar to the rotational composters available on the North American market. The compost trials were initiated using the fish waste generated from the fish-smoking section of the workshop. To ensure rapid and thorough composting, fish waste needs to be chopped up into small (2 cm) pieces. We considered macerators and wood chippers available in markets in Belo Horizonte, but given the small quantities of fish waste, hand chopping was just as quick and effective, and certainly it was an easy way to keep things hygienic.

The other ingredient needed for compost is a cheap and plentiful source of carbon. In both the communities of Ibiai and Três Marias, wood shavings and sawdust are readily available for no cost from local woodworking businesses. Given that these demonstration composters would be used mainly in individual homes, the addition of other kitchen waste was discussed. We believe the small size of these composters does not permit the composting of cooked food and meat but all other fruit and vegetable waste can be accommodated. The addition of too much animal protein would lead to unpleasant odours, in addition to attracting rats.

Composting of fish takes 6 to 12 weeks depending on ambient heat, total volume compost bin, ratio of fish waste to carbon (as discussed in pre-trip report). The

maintenance of optimum temperature, oxygen and humidity was discussed. There is concern that the 120 litre barrels were not large enough in volume for the bacteria to generate enough heat to compost the animal waste quickly. However, even within two days temperature within the compost bin was increasing rapidly. The success of these composting trials remains to be assessed.

RECOMMENDATIONS

1. Monitor the inner temperature and pH of the compost workshop trials
2. Analyze the final compost results in terms of texture, smell, and nitrogen content
3. In Ibiai, evaluate the acceptance of compost for home gardens
4. In Trés Marias, WFT should follow-up about the success of their composting trial and the suitability of using this compost in grounds maintenance
5. If there is sufficient interest, test alternate compost designs such as a rotating steel drum design or a $1m^3$ concrete bunker system for larger operations
6. Evaluate potential use of compost in municipal garden/vegetable programmes

PHOTOGRAPHS OF THE FISH COMPOSTING TRIALS

1. Plastic barrel used for composting

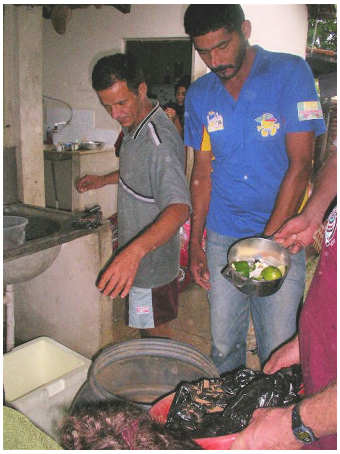
2. Commercial plastic barrel composters.

3. Garden chipper in Belo Horizonte being considered as a fish waste nascerator

4. Fisherman, Vincente chopping up fish heads and fins with a simple knife and mallet

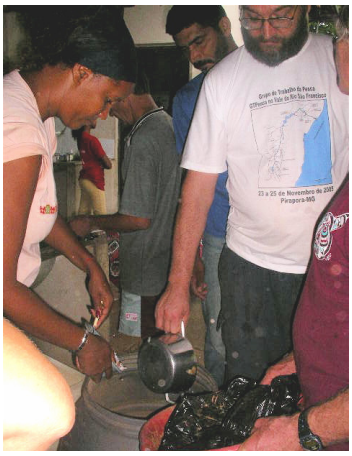
5. Local source of high content and surface area (carbon) sawdust from local wood working shop (at hardware store).

6. Sawdust on bottom of barrel (20-25 cm deep). Varieties pf sawdust must be checked for suitability for bacterial growth



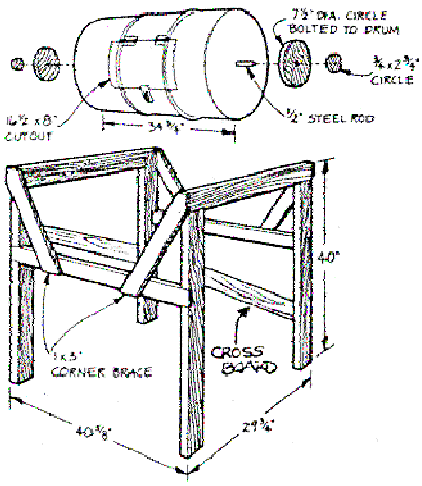
7. Addition of kitchen vegetable and fruit waste

8. Layered compost material, a 15-20 cm layer of sawdust was added next



9. Adding water to ensure adequate moisture content (40%)

10. Within two days the inner temperature increased 6°C



11. Steel drum rotating compost bin

12. Bins for composting fish mortalities in a 2-stage system at Buhl, Idaho.

Appendix D-4: Section E

Fish Leather
Health Concerns and Marketing

Fish (Tilapia) leather items made by the Três Marias participants

FISH LEATHER – HEALTH CONCERNS AND MARKETING

Both workshops in Ibiai and Três Marias were given a brief PP presentation overview of the wide range of fish leather products that are now being marketed in several countries around the world. The difference between the traditional natural tanning agents and the more modern, faster chromium tanning processes was reviewed. In particular, some time was spent explaining the hazards of using the highly toxic chromium-tanning agents, especially Chromium(VI).

The Ibiai workshop participants seemed to have little interest in and no intention of pursuing the idea of making fish leather and products. However, almost all of the participants at the Três Marias workshop had already been given a workshop on tanning and basic product fabrication using all manual tools. They had brought with them many of their crafted items and were very enthusiastic about developing their skills and a marketing strategy.

Once explained, the issue of health risks of exposure to and subsequent proper disposal of chromium tanning liquors was obviously of great concern to all. It appeared that proper handling and storage of these dyes had not yet been strictly adhered to. Unfortunately, because the chromium based tanning is much quicker and the dyes so much brighter than natural tannins and dyes, there was little interest in pursuing this less hazardous technology. It was noted that so far only one participant had done all the tanning of the skins.

Despite this somewhat negative introduction to fish leather potential, after the presentations, the participants proudly showed the various purses, wallets, and wall hangings they had designed and sewn using primarily tilapia skins (Photos above). The participants had priced their crafts according to the amount of time that it had taken them to hand-sew or macramé them. Wallets ranged wound R$20, while the purses ranged up to R$90. The workshop discussed marketing potential of the products.

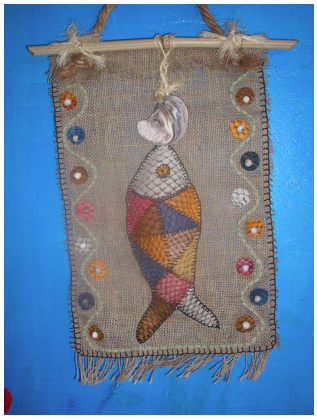
RECOMMENDATIONS

The market for small leather purses, wall hangings, and key fobs, is relatively small as it is an extremely competitive market that is often multinational. Distribution of these products is global. Wages can be much lower than in Brazil. In addition, most of the items sold internationally are machine-sewn with more detail and precision. For these reasons is suggested that competing for this market is unrealistic. Producing haute culture items -women's shoes, handbags, and bikinis - that sell for hundreds of US dollars is a completely different business venture. Again we feel that to enter this market is beyond the capabilities of small artisanal groups using only hand sewing. However, they may be able to sell a few of their items at local craft shows, and possibly mementos for passing tourists, but it will not become a large source of added value to the fishery.

N.B. Brazil has an extremely competitive leather-marketing infrastructure, but we feel that entering this market is beyond the scope of the WFT project. Apparently, a progressive local aquaculturalist has spent considerable money and time trying to develop a market for fish leather. Despite a product that appears competitive, he has not succeeded in marketing it (Pers. Com, Alison Mcnaughton, 2006).

PHOTOGRAPHS OF FISH LEATHER PRODUCTS

1. Display handicraft items made from fish leather at the Três Marias workshop



2. Wallets of various sizes and colours

3. Vincente, the tanner, and his wallets

4. Vanilda and one of her attractive handbags

5. Paulina and her handcrafts