

EMPOWERING FISHERWOMEN IN PAPUA NEW GUINEA BY INTRODUCING INNOVATIVE TECHNOLOGY (FAO THIAROYE TECHNOLOGY-FTT)

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The Food and Agriculture Organization (FAO) has introduced the FAO-Thiaroye Technology (FTT) in Papua New Guinea to address the challenges of post-harvest losses within the fisheries sector and to provide better market opportunities. To determine the financial and economic viability, FAO established two demonstration sites and conducted a Financial and Economic Analysis (FEA) to compare traditional smoking practices with the FTT smoking technique. The results showed that the incremental benefit is 59% IRR, and the analysis also identified the sensitive parameters of the business. Moreover, FTT empowers fish operators by solving cold chain, market access, and transport constraints in remote areas. It boosts fish production and quality, reduces losses, and extends shelf life by 5-6 months.



Credit: EU-STREIT PNG Programme

The FAO-Thiaroye Technology is an innovative technology that empowers fisherwomen to own and operate profitable fish businesses

Papua New Guinea, an archipelago nation, is deeply influenced by its surrounding Pacific waters, rivers, and lakes, shaping the livelihood of its communities. Approximately 30% of the population resides along the 10 000 km coastline, heavily reliant on marine fishing for sustenance and livelihood. Additionally, the country hosts over 5 000 freshwater lakes, supporting communities in floodplains and extensive water bodies.

Fishing and aquatic life are vital for a significant part of the populace, impacting the nation's culinary practices, cultural traditions, and social dynamics. Fish, a dietary staple, plays a key role in providing protein and ensuring food security for both marine and freshwater communities.

Despite their abundant aquatic resources, these communities face significant challenges in effectively using the resources to enhance their well-being. These challenges, such as limited market access and

underdeveloped post-harvest processing, prevent communities and the nation from benefiting from the vast fisheries resources.

Poor road infrastructure is also a major bottleneck, hindering the transport of goods from rural areas to markets. This particularly affects fishing communities as fresh fish spoil quickly, thus making it difficult to reach distant markets. Moreover, with most households engaged in fishing, local markets become oversaturated, especially during peak fishing seasons. The combination of poor roads, scarce vehicles, and high transport costs impede intermediaries from collecting fish, often leaving communities with unsold catches.

The above challenges are compounded by the fact that only 13% of the country's population has access to electricity, severely impacting fishing communities. The absence of reliable refrigeration and ice-making

facilities, which need a reliable energy supply, hampers the preservation of fresh fish, crucial for consistent market supply.

In Papua New Guinea, fish drying offers a viable preservation method for seafood, yet its widespread adoption is hindered by several factors. High humidity, frequent overcast conditions, and persistent rainfall challenge the wider adoption and effectiveness of this practice.

Despite the potential benefits, the country has seen limited technological advancement in enhancing artisanal fish smoking quality. Fishing communities often lack the necessary resources and know-how for efficient fish-drying techniques. Typically, rudimentary methods are used, such as steel meshes balanced on sticks or stones.

Traditional open-fire smoking methods, prevalent in the country, primarily use firewood from untouched forests or coastal mangroves, leading to environmental degradation. These methods are not only energy-inefficient and time-consuming but also emit harmful pollutants, posing health risks. Moreover, these labour-intensive practices disproportionately burden women, who are central to fish drying processes, often resulting in poorly-smoked fish unsuitable for commercial sale.

Innovative technology

FAO, as part of the European Union-funded STREIT PNG Programme, introduced the FAO-Thiaroye Technology (FTT) in Papua New Guinea. This innovative technology aims to revolutionize fish processing, quality, safety, and marketability, ultimately enhancing the income of fishers and other stakeholders in the fisheries value chain.

FTT represents a significant advancement, addressing the inefficiencies of traditional fish smoking and drying methods. Developed collaboratively by FAO and Senegal's National Training Center for Fisheries and Aquaculture Technicians (CNFPA), FTT targets enhancing food safety, efficiency, and working conditions in small-scale fish smoking and drying operations across developing nations.

Adopted in over 20 countries across Africa, Asia, and Latin America, FTT has proven its value in enhancing fish product quality, safety, and marketability, contributing to sustainable fisheries development.

FTT, introduced in the 1990s, has undergone iterative evolution driven by experiential insights. This evolution emphasizes reduced construction timelines and enhanced component functionality and usability, adapting to diverse social, cultural and economic contexts (Nyemah, 2021)¹. In Papua New Guinea, the FTT implemented in the country comprises a masonry-made kiln, housing four metal components: (i) Lid: used to cover the top of the FTT kiln; (ii) Smoking racks: used to place fish for smoking; (iii) Fat collection tray: serves to collect fat/fish oil while the fish is being cooked and preventing direct flames; and (iv) Furnace: holds firewood that generates heat for cooking fish (Mindjimba, 2020²; Rotawewa, 2023³). Figures 1 – 5 depict these various components.

¹ Nyemah, J. N. (2021). *The FAO-Thiaroye Processing Technique (FTT)*. Apia, Samoa: FAO.

² Mindjimba, K. (2020). *Study on the profitability of fish smoking with FTT-Thiaroye kilns in Côte d'Ivoire* (FAO Fisheries and Aquaculture Circular). Rome, Italy: FAO.

³ Rotawewa, B. (2023). *Training on construction of FAO-Thiaroye Processing Techniques (FTT) fish smoking unit*. Wewak, Papua New Guinea: FAO (unpublished training module).

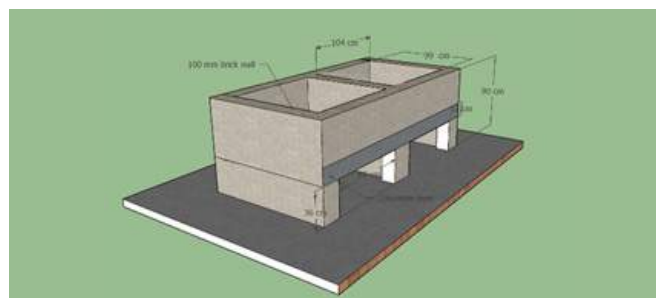


Figure 1- FTT Kiln design

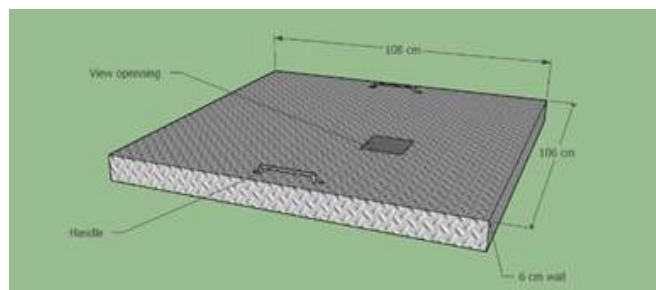


Figure 2 - Lid

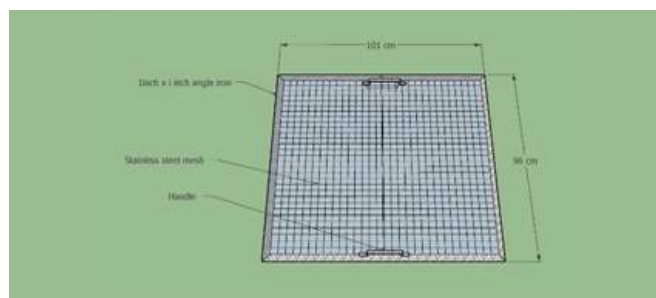


Figure 3 - Metal Racks

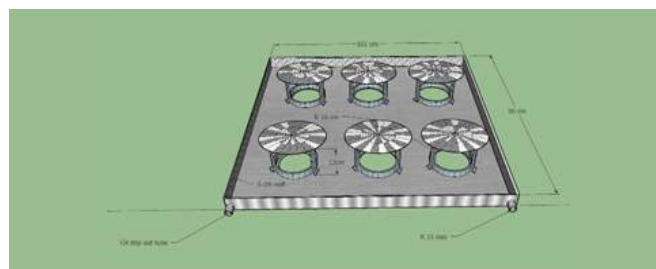


Figure 4 - Fat Collection Tray

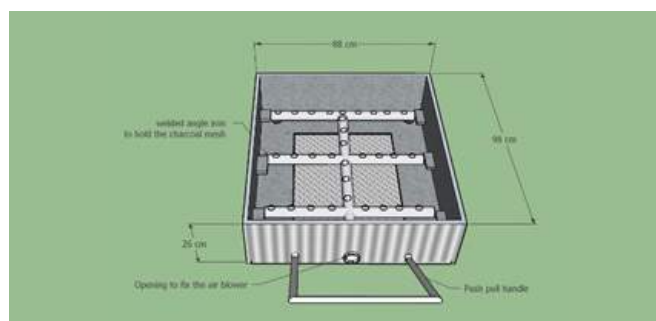


Figure 5 - Furnace

To ensure the sustainability of FTT in Papua New Guinea, FAO trained and empowered national entrepreneurs to build and run FTT facilities on their own. This involved engaging experts, fish processors, and community leaders throughout the process, encompassing construction, operation, maintenance, and quality control of fish products. Furthermore, FAO developed adaptable training modules on FTT, catering to the varied needs of different beneficiaries.



The final product in the Papua New Guinea site: the FTT kiln, variations of which have been constructed in small-scale fish smoking and drying operations across over 20 developing nations

This approach has made FTT a replicable technology across Papua New Guinea. Collaborating with local stakeholders, FAO identified optimal sites for FTT facilities and strategized their construction and management. For instance, under the EU-STREIT PNG Programme, FAO, with partner consultation, planned 30 FTT sites in the Sepik region, demonstrating its commitment to widespread and sustainable implementation.

Financial and economic analysis

FAO has set up two FTT sites in Papua New Guinea's Sepik region, one in the marine-rich Karawap Community, Wewak, near the Bismarck Sea; and another in Angoram, by the fish-abundant Sepik River.

A Financial-Economic Analysis (FEA) was conducted to determine the economic feasibility of these sites. FEA, a method for evaluating financial and economic factors of a program or investment, employs cost-benefit analysis to gauge the viability of FTT businesses by contrasting scenarios with and without the FTT, considering intervention costs and outreach.

A 10-year cash flow analysis was conducted to calculate the Net Present Value (NPV) and Internal Rate of Return (IRR) of the FTT business (Table 1). In this analysis, the FAO is considered as a stakeholder because it is contributing resources, including capital investment and other related costs, to the business. Data for this analysis were gathered from beneficiary farmers, local input suppliers, and stakeholders involved in FTT implementation.

Table 1. FTT operating parameters and financial model

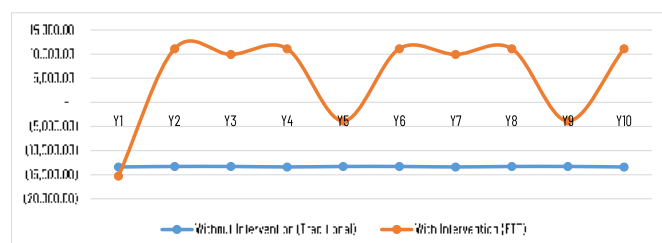
Description	Unit of measurement	Without FTT	With FTT	Remarks
Capital investment for the establishment of FTT	Kina	0	15,000	4 years of economic life
Processing capacity per cycle	Kg	15	50	
Smoking cycle (per year)	No	104	104	Twice a week
Wastage	%	10%	5%	Proper smoking method reduces the amount of wastage
Fresh to smoked ratio	%	33%	33%	The average weight of the fish is reduced to one-third after smoking.
Prices				
Price of fresh fish	Kina per kg	7.0	7.0	
Price of smoked fish	Kina per kg	30.0	35.0	The price increases by 5 Kina because of the improved quality.
Cost per cycle				
Labour	Kina	42	84	More labour is needed to manage the FTT business as the fish processing volume has grown by nearly four times. Comparatively, the labour decreases per unit.
Transportation	Kina	15	25	The transportation cost is directly proportional to the quantity.
Other Inputs (firewood, cleaning)	Kina	110	77	FTT is an efficient way of smoking fish, as it saves 30% of firewood.
Revenue				
Average annual revenue	Kina	13 900	55 916	
Average production costs	Kina	21 268	42 588	FTT doubles the processing cost; however, at the same time, FTT smokes four times more in quantity
Average annual net profit	Kina	-ve	10 000	
Profitability				
Net Present Value (NPV)	Kina	-ve	24 050	
Internal Rate of Return (IRR)	%	-ve	59.28%	

Findings

The implementation of FTT is projected to increase fish processing volumes from 15 kg to 50 kg per batch, reduce wastage from 10% to 5%, and raise prices by 5 kina per kg due to improved fish quality. The intervention is expected to yield an annual net profit of PGK 10 000 for FTT, with an incremental NPV of PGK 24 050 and an IRR of 59.28%.

The cash flow reveals initial negative cash flow in the first year due to upfront investments, turning positive mid-year (Figure 6). However, in the fifth and ninth years, cash flow drops to zero, correlating with the FTT's four-year economic life and the need for replacements.

Figure 6. Annual cash flow of FTT



The analysis incorporates labour costs, which are traditionally performed as household labour, primarily by women, in fish smoking. However, when using the Programme-supported FTT to process 50 kg of fish, extra labour is required.

Sensitivity analysis

To gain a deeper understanding of the model's profitability, a sensitivity analysis was conducted to assess the impact of variations. The sensitivity analysis showed that the model's Internal Rate of Return (IRR) is stable against smoked fish price changes but sensitive to fresh fish price fluctuations. A significant rise in fresh fish price (above PGK 8 per kg) combined with a smoked fish price drop to PGK 32.5 per kg could jeopardize financial viability. Green cells indicate a viable IRR range, while yellow cells suggest potential unfeasibility (Table 2).

Table 2. Sensitivity analysis for the IRR of FTT (fresh fish and smoked fish price)

		Price of Fresh Fish/KG in Kina						
		4	5	6	7	8	9	10
Price of Smoked Fish/kg in Kina	30.0	248%	96%	27%				
	32.5	585%	188%	76%	16%			
	35.0	5760%	384%	147%	59%	4%		
	37.5		1174%	279%	117%	46%	-9%	
	40.0			631%	214%	94%	34%	-32%

Source: Rotawewa, 2023

Another analysis assessed the impact of changes in smoked fish quantity and price on viability. A 100 kg yearly reduction in smoked fish quantity, coupled with a price drop to 32.5 kina per kg, risks the model's financial

sustainability. Green cells represent an acceptable IRR range, while yellow indicates potential unviability (Table 3).

Table 3. Sensitivity analysis for the IRR of FTT (Quantity of smoked fish per year and price)

		Smoked Fish (KG/Year)						
		1,330	1,430	1,530	1,630	1,730	1,830	1,930
Price of Smoked Fish (kg) in Kina	30.0					3%	36%	69%
	32.5				15%	50%	91%	148%
	35.0			22%	59%	107%	180%	309%
	37.5		22%	63%	117%	203%	372%	873%
	40.0	18%	61%	118%	213%	414%	1154%	

Developing FTT capacity of women

FTT necessitates SME-scale operations for its viability and sustainability. Consequently, FAO is dedicated to fostering SME development among fish farming groups, with a particular focus on women-led business groups that play a pivotal role in the post-harvest stages of the fish value chain.

Key efforts by FAO include enhancing the capabilities and knowledge of these groups in various business aspects. This encompasses training in group dynamics, leadership, effective communication, conflict resolution in business settings, enterprise management, financial literacy, and promoting gender and youth participation. Additionally, FAO linked the groups to development partners (UN Agencies and private sector bodies) to access finance, market opportunities, ICT services and transport infrastructure. It will provide a conducive environment to business groups for the implementation of FTT businesses.

In Papua New Guinea (PNG), women are integral to the fish sector, traditionally dominating fish processing and local market sales. However, they often face limitations in resources and knowledge necessary for enhancing and managing their practices and business growth.

Recognizing this, FAO is actively working on empowering women's business groups. This involves training on utilizing FTT for producing high-quality, safe smoked fish; accessing and connecting with markets; and effectively managing and expanding their collective enterprises. Additionally, FAO encourages the formation and operation of women-led businesses that can capitalize on FTT for the production and marketing of superior fish products, thereby reinforcing women's pivotal role in the sector.





Women in Karawap and Angoram have been trained to operationalize the FTT, and are now producing high quality smoked seafood

Prospective transformative change

FTT has brought about profound improvements in the livelihoods and quality of life for fish operators. Its benefits extend beyond economic gains:

- **Better production:** FTT markedly improves fish product quality, ensuring consistency in appearance, texture, and taste, which boosts consumer satisfaction and demand. It effectively reduces post-harvest losses and food waste, functioning well in various weather conditions and simplifying processing to save time and labour;

- **Better nutrition:** FTT contributes significantly to food and nutrition security by extending the shelf life of fish products up to 5-6 months (Ndiaye, Komivi, & Ouadi, 2015⁴), under proper handling and monitoring, thereby enhancing food security;
- **Better environment:** FTT promotes environmental sustainability with improved fuel efficiency and lower wood or charcoal usage. This conservation effort helps preserve forests, cut greenhouse gas emissions, and combat climate change;
- **Better life:** By increasing income and reducing smoke exposure and workload, especially for women, FTT facilitates opportunities for fish post-harvest operators to diversify income and engage in community activities. Overall this contributes to comprehensive personal development. Moreover, FTT reduces the risk of harmful contamination, such as exposure to polycyclic aromatic hydrocarbons (PAHs) from traditional smoking methods, which can negatively impact human and animal health;
- In Papua New Guinea, where women are central to fish processing and marketing, FTT offers significant potential for business and personal development. This technology is especially advantageous for women, who typically manage both reproductive roles (like family and household duties, childcare, and domestic chores) and productive work. FTT not only improves their work quality but also lessens their time burden, enabling women to assume a leading role in the fisheries industry;
- **Enhanced decision-making influence:** Women's involvement in income-generating activities through FTT boosts their influence in household decisions, promoting gender equality and empowerment within families and communities;
- **Expanded market access:** Producing superior smoked fish through the FTT opens new market avenues for women, enabling them to create unique brands. This leads to increased market presence and financial autonomy;
- **Diversified entrepreneurial pathways:** Skills acquired from FTT training empower women to pursue various entrepreneurial opportunities beyond fish processing, such as value-added products or related businesses, contributing to their long-term economic resilience; and
- **Elevated standing:** Women's active participation in economic activities like FTT enhances their social standing and visibility in their communities, garnering increased respect, agency, and acknowledgement of their contributions.

⁴ Ndiaye, O., Komivi, B. S., & Ouadi, Y. D. (2015). Refer to: Guide for developing and using the FAO-Thiaroye Processing Technique (FTT-Thiaroye). Rome: FAO.

Discussion

The two demonstration FTT sites in Angoram and Karawa built by the FAO have been met with open arms by the local beneficiaries. The enthusiastic adoption of this technology by beneficiary groups illustrates the crucial role of such initiatives in empowering local communities, especially women, by providing them with the tools and knowledge to thrive in their endeavours.

The Financial and Economic Analysis affirms the benefits of investing in FTT kilns over traditional methods. The resilience of FTT, as shown in the sensitivity analysis, highlights its adaptability to changing circumstances and underscores the need for strategic decision-making based on fluctuations in prices and quantities to ensure its ongoing effectiveness.

Furthermore, the advancement in fish smoking technology offered by FTT not only improves the quality and safety of smoked fish products but also lessens environmental impacts and better the livelihoods of fish operators. With reduced wood or charcoal use; lower emissions of smoke and harmful substances; and prolonged shelf-life of fish products, FTT contributes to increased consumer satisfaction and demand. These advantages are particularly impactful in elevating the income and quality of life for fish operators, notably women. Hence, FTT's contribution to food security, nutrition, health, and sustainable development is substantial, embodying its intended outcomes.

There have been some challenges encountered during the implementation of the FTT, offering guidance for future interventions:

- A pivotal lesson is the need for a paradigm shift from subsistence to commercial fishing among local communities. The transition is not straightforward, as many communities are accustomed to fishing for sustenance, selling only surplus catches. The lack of experience in commercial or SME-scale operations presents a significant hurdle. Future initiatives must, therefore, focus on nurturing a business-oriented mindset, providing comprehensive training and resources to facilitate this transition from subsistence to profitable fishing enterprises;
- Another critical insight relates to asset management, particularly regarding the FTT. Communities often show limited prowess in valuing such assets, optimizing their use for sustained profits, effective maintenance, and financial planning for future reinvestment. It becomes imperative for implementers to impart knowledge on the economic value of FTT; guide its proper usage and maintenance; and educate on financial strategies for long-term asset sustainability; and
- The concept of community organization for larger-scale operations poses its own set of challenges. The inherent unfamiliarity among fisher communities with operating collectively at a larger scale suggests a more pragmatic approach: starting with smaller, family sized FTT units. These are likely to be more successful initially, as families tend to be more committed to the success and upkeep of their businesses. For larger groups, addressing the complexities

of labour division and collective responsibility is crucial. This phased approach, beginning with smaller models and gradually scaling-up, can build a strong foundation for more extensive collaborative ventures.

In conclusion, the lessons learned from FTT implementation emphasize the importance of training and extension programs focused on business management, financial literacy, and cooperative operations, tailored to align with the unique needs and customary practices of the local fishing communities. Such an approach will bridge the gap between traditional subsistence fishing methods and modern, sustainable commercial practices.

The FTT model also improves household nutrition by increasing protein intake and adhering to international smoked fish standards, thereby contributing to environmental sustainability. FTT has also been shown to boost fishers' incomes, reduce exposure to smoke, lighten workloads, and promote community participation, thus improving living standards.

Note: This article, based on an intervention by FAO under the EU-STREIT Programme in Papua New Guinea, presents the authors' views. These views do not necessarily represent the official stance of FAO or any other entity. The article is for informational purposes and is not endorsed by FAO for other purposes.



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