



A CASE STUDY FOR HARVEST THE SUN

Out with the Old & In with the New:

Harvest the Sun Introduces Sustainable Drying Methodology for Cambodia's Fresh Produce

SWITCH to Solar
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SWITCH
to Solar

switchasia
GRANTS PROGRAMME



(Energy)^{Lab}

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1. Overview

Fish is one of the most valued agricultural products in Cambodia, making the country heavily reliant on its aquatic resources and biodiversity for food security and livelihoods. According to the Food and Agricultural Organization (FAO), fisheries play an important role in the national economy as they employ around 654,692 people (2017)¹, and more than 2 million people are said to gain livelihood benefits from the sector.

Cambodia's freshwater fisheries are among the most productive in the world as they are located around the Great Lake and along both the Tonle Sap and Mekong Rivers. Fish has become a major part of the Cambodian diet, accounting for 61% of households' protein intake², and is the second most consumed food. The agriculture, forestry, and fishery sectors play an important role in the Cambodian economy, contributing 22.85% to the national GDP in 2021.³ As an agricultural product, fish plays a significant role in trade regionally and globally.



¹ FAO, 2019: Fisheries and Aquaculture

² Cambodia World Fish <https://www.worldfishcenter.org/where-we-work/asia/cambodia#:~:text=Fish%20is%20a%20major%20part,most%20consumed%20food%20after%20rice>.

³ World Bank, 2021: <https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=KH>

2. Executive Summary

The case study presented focuses on a local company, Harvest the Sun (HTS), established in 2021 and registered in Cambodia as a limited liability company. HTS's core business is the distribution and installation of Covestro designed Solar Dryer Domes (SDDs) within Cambodia's agri-fishery sector. The purpose of this demonstration site is to test the technology's ability to successfully dry fish with a medium-sized fish processor located outside of Siem Reap, and its impact on business operations.

The main benefits of the usage of SDD technologies are:

- **Increased Production:** SDDs decrease drying time, allowing for an increase in the number of production cycles.
- **Increased Consumer Safety:** Production under a fully controlled environment (temperature, humidity, hygiene) contributes to the improvement of consumer safety.
- **Optimization of the work force:** By eliminating the constant moving of fish to accommodate the weather and daylight, staff have additional time to devote to higher-value tasks.
- **CO2 Emission reductions:** avoided CO2 emissions: 1.75 tCO2/year.
- **Return on investment:** between 6 and 19 months depending on the dried fish.

3. The SWITCH to Solar Project supporting Cambodia's Agri-fisheries

Acknowledging the importance of the agri-fishery sector in Cambodia, the **SWITCH to Solar project** was conceptualized by People in Need along with EnergyLab⁴ and Sevea⁵, funded by the European Union through the SWITCH Asia Programme⁶, and the Czech Republic Development Agency (CzDA)⁷. The project is implemented across the Tonle Sap Region of Cambodia to support micro, small, and medium-sized enterprises (MSMEs) to adopt solar-based technologies with the purpose of promoting clean energy and fostering green employment in the agri-fishery sector. The project also aims to support local farmers by educating them on the benefits of using solar-powered technologies that can make their products more sustainable and of higher quality standards.

⁴ www.energylab.asia

⁵ www.seveaconsulting.com

⁶ <https://www.switch-asia.eu/>

⁷ <http://www.czechaid.cz/en/>

One of the main activities of the project is the implementation of the **SWITCH to Solar Startup program**, a program that aims to support the development of businesses for the agri-fishery market using solar energy technology to promote sustainable economic growth in Cambodia. The goal of the program is to help entrepreneurs successfully conceive, validate, and launch their solar energy businesses through a well-structured process that includes Hackathons, a 6-week pre-incubation, a 1-year incubation, and a 6-months acceleration. The various stages of the process consist of different activities such as mentoring, market linkage and networking, financial support, and training, among others.



Photo Sevea consulting

3.1 Harvest the Sun Case Study

Harvest the Sun (HTS), a Khmer company, is one of the 6 startups that have joined the SWITCH to Solar Startup Program in 2022⁸. Thanks to the program, HTS developed and tested innovative

⁸ The SWITCH to Solar Startup Program has gone through 2 Cohorts: Cohort 1 with 5 teams, and Cohort 2 with 6 teams. <https://energylab.asia/switchstartup>

solar dryer domes, a more sustainable technique for drying fresh products, and started to generate revenue.

After meeting a client who is an alumnus of the Startup Program, the HTS founders were encouraged to join the program. *“As part of the second cohort, we find that the program is well structured. The support provided to the startups joining is essential to sustain the business and be able to scale up”* said Ms. IM Soukhim, one of the co-founders of Harvest the Sun.

Harvest the Sun was founded in 2021 by three aspiring solar technology game changers. It was not an easy journey for Ms. IM and her team to get to where they are today. Just like other start-up companies, Harvest the Sun faced challenges along the way, especially during the outbreak of COVID-19. In fact, they were officially registered as a company at the peak of COVID-19 in Cambodia in 2021. Due to global and nationwide restrictions, borders were forced to close, hence, exports were put on hold. On the other hand, the company struggled financially due to the low volume of investments linked with the existing unfamiliarity among farmers of solar technologies for agricultural use.

Although the pandemic caused instability for most local businesses in Cambodia, Ms. IM and her team also found opportunities from the situation. *“Proper sanitation and boosting our immune system emerged as important safety measures which promote food safety”*, Ms. IM highlighted. *“In fact, a lot more people have become aware of food safety and quality, hence, the demand has gone up. An example would be the drying technique for fresh produce”*, Ms. IM added.

Harvest the Sun took advantage of the opportunities they discovered during the pandemic. The company provides consultancy services on drying process/methods and sells its own technology. The Solar Dryer Dome, the pride and joy of Harvest the Sun, is a sustainable drying technology used for agriculture, specifically for fresh produce. They currently cater to farmers who have fresh produce and aquaculture and agriculture processors.

3.2 The Entrepreneurship Journey for HTS

Their overall experience was described as a rollercoaster ride: *“entrepreneurship is like being on a rollercoaster, scary but it makes you excited”*, said Ms. IM. The mentorship and knowledge

shared became valuable to the company as it boosted the confidence of their team, and they became better prepared for potential challenges that may come their way.

With three main lessons learned from the program, Ms. IM shared that strategic planning, financial planning, and effective decision making were the team's key takeaways. *"Running a startup consists of multiple levels of preparation and work; without a proper plan, your team will end up wasting time. (That is why) strategic planning is essential. Financial planning is just as important as the human body, it has to be nurtured. If it gets infected, it will take time to recover. So, good financing is a good way to keep a healthy company running. Lastly, effective decision making is also very important when running a business"*, Ms. IM said.

4. Drying Techniques in Cambodia

A field visit and case study were conducted at a fish processor in Siem Reap province prior to the installation of solar technology at the processing facility. This allowed for an understanding of the business operations, expenditures and incomes, and challenges faced by the processor when using the traditional fish drying method— direct exposure to sunlight.

Mr. Sam Nang is a farmer from Aranh Village, Siem Reap province, who produces dried fish, his main business income. He purchases fresh fish from local producers, to process and sell as packaged dried products. The fish products Mr. Sam works with are catfish (*"trey andeng"*), snakehead fish (*"trey ross"*), giant snakehead fish (*"trey chhdao"*), and pangasius (*"trey pra"*).

4.1 Sun Drying Process

Mr. Sam Nang produces a wide variety of products, both in terms of fish species and in terms of cut and recipe, adapting to the available species and market demand.

The fresh fish purchased each day are stored in cool boxes before being processed. The first step is to manually empty the insides of the fish and remove their heads. They are then cut and filleted or not, depending on the species.



Picture: People In Need Cambodia

The drying time can vary greatly depending on the season and weather: in

September and October this is particularly challenging because of the rain and colder temperatures. For this reason, Mr. Sam Nang has purchased two electric dryers, which are only used two to four months a year. These can dry 30 kg of fish per day each, and simply require turning the fish every 4 hours. However, they have a significant operating cost: in the months that Mr. Sam Nang uses the electric dryers, the electricity bill increases by \$125 per month. Finished products are then vacuum-packed to be sold online to individuals or to local retailers.



Picture: People In Need Cambodia

The table below describes the average time needed to dry products from each species.

Products	Sun Drying Hours (Avg)
Catfish	14
Catfish with chili	14
Fillet catfish	10
Snake head fish fillet	15
Giant snake head fish fillet	15
Salty Pangasius	10
Pangasius fillet	14
Snake head fish	10
Snake head fish with chili	15
Dried small catfish	15
Snakeskin gourami	13
Trout fish	13
River catfish	14
Peacock eel	13

Table 1: Average Sun Drying Times

Mr. Nang also has other lines of the business such as smoked catfish which is produced in a large charcoal furnace and crocodile hatcheries. Since those products do not involve drying, these business lines are not considered in this study.



Picture: Sevea consulting

4.2 Commercial Practice: Solar Dryer Domes (SDDs)

In 2018, HTS started studying solar technology and its potential in the Cambodian market. ***“We believe that switching to solar or renewable energy is moving towards sustainability. Renewable energy is free and production of fresh produce can also leverage its quality and safety”***, explained Ms. IM.

The drying process in Cambodia is pricey and often compromises the quality and safety of the products. Harvest the Sun develops Solar Dryer Domes to improve the drying method for dried

products, assuring the safety and up-to-standard quality of the products. By using renewable energy, the Solar Dryer Domes will reduce the cost of food processors, food loss, and also protect the environment. In addition, based on a cost-analysis study conducted by Sevea Consulting, SDDs generate higher revenue compared to the traditional practice of sun drying. After 1.5 months of data collection, it was seen that solar dryer domes, **producing 2.9 tons of dried fish**, generated a revenue of **10,545.26 USD** (excluding smoked fish), compared to sun drying, which produces 3.8 tons of dried fish, generating about 9,670 USD (excluding smoked fish).⁹

Introducing a more sustainable technique to dry fresh produce, Harvest the Sun invested time and effort to understand the advantages of their Solar Dryer Dome. The technology offers post-harvest fish processors an efficient, clean and economically attractive way to dry fish in bulk. The product inside the dome is fully protected, assuring quality and safety. Moreover, Ms. IM points out that Solar Dryer Domes promote sustainability in three pillars, namely, economic, social, and environmental.



Picture: People In Need Cambodia

⁹ Although there was a drop in production and increase in revenue between using solar dryer domes and sun drying, the study explained that the drop in production was a result of lack of fresh fish supply.

“Solar technology in general, can provide more employment for people, raise more awareness of food security, safety, and public health, help reduce the emission of greenhouse gases, and save electricity costs”, Ms. IM said.

Currently, Harvest the Sun has one operational demonstration site, in collaboration with Mr. Sam Nang’s fish processor. Data is gathered from the processor to monitor the efficiency of this innovative drying method in comparison to the traditional technique for drying fish. They have also partnered with different non-governmental organizations working within the aquaculture value chain. The demonstration site was established to showcase that the technology works and further promote the use of solar energy for the agriculture and aquaculture sectors.

The company currently imports and distributes five differently sized models which can be used to produce a variety of dried food products in a safe and hygienically controlled environment. Although a relatively new company, HTS has leveraged its connection to Cambodia’s robust NGO sector to make a number of initial sales. The purpose of this demonstration site is to test the technology’s ability to successfully dry fish with a medium-sized fish processor located outside of Siem Reap province and its impact on business operations. To date, Harvest the Sun has a total revenue of USD55,100 and has sold a total of 10 units within one and a half years.

“We are confident that we have proved a point for Cambodia’s aquaculture through the establishment of our first demonstration site earlier this year (2022). The Solar Dryer Dome is the new and innovative drying technique for Cambodia’s agriculture value chain”, Ms. IM said confidently.

Technology Description

HTS’s Solar Dryer Domes (SDDs) are greenhouse-like shelters composed of polycarbonate sheets which adhere to a metal dome frame and are manufactured by Covestro, a German materials company. The polycarbonate sheets are a high-performance and durable plastic which are well suited to creating ideal drying conditions by i) filtering out UVA and UVB which can destroy nutrients in food products, including

fish, and ii) efficiently creating ideal drying temperatures. The domes are also fitted with a solar powered ventilation system consisting of exhaust fans which control and monitor temperature and humidity.

HTS's SDDs come equipped with a system of exhaust fans that control temperature and humidity powered by a 170-Watt solar panel and a 12V/70Ah back-up battery. The automated system is accessed via a control box located outside of the SDD. After installation was complete, HTS conducted a training session on how to monitor and adjust temperature and humidity. Throughout the month of February, Mr. Sam Nang experimented with temperature and humidity levels on various fish species to pinpoint optimal conditions and to familiarize himself with the system's operation. Additionally, Mr. Sam Nang's SDD includes an LPG powered gas heater that provides auxiliary heating when environmental conditions dictate, such as during long rainy periods. All of these factors allow the farmer significant control over conditions in the SDD to maximize production.

The SDD installed at the demonstration site is 6M x 8M. Its capacity is 350kg per cycle, and it can hold approximately 30 drying trays at a time. It may be possible to stack trays as a way to increase capacity, but this method will need to be tested before it is fully implemented. The SDD unit sits on a concrete slab designed to isolate the SDD unit from moisture rising from the soil. Installation took place in January 2022 and took about two weeks.

The cost of Mr. Sam Nang's SDD unit was \$16,500 USD and the cost of the concrete slab, including labor, was \$500 USD. The total cost, including installation, was \$17,000 USD.



Picture: Sevea consulting

Testing Sustainability: A Study of Solar Dryer Domes

A study was conducted by Sevea Consulting (September 2022)¹⁰ to better understand the business operations, expenditures, and incomes, after using Solar Dryer Domes. Moreover, the study highlighted the main expected benefits of Solar Drying Domes:



Increased production: SDDs should decrease drying time allowing for an increase in the number of production cycles.



Increased safety and quality: Production under a fully controlled environment (temperature, humidity, hygiene) contributes to improving the quality and consumer safety of the products.



Increase in operational efficiency: By eliminating the constant moving of fish to accommodate the weather and daylight, staff should have additional time to devote to higher-value tasks.



Price Increase: If successful, this solution could be an opportunity for the processor to access premium markets through export or to obtain higher selling prices in the local market.

To help assess the expected benefits of the Solar Dryer Domes, a commercial impact analysis was conducted on Mr. Sam's processing business to determine the return on investment on the SDD provided by HTS. The analysis seeks to understand additional tangential benefits, including operational efficiency impacts and CO2 emission reduction. Three months of data were collected, including March (dry season), June (wet season) and July (wet season). One of the most significant impacts of an SDD is the reduction in drying times. This allows the processor to increase the number of cycles and overall production. The data collected from Mr. Sam Nang illustrates a significant reduction in drying times across all species of fish. This is illustrated in the table below.

¹⁰ Based on the Solar Dryer Dome Demonstration Site- Evaluation Report on Harvest the Sun's Solar Dyer Dome a fish processing facility in Siem Reap.

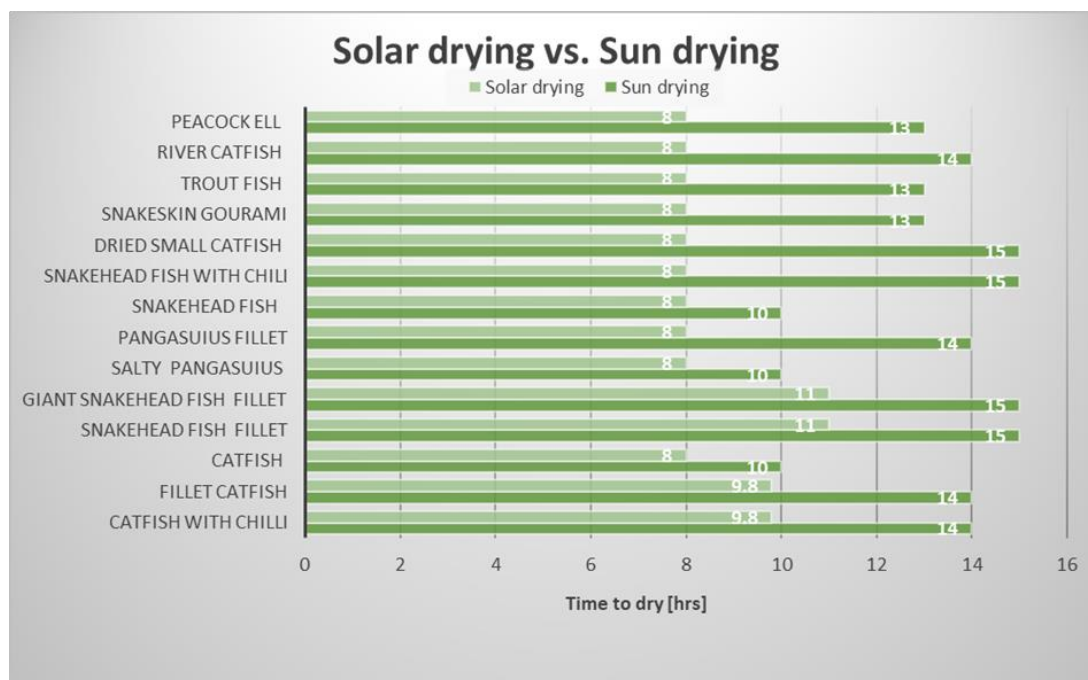


Figure 1: Average drying times of fish species from sun and solar drying

As illustrated above, drying times are significantly reduced when using the SDD. This should correspond to an increase in production and revenue. When looking at the monthly figures for March, June, and July, and comparing them to the sun drying production and revenue, significant increases can be observed. Another factor contributing to Mr. Sam Nang's increase in revenue is a strategic switch to focus on higher value fish species after the installation of the SDD. Specifically, this meant only drying Snakehead and Giant Snakehead fillets, instead of non-fillets. Additionally, there is a small cost saving from the electricity use eliminated from the electrical dryers used during the wet season. Labor costs fluctuate due to uncertainty in production levels and efficiency, but based on conversations, Mr. Sam Nang anticipates hiring additional staff to accommodate the increase in production.

March 2022

Revenues			
Fish type	Units [kg]	Units price [\$ /kg]	Total per month [\$]
Dried small catfish	80	\$12.50	\$1,000.00
Dried catfish fillet	468	\$8.75	\$4,095.00
Dried catfish fillet with chilli	468	\$9.50	\$4,446.00
Dried snakehead fish fillet	1786	\$8.75	\$15,627.50

Dried giant snakehead fish fillet	760	\$15.00	\$11,400.00
Dried pangasius fillet	1199	\$8.75	\$10,491.25
Dried small catfish	80	\$12.50	\$1,000.00
Dried river catfish	21.6	\$8.75	\$189.00
Dried peacock eel	80	\$22.50	\$1,800.00
Dried Trout fish	84	\$32.50	\$2,730.00
Snakeskin gourami	80	\$12.50	\$1,000.00
<u>Total Dried Fish</u>	<u>5,254.60</u>		
Total Revenue			\$53,778.75
COGS			
Fresh catfish	2900	\$1.38	\$4,002.00
Fresh snakehead fish	5100	\$1.88	\$9,588.00
Fresh giant snakehead fish	2500	\$2.50	\$6,250.00
Fresh pangasius	3200	\$1.50	\$4,800.00
Fresh Reviver catfish	120	\$3.00	\$360.00
Fresh Peacock eel	200	\$10.00	\$2000.00
Fresh Trout fish	240	\$11.13	\$2,671.20
Fresh Snakeskin gourami	200	\$6.13	\$1,225.00
Fresh small catfish	400	\$2.00	\$800.00
Total Fresh fish delivery	14,860	\$0.05	\$743.00
Ingredients (sugar, chilli, MSG)			\$3,672.00
Packaging			\$300.00
Ice cube			\$270.00
Total COGS			\$36,681.20
Expenses			
Electricity	152	0.21	\$32.00
Overhead (Water and other)			\$25.00
Labour			\$1,050.00
Gas	4	22	\$88.00
Total Expenses			\$1,195.00
Monthly Earnings			\$15,902.55

Table 2: March 2022 (Dry Season) Financial using SDD

June 2022

Revenues			
Fish type	Units [kg]	Units price [\$/kg]	Total per month [\$]
Dried catfish fillet with chilli	256	\$9.50	\$2,432.00
Dried snakehead fish fillet	1,440	\$8.75	\$12,600.00
Dried giant snakehead fish (fillet)	960	\$15.00	\$14,400.00
Dried pangasius salty	1,248	\$8.75	\$10,920.00
Dried catfish fillet	256	\$8.75	\$2,240.00

<u>Total Dried fish</u>	<u>4,160</u>		
Total Revenue			\$42,592.00
COGS			
Fresh catfish	1,600	\$1.50	\$2,400.00
Fresh snakehead fish	4,000	\$1.90	\$7,600.00
Fresh giant snakehead fish	3,200	\$3.00	\$9,600.00
Fresh pangasius	3,200	\$1.50	\$4,800.00
Total Fresh fish delivery	12,000	\$0.05	\$600.00
Ingredients (sugar, chilli, MSG)			\$2,345.00
Packaging			\$300.00
Ice Cube			\$270.00
Total COGS			\$27,915.00
Expenses			
Electricity	100	\$0.21	\$21.00
Overhead (water and other)			\$25.00
Labour	9	\$150.00	\$1,350.00
Gas	4	\$22.00	\$88.00
Total Expenses			\$29,499.00
Monthly Earnings			\$13,193.00

Table 3: June 2022 (Wet Season) Financial using SDD

July 2022

Revenues			
Fish type	Units [kg]	Units price [\$/kg]	Total per month (\$)
Dried catfish fillet with chilli	240	\$9.50	\$2,280.00
Dried snakehead fish fillet	612	\$8.75	\$5,355.00
Dried giant snakehead fish (fillet)	600	\$15.00	\$9,000.00
Dried pangasius fillet	780	\$8.75	\$6,825.00
Dried catfish fillet	150	\$8.75	\$1,312.50
<u>Total Dried fish</u>	<u>2,382</u>		
Total Revenue			\$24,772.50
COGS			
Fresh catfish	1,300	\$1.50	\$1,950.00
Fresh snakehead fish	1,700	\$1.90	\$3,230.00
Fresh giant snakehead fish	2,000	\$3.00	\$6,000.00
Fresh pangasius	2500	\$1.50	\$3,750.00
Total Fresh fish delivery	7,500	\$0.05	\$375.00
Ingredients (sugar, chilli, MSG)			\$1,172.50
Packaging			\$300.00
Ice Cube			\$270.00
Total COGS			\$17,047.50

Expenses			
Electricity	100	\$0.21	\$21.00
Overhead (water and other)			\$25.00
Labour	9	\$150.00	\$1,350.00
Gas	5	\$22.00	\$110.00
Total Expenses			\$1,506
Monthly Earnings			\$6,219.00

Table 4: July 2022 (Wet Season) Financial using SDD

Production increases were highest during the dry season, as expected. The month of July saw a sharp decrease in production, despite shorter drying cycles. This was the result of drastic decreases in local fresh fish supply. Mr. Sam Nang's normal suppliers within the Siem Reap area could not meet the demand of local and regional fish processors. As a result, Mr. Sam Nang is actively looking to increase his number of suppliers, including reaching beyond the Siem Reap area.

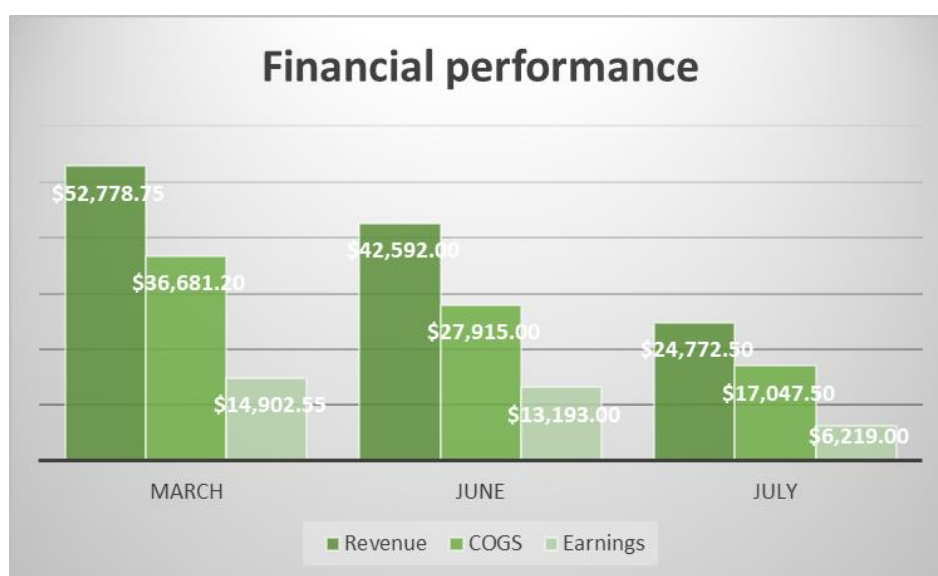


Figure 6: Financial performance of the business for three selected months.

Photovoltaic Solar Performance and CO2 Emissions

Solar technology installed on the SSD at the demonstration site powers a ventilation system (exhaust fans) to run and maintain the required temperature and humidity conditions within the SSD to ensure the optimal process of drying fish. The installed PV solar capacity of a 170-Watt panel generates **265.6 kWh** of energy under the Cambodian sun on an annual basis. The excess power is stored in a 12V/70Ah battery to ensure longer operating hours for the ventilation system.

As with all solar technology, during cloudy or rainy days, the PV solar technology will have insufficient irradiation to properly power the ventilation system. However, during these days the temperature is relatively low, and the ventilation system is not expected to be necessary.

A significant reduction of CO₂ is not expected for this technology given the limited use of the electrical dryers, and Mr. Sam Nang's decision to add the LPG powered heater to assist in regulating the temperature during the rainy season.

Technology	Consumption/production	Forecast daily usage ratio	Total annual power production	Conversion factor of tCO ₂ for Cambodia	Annual emission added/saved
PV solar	0.17 kWp	100%	312.44 kWh	0.58 grid	0.15403
LPG heater	4.5 l/month	-	54l	0.00186 LPG	0.1004
Electric heater	244 kWh/month	-	2928 kWh	0.58 grid	1.698

Table 1: CO₂ emissions and reductions while using SDD

- **CO₂ reduction** as a result of solar powered ventilation system: **0.154 tCO₂**
- **CO₂ addition** due to LPG gas heater (aver 4.5l/month): **0.10 tCO₂**
- **CO₂ reduction** as a result of electric dryers no longer in use: **1.7 tCO₂**

TOTAL avoided CO₂ emissions: **1.75 tCO₂/year**

Post-installation of the SDD, Mr. Sam Nang installed a household fan inside the SDD in an attempt to further control the internal temperature. These fans are connected to the electrical grid via Mr. Sam Nang's household connection. This decision and subsequent action were not vetted by HTS or Sevea. Due to complications in partitioning data from Mr. Sam Nang's household electrical consumption, the fan's electrical consumption was not factored into this analysis.

Dried Fish Quality and Safety

The utilization of an SDD for fish drying presents an opportunity to conduct production in a controlled setting free from environmental impact. It is anticipated that this change could have a significant positive impact on quality and safety. As mentioned above, sun drying fish outdoors exposes the product to the elements, insects, rodents, and other animals. The sun drying trolleys used by Mr. Sam Nang provide no protection for the fish. Producing a higher quality product that also ensures consumer safety may allow Mr. Sam Nang to fetch higher local prices and access premium export markets.

Within the confines of this analysis, Sevea did not analyze the changes in food quality and safety. However, given the importance of these topics, Sevea has engaged with the Institute of Technology of Cambodia (ITC), a leading research institution, to better understand the parameters of a study and potential costs. These actions proved fruitful. In September 2022, ITC, in partnership with HTS and Sevea, will submit a

grant application to the UNIDO CAPFish project to fund a food quality and safety analysis of fish dried using HTS's SDD. The objective of the study would be to analyze 4 species of fish in both the SDD and sun drying environments while measuring the following parameters:

- Protein
- Total Carbohydrates
- Ash
- Moisture
- Aw (Water Activity)
- Color
- Total Plate Count
- Total Yeasts
- Total Mold

The intended outcome would be a scientific research paper that could validate the quality and safety benefits of using an SDD over traditional sun drying.

5. Findings

5.1 Return on Investment

A simple return on investment calculation was performed based on the data collected over a three-month period. The results show that the ROI for Mr. Sam Nang is approximately 6 months.

- SDD technology and installation price = \$17,000 USD (Because SDD systems are customized based on each client's needs, the price of each unit fluctuates)
 - o Cost of Mr. Sam Nang's SDD: \$16,500 USD
 - o Cost of concrete slab for SDD foundation: \$500 USD
- Assumption: The processor has invested \$17,000 USD into the system, and if his monthly production performance and earnings remain at approximately \$11,438.18 USD on average then the ROI will be roughly 6 months.

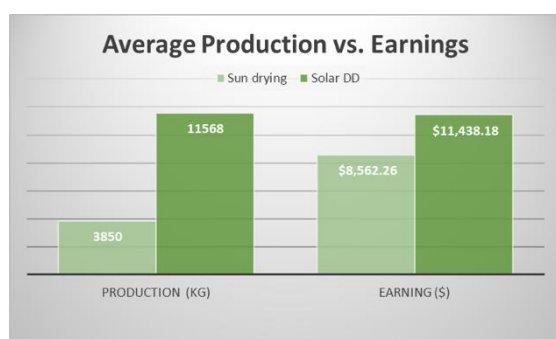


Figure 7: Comparison of performance of Sun drying method vs. Solar Dryer Dome

ROI = cost of investment/ additional monthly revenue generated compared to previous method
 $\$17,000 / \$2,876.42 = 5.9$

The ROI for this system based on data provided by Mr. Sam Nang is approximately 6 months.

Based on Mr. Sam Nang's business case, an investment in an SDD unit yields an extremely short payback period. However, it is important to take into account two key considerations:

- Mr. Sam Nang made a decision once the SDD was installed to increase production of high value fish species, including Snakehead and Giant Snakehead fillets. Previously, he had a significant

amount of production dedicated to Snakehead and Giant Snakehead non-fillets, which are a lesser value dried fish product.

- The lack of fresh fish supply limited Mr. Sam Nang's production during the month of June and July. If this continues, revenues will decrease and the ROI will increase.

5.2 Sensitivity Analysis

SDDs and their application within Cambodia's fishery sector are new developments, and Mr. Sam Nang's use of this technology accompanied changes in his business operations, and a steep learning curve. In order to have a broader understanding of an SDD's impact and payback period it is valuable to consider a second scenario that addresses the two inputs detailed above, which had a considerable impact on Mr. Sam Nang's finances. The input adjustments include i) producing a ratio of snakehead fillets/non-fillets and giant snakehead fillets/non-fillets that aligns more with pre-SDD production, and ii) a fresh fish supply that mimics March 2022, a period where there were no supply disruptions.

Under these scenarios the ROI calculation would be:

$$\$17,000/\$893.51 = 19.02$$

The payback period would be 19 months.

Scenario #2	Avg Monthly Earnings (USD)
Post SDD Installation	\$9,455.27
Pre SDD Installation	\$8,561.76
Revenue Increase	\$893.51
ROI (Months)	19.03

Table 10: Scenario 2 Return on Investment

5.3 Increase in Operational Efficiency

Through interviews with Mr. Sam Nang, he revealed that the SDD did reduce the need for staff to move dried fish throughout the processing facility. The technology cut down on the need for staff to flip fish fillets, to move the fish to a metal enclosure at night and then back out to the trolleys in the morning, to monitor the weather for climate-impact events, and to be vigilant in guarding against insects, rodents, or other animals. This allotted more time for staff to concentrate on other, value adding tasks.

Despite these efficiencies, Mr. Sam Nang is not planning on reducing the number of staff. Instead, as long as the fresh fish supply remains consistent, he intends to add staff to further assist in managing the increase in production, and subsequent packaging and shipping duties.

6. The Way Forward for Harvest the Sun

As a start-up company focusing on a niche market in Cambodia, Harvest the Sun is ambitious with their plans for the company's future moving forward. When asked about how the company will look like in 5 years' time, Ms. IM shares her team's plan: *"We want to have a franchise in the future, perhaps in Africa. The weather is quite similar and they produce many crops. So, our technology could potentially be used there"*.

Harvest the Sun, as a company, wants to be recognized in the food system space globally. With Cambodia making the switch to renewable energy, the company would like to be a part of building a greener country with a more sustainable food system.

"As a food scientist and a solar dryer supplier, I would highly recommend people consider investing in solar dryers, because to compete on the international level, you need low production costs and high-quality products. In short, investing in solar technology is actually investing in the future's sustainability", said Ms. IM.

As a local start-up, Harvest the Sun continues to strive for the best for their company through more recognition, sales, and partnerships with different stakeholders. Their Solar Dryer technology is indeed a game-changer to drying fresh produce in Cambodia. This technology is worth investing in to ensure food safety and sustainable practices towards greening Cambodia's aquaculture and agriculture sectors.



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