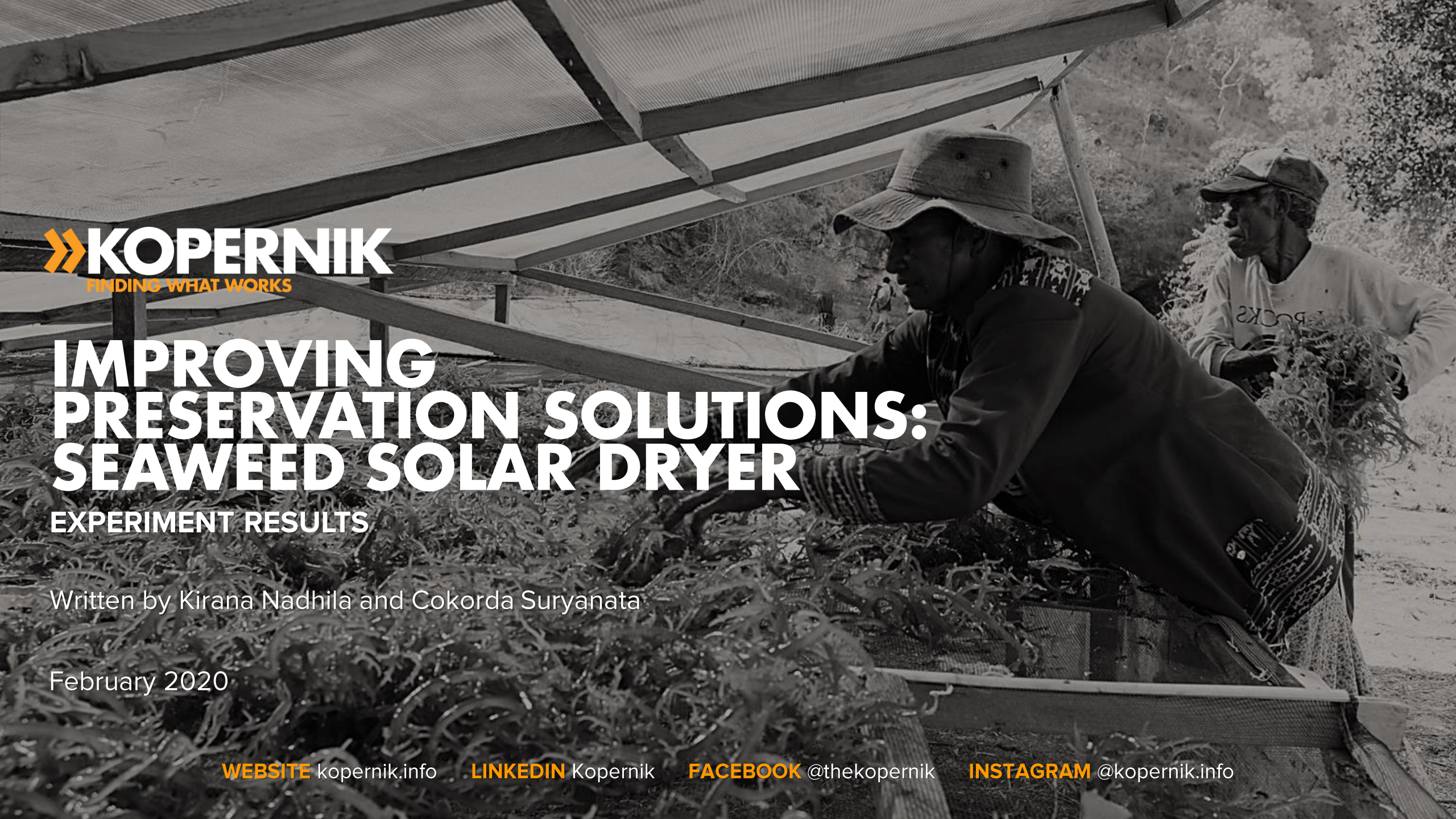

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IMPROVING PRESERVATION SOLUTIONS: SEAWEED SOLAR DRYER

EXPERIMENT RESULTS

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The Creative Solutions for Sustainable Consumption and Production of Fish (MATA KAIL) Project, funded by the European Union, is being implemented from **March 2018 to February 2021**. It focuses on three regencies in East Nusa Tenggara; Lembata, Nagekeo and Sikka. This project aims to **promote sustainable economic growth** and **employment opportunities** of marginalized youth, particularly young women, in the fish-processing sector in Indonesia. To support the implementation of the MATA KAIL project, technology testing is being conducted, with the Seaweed Solar Dryer project being one of several experiments through which we are testing solutions to improve the efficiency of the fisheries sector as well as increasing the incomes of those working in the fishing industry in East Nusa Tenggara.

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EXECUTIVE SUMMARY

As part of the MATA KAIL project, Kopernik tested a simple solar dryer to improve post-harvest processing of seaweed in Lembata regency, Nusa Tenggara Timur province. The dryer was introduced as an alternative to the current practice of drying seaweed on the ground or on a raised bamboo rack. We compared the performance of these methods by measuring temperature and humidity of the drying environment, as well as the time required for the seaweed to reach the optimal moisture content.

We found that:

- The solar dryer resulted in better drying conditions than the floor or bamboo rack methods;
- On average, the solar dryer dried seaweed 19 percent faster than traditional methods, during the rainy season;
- The overall quality of dried seaweed was improved by using the solar dryer; and
- The solar dryer has the potential to increase farmers' income by 33 percent if farmers can dry seaweed at full dryer capacity every day during the rainy season.

PROJECT OVERVIEW

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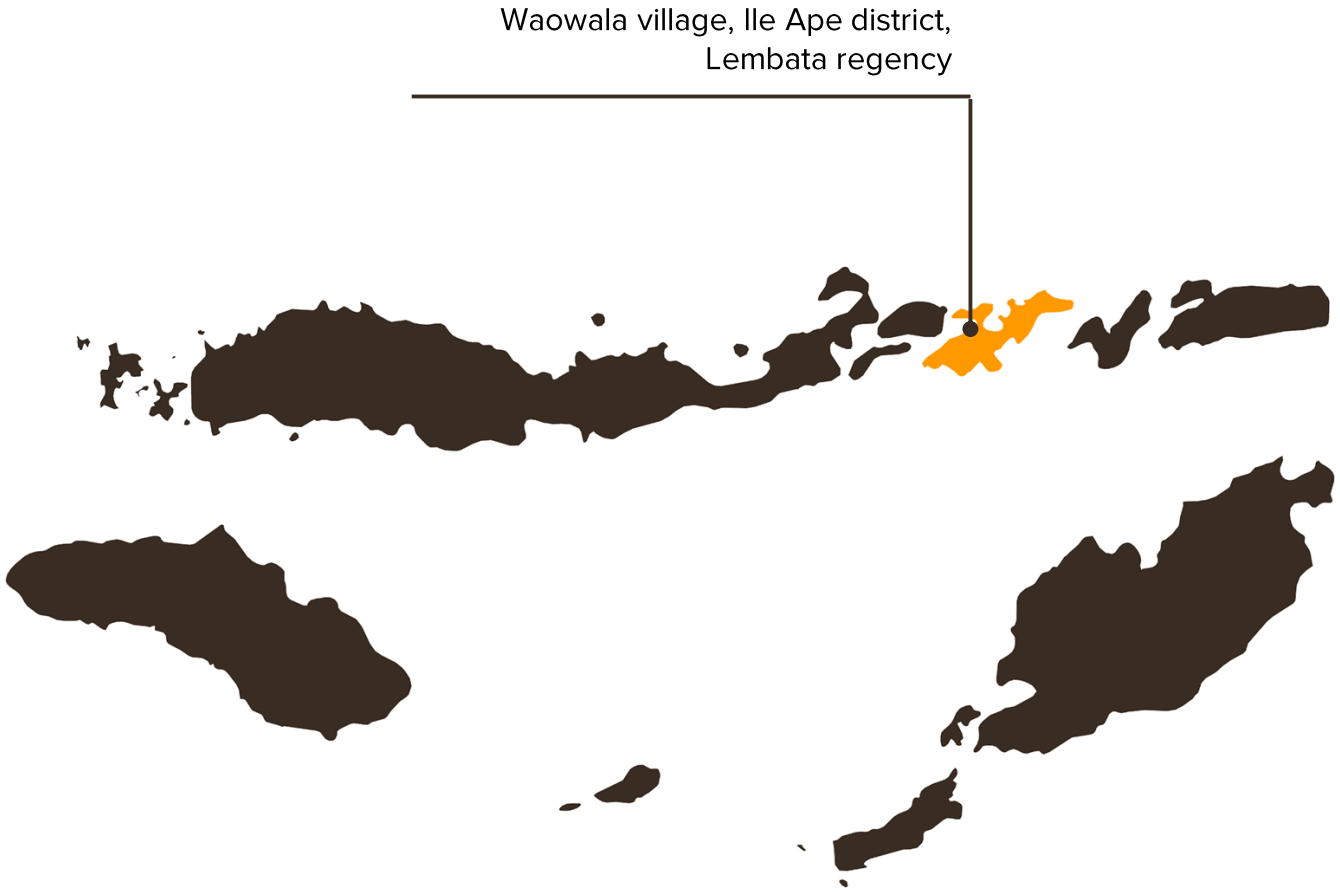
CONTEXT

East Nusa Tenggara province is the second highest seaweed producing region in Indonesia.[1] Many people in the Lembata Regency depend on seaweed farming as it is a stable source of income. One farmer in Lembata reported earning up to IDR 14 million (US$1,017[2]) per harvest.

Farmers find it hard to protect their seaweed while it is drying, particularly during the rainy season. The most common drying method is to lay seaweed on a net on the ground, thus exposing it to rain and making it susceptible to contamination.

We wanted to improve the seaweed drying process by using an enclosed solar dryer. With a solar dryer, the seaweed will be fully protected from weather conditions, eliminating the need for the farmers to manually cover the seaweed if it rains. It will also be protected from sand and other contaminants.

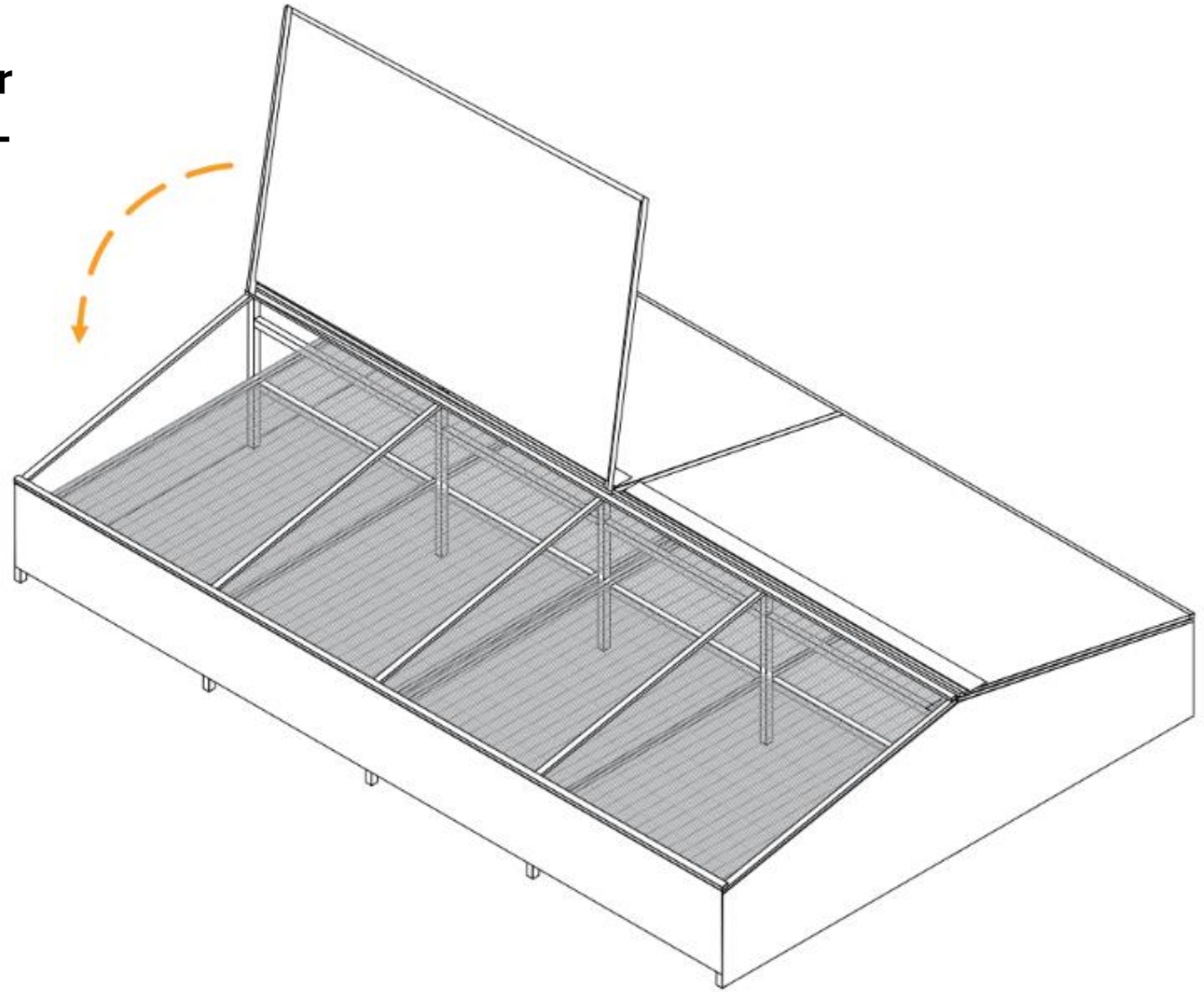


East Nusa Tenggara province

[1] Ministry of Maritime Affairs and Fisheries. (2013). *Investment opportunity profile of seaweed commodity*.
[2] US$1 = IDR13,772 on February 1, 2020 from https://www.exchangerates.org.uk/

HYPOTHESIS

We hypothesize that by using a solar dryer the seaweed drying process will improve—in terms of speed, weatherproofing and dried seaweed quality—which in turn will increase farmers' net income.



Seaweed solar dryer design

EXPERIMENT DESIGN

We compared the enclosed solar dryer (Treatment Group) to floor drying (Control Group 1) and bamboo rack drying (Control Group 2) in terms of drying performance, dried seaweed quality and cost.

CONTROL GROUP 1

CONTROL GROUP 2

TREATMENT GROUP

		CONTROL GROUP 1	CONTROL GROUP 2	TREATMENT GROUP
Type of drying		Floor drying	Bamboo rack	Enclosed solar dryer
Characteristics	Material	● Open ● Net ● On the ground	● Open ● Bamboo ● Elevated ● Wood	● Closed ● Bamboo/net ● Elevated ● Wood ● Polycarbonate
Parameters		(1) Drying performance	(2) Dried seaweed quality	(3) Cost

EXPERIMENT FLOW

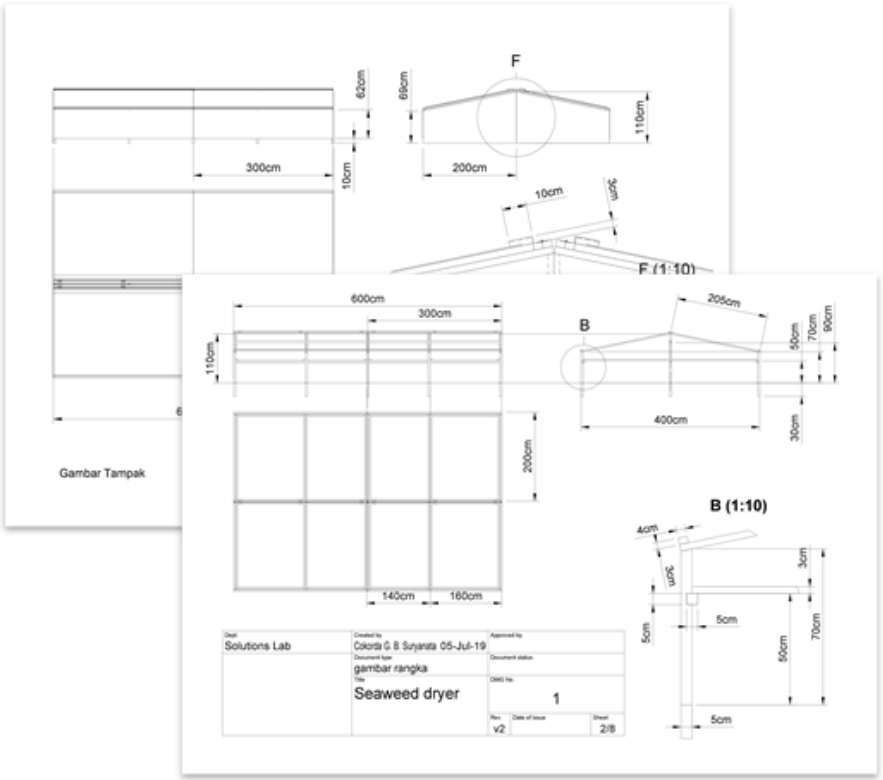
The implementation, including the solar dryer construction and data collection, was conducted from May to December 2019.

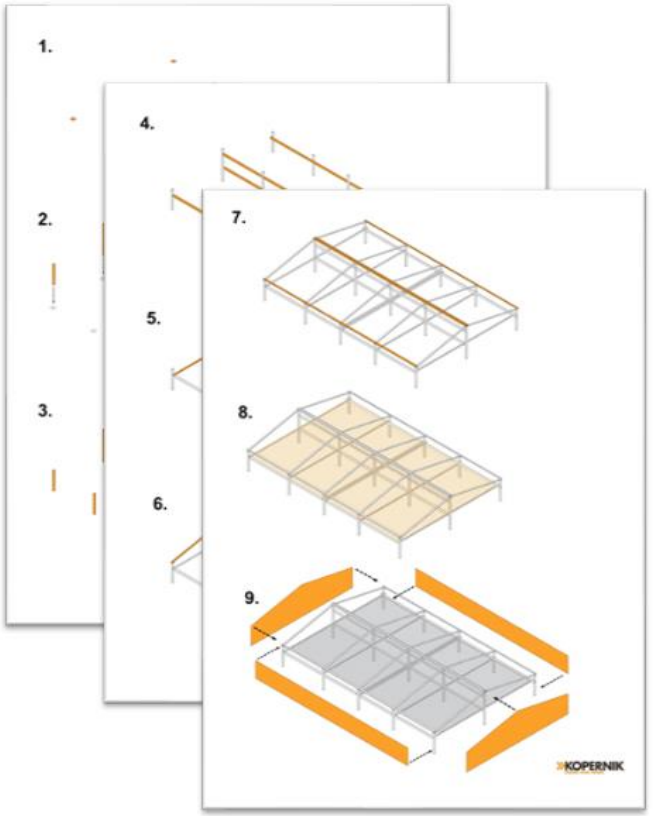
Research and Development		Implementation		Closing
Research	**Development**	**Construction**	**Data Collection**	**Reporting**
				
Activities				
● Identify solar dryer design requirements ● Survey local setting	● Design the solar dryer	● Build the solar dryer	● Collect humidity and temperature data ● Test seaweed quality in a lab	● Evaluation ● Data analysis ● Reporting
Measurement Indicators				
Solar dryer design criteria are identified	The solar dryer is designed	Solar dryer is constructed	Data is collected	Comparison of drying methods in terms of: (1) drying performance, (2) seaweed quality maintenance, (3) cost
Timeline				
Feb-Apr ‘19		May-Dec ‘19		Jan-Feb ‘20

Based on the intended users and location, the final solar dryer design is made mostly from locally available materials and uses the principles of passive drying.

Key Consideration	Requirement	Design Feature
User: ● Work in groups of 10 ● Mostly women ● Basic level of education	● Low effort in loading/unloading ● Must be affordable ● Simple construction for easy replication ● More efficient drying ● Increase product quality	**Raised bed** to make it easy to load/unload seaweed **Fully enclosed** to increase drying temperature, weather protection and reduce contamination **Passive drying** to minimize maintenance **Wooden frame** for easier construction **Polycarbonate roofing** for optimum heat retention & durability
Location: ● Semi-arid climate, low precipitation ● Rocky coastline with cliffs and mangroves ● No electricity ● Limited road access	● As few materials as possible ● Can be built without electricity/ large equipment ● Withstand seasonal winds and harsh weather conditions	

Since the farmers were not familiar with technical drawings we provided them with a simple construction guide in the form of a pictogram.





The solar dryer manual can be accessed here.

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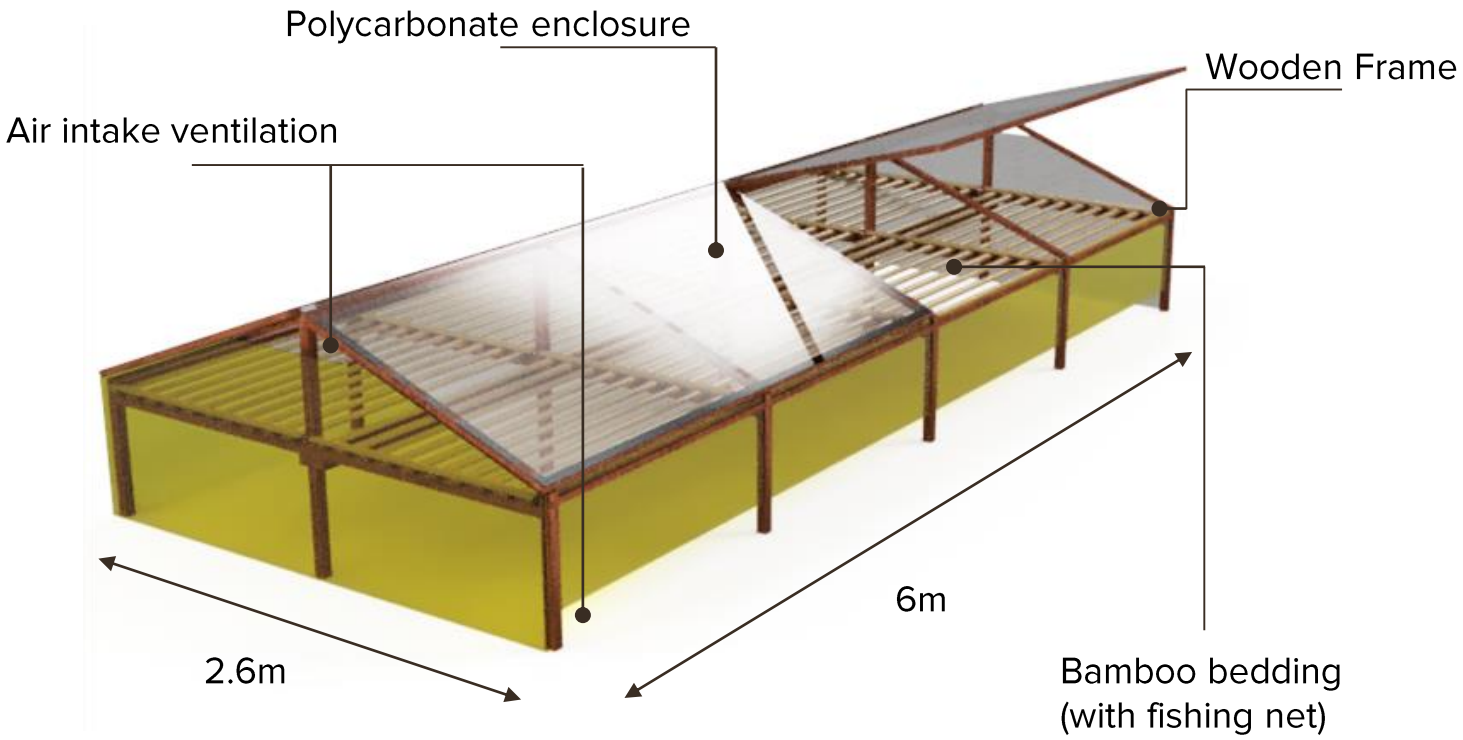
The solar dryer should address the farmers' current challenges by protecting the seaweed from rain and accelerating the drying process.



Dryer Features

- Enclosed drying chamber to optimize heat retention and avoid external contamination
- Passive drying from natural air convection.
- Large drying bed capable of drying 500 kg of seaweed (wet)
- Main construction materials can be substituted with similar materials (i.e. bamboo frame, PVC sheets for enclosure)
- Height of the dryer bed uses an ergonomic design to prevent injury during use

Cost

(for construction tools and materials)

IDR5,182,000 or **US$376.27***

*US$1 = IDR13,772 on February 1, 2020 from https://www.exchangerates.org.uk/

FINDINGS

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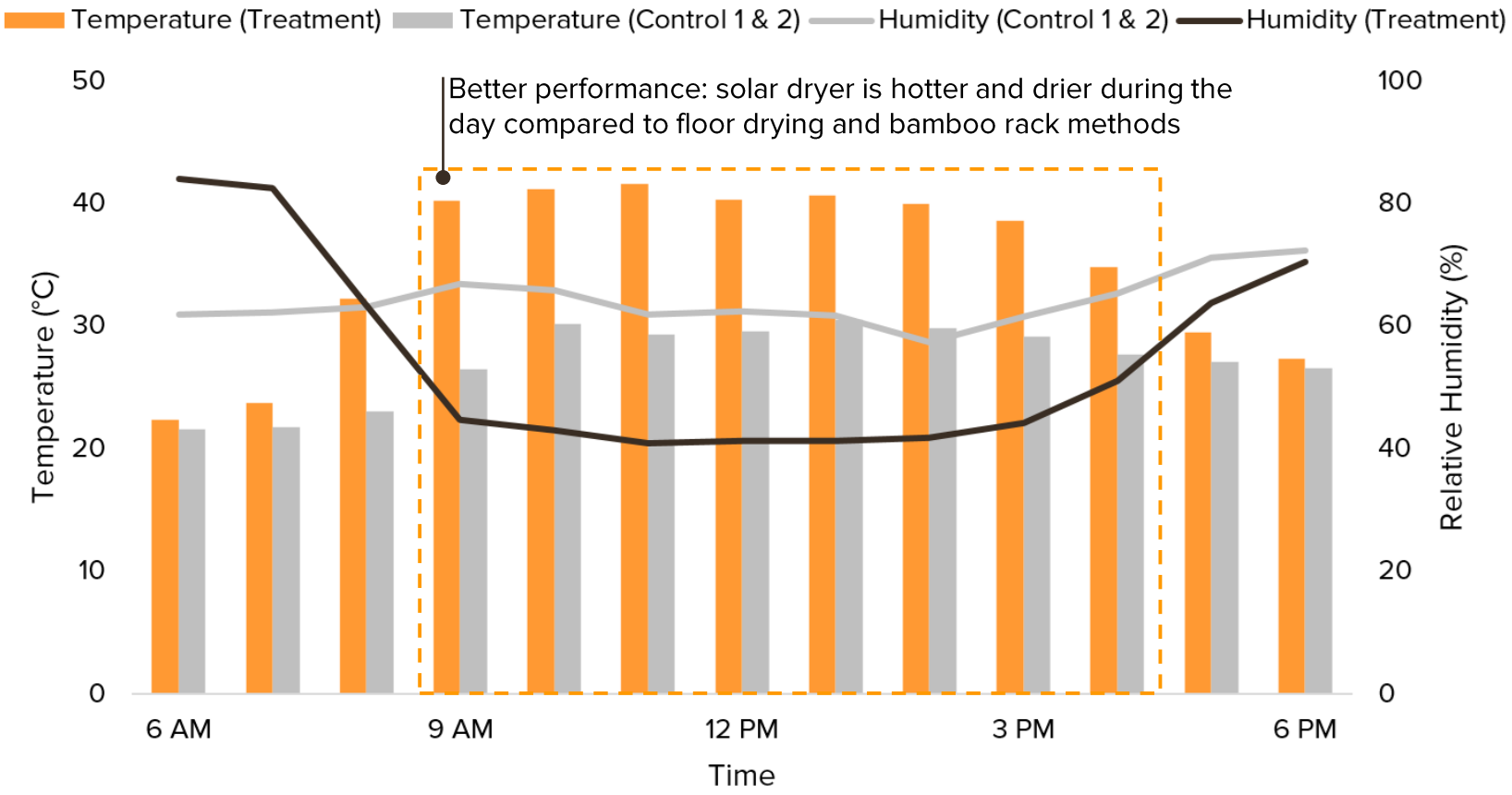
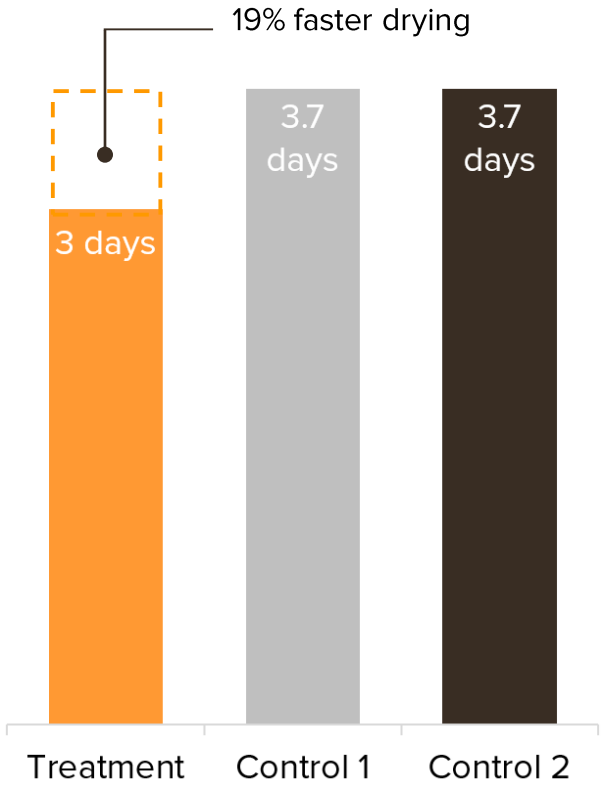
The findings confirmed that the solar dryer results in better drying conditions than the floor drying and bamboo rack drying methods.

Temperature and humidity*



Drying time**

N=3



*Data collected during the dry season over a two-month period
**Data collected during the rainy season; 3 x data collection

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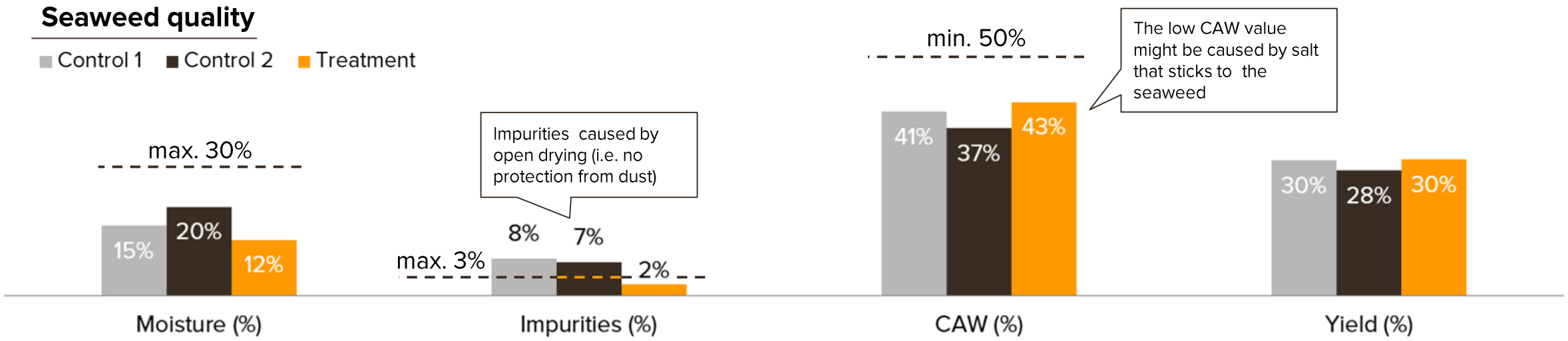
SEAWEED QUALITY

Overall, seaweed from the treatment group was of higher quality than seaweed from the control groups. However, there was not any direct economic benefit from the solar dryer as the sale price was the same for all three methods.



Parameters of SNI 2690 2015

Moisture content (max. 30%) affects the probability of seaweed deteriorating, The lower the moisture content, the longer it takes to deteriorate

Impurities (max. 3%) are undesired foreign objects (e.g., sand, dust)

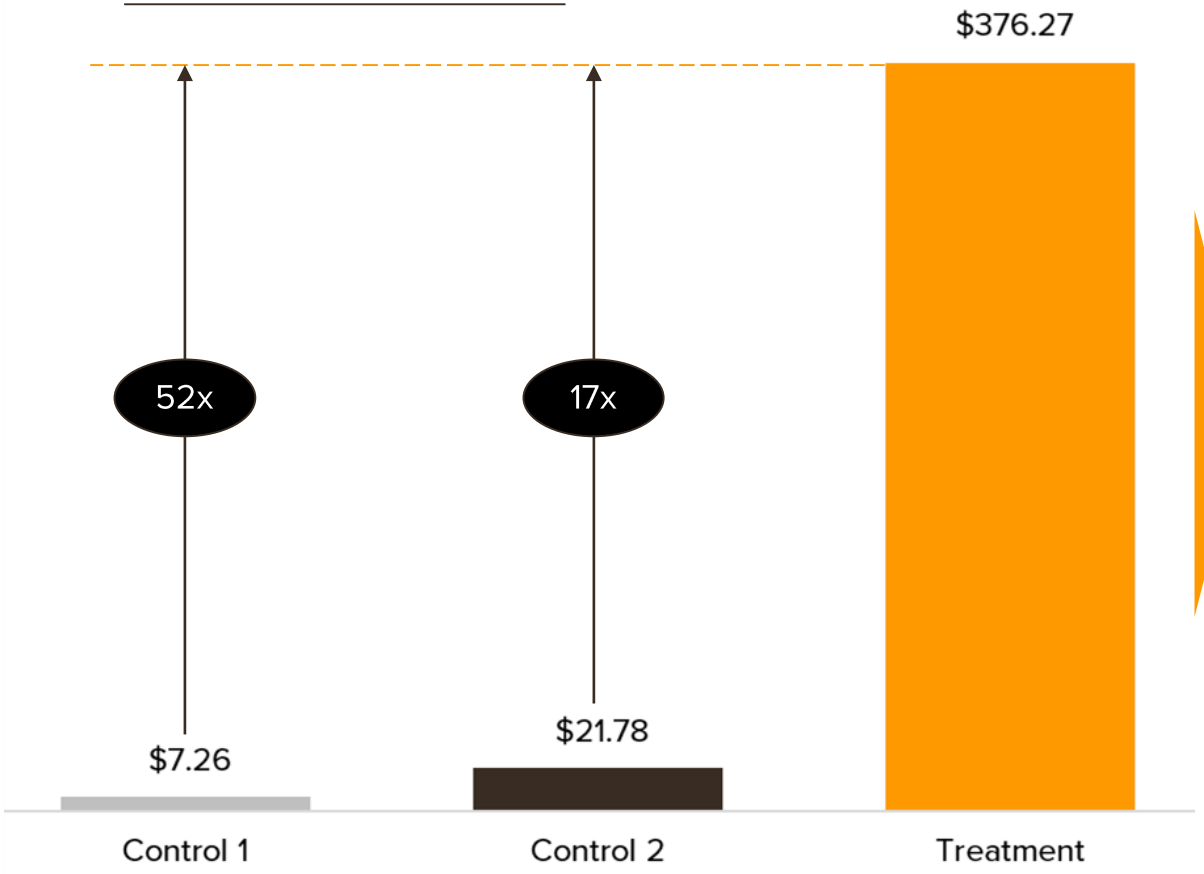
Clean Anhydrous Weed (CAW, min. 50%) reflects the cleanliness of dried seaweed. CAW includes carrageenan yield

Yield or carrageenan yield determines the price of seaweed

– – – – – –: Indonesia National Standard (SNI) 2690:2015 on dried seaweed

The cost to build the solar dryer (Treatment Group) was significantly more expensive than Control Group 1 and Control Group 2.

Cost comparison (USD)

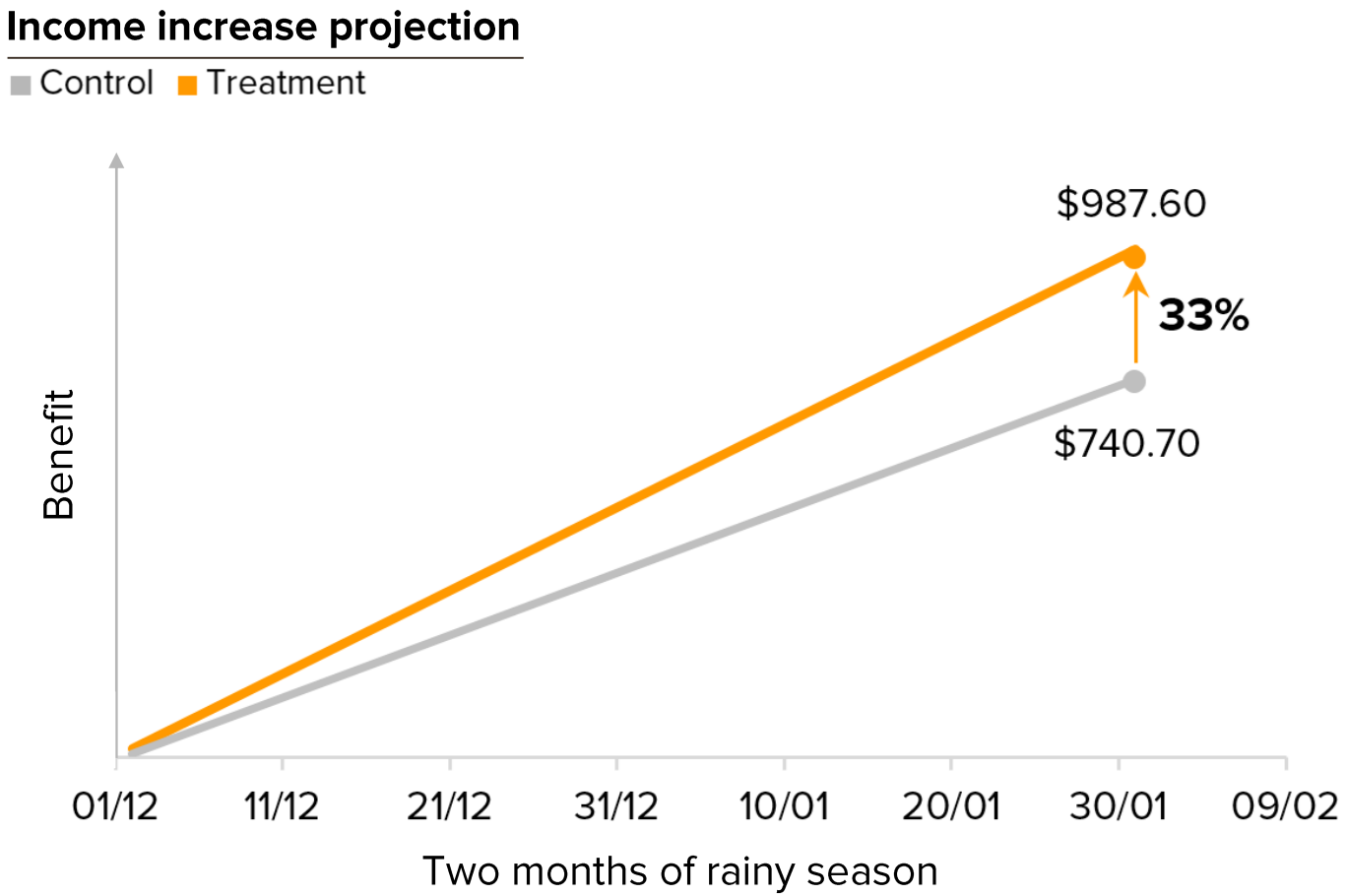


Solar dryer construction cost

No	Item	Unit	Price (IDR)	Price (USD)
1	Polycarbonate	1	Rp2,250,000	$163.37
2	Solar dryer construction tools and materials	1	Rp1,197,000	$86.92
3	Structural wood	1	Rp1,000,000	$72.61
4	Structural wood	1	Rp435,000	$31.59
5	Polycarbonate shipping fee to Lembata	1	Rp300,000	$21.78
Total Price			**Rp5,182,000**	**$376.27**

INCOME INCREASE PROJECTION

The solar dryer has the potential to increase farmers' income by 33 percent compared to floor drying and bamboo rack during the rainy season.



Assumptions

Control 1 and Control 2 take four days to dry seaweed; Treatment takes three days

Farmers have the capacity to grow more seaweed

The drying process takes place every day during the rainy season

The rainy season lasts two full months of December and January

Drying capacity of each method is 400kg, producing 40kg of dried seaweed

The price of dried seaweed IDR17,000 (US$1.23) per kg

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Although the solar dryer is effective, some improvements are still required to reduce the initial investment cost.

- Change the roofing material to PP sheet to reduce cost
- Adjust the frame to use cheaper materials such as tree trunks and bamboo
- The bed height is good, but the inner part of the drying bed is difficult to reach
- Heat retention can be improved by changing the side panel material to PP sheeting

SUMMARY OF KEY ASPECTS

We considered the following key aspects when assessing the drying methods: cost/availability, product quality, and weatherproofing. Based on these aspects, the solar dryer was deemed the best method of the three tested.

Description:
✓ = Bad
✓✓ = Moderate
✓✓✓ = Good

Key Aspects	Floor Drying (Control Group 1)	Bamboo Rack (Control Group 2)	Solar Dryer (Treatment Group)
	Seaweed is placed over an area covered with net.	*An elevated wood and bamboo rack.*	*Enclosed solar dryer using wood and polycarbonate.*
Cost/Availability Material needed to construct the dryer considering price and availability in the local market	✓✓✓	✓✓	✓
Quality Maintenance The ability to produce dried seaweed with good quality	✓	✓	✓✓
Weatherproofing The capability to protect seaweed from weather conditions i.e. rain	–	–	✓✓✓
	4	**3**	**6**

Seaweed impurities content exceeds national standard

Does not provide protection against weather at all

Polycarbonate is expensive and has to be shipped from Larantuka

CONCLUSION AND RECOMMENDATIONS

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CONCLUSION

We found that the solar dryer improved the drying process and the quality of dried seaweed. Compared to the current practices (floor drying and bamboo rack), the solar dryer resulted in the best drying conditions, and dried seaweed 19 percent faster in the wet season. Furthermore, the overall quality of dried seaweed from the solar dryer was better than that of other groups. The solar dryer has the potential to increase farmers' income by 33 percent if farmers can dry seaweed at full dryer capacity every day during the rainy season.

RECOMMENDATIONS

Based on the results of this experiment, Kopernik recommends:

- Finding a more affordable material to substitute polycarbonate for roofing; and
- Reducing bed depth to improve the ergonomic design and ease of use.

TESTIMONIAL

“I like the solar dryer as it allows faster drying in the rainy season. Plus, we don’t need to cover the seaweed with a tarp when it rains. Because of all the benefits, we replicated the solar dryer using locally available materials and polycarbonate sheets from Kopernik”

- Hafia, Head of a seaweed farmers group in Lembata

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