

# Innovation in the Development of Added Value of Seaweed Through the Application of Solar Powered Seaweed Drying and Management Technology With a Smart Control System Based on Green Economy

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**Abstract-** *The development of seaweed production in Olat Rawa Hamlet, Moyo Hilir District, Sumbawa Regency, has a high potential for seaweed production of around 1,100 tons/year. Most of this seaweed is marketed as wet and dry seaweed, the drying process takes quite a long time and the price the sales will be low or cheap, this condition really requires innovation and increasing the added value so that it can improve the standard of living of the local community. The aim of this Beginner Community Service (PMP) is to identify, analyze and improve the welfare of seaweed farmers assisted by Bumdesa Tunas Bakemang Olat Rawa (BOR). The current condition is that only the traditional seaweed drying process is carried out and it is not optimal, resulting in dried seaweed results that do not meet the requirements or poor quality standards and ultimately do not comply with SNI 01-2690.1:2009 standards. The traditional mechanism used by seaweed farmers is to use solar heat. In the summer the drying time for seaweed reaches 5-7 days, while in the rainy season the drying time is 1-2 weeks or even more. Because seaweed that is dried for a long time can cause mold, rot and low quality seaweed, so the price of seaweed becomes cheaper. Apart from that, products derived from seaweed that do not grow well and optimally help improve the farmer's economy. This seaweed drying and processing machine uses solar power and electricity,*

*considering that the availability of solar power is abundant in the geographical location of seaweed farming partners, based on test results, the seaweed drying machine has increased 1.2 times compared to traditional methods.*

**Indexed Terms-** *Process Efficiency; Production Capacity; Dryer Technology; Green Economy; Community empowerment*

## I. INTRODUCTION

Based on the administrative area, Olat Rawa village is located in Moyo Hilir, Sumbawa. Seaweed is one of the potential farmers' products owned by the Olat Rawa Village Community and is known nationally as a Seaweed Producing Area. Seaweed is planted on an area of approximately 1,000 hectares of the Saleh Bay Strait which is famous for its biodiversity with the number of fish variations being one of the largest in the world.

It is in this pious bay that Gelidium, Pterocladia, and Genus Gracilaria are cultivated, which produce agar and the Euchema genus which produces carrageenan, and the Sargasum genus which produces alginate, with total production reaching 1,100 tons per year. So far, seaweed has been harvested to meet market demand throughout Indonesia such as Lombok, Bali,

Java, Sulawesi, and East Nusa Tenggara, or exported abroad. Apart from that, Seaweed is a complement to fruit iced drinks for tourists because Olat Rawa is close to Moyo Hulu ecotourism and paragliding sports. The income of Seaweed farmers in Olat Rawa village can still be increased by primary and secondary processing of Seaweed to improve the quality of Seaweed so that it is suitable for export and meets national standards as a typical Seaweed food ingredient, however, this type of processing is very few. It is only sold semi-finished or raw without providing added value because it requires further processing.

The drying process is a sub-part of post-harvest handling in improving and influencing the quality of seaweed. According to Gunasekaran (2012), drying is a low-cost way of preserving seaweed to prevent fermentation or fungal growth, remove water, and slow down chemical changes in the product. So far, traditional drying processes include using direct sunlight or drying. This drying method is not effective due to several weaknesses, namely easy contamination (dirt, rocks, foreign materials, and animal disturbances), the need for large areas of land, impracticality in areas that often experience quite drastic weather changes, high levels of humidity because it is on the coast, the topography of the location is mountainous and fine sand as well as obstacles during the rainy season, the length of drying time.

A drying process that is not optimal will cause damage to seaweed because it can grow fungus and so on, where the good water content for seaweed is below 20% - 30%. Most seaweed in Indonesia, including in Olat Rawa Village, does not meet the quality standards based on SNI 01-2690.1: 2009, because it has a water content of above 30%. In the seaweed drying process, the drying temperature must be maintained constantly so that the quality of the seaweed can be maintained. Apart from that, Seaweed marketing is still carried out by selling directly to buyers who come to Olat Rawa Village and most of the sales are in the form of freshly harvested wet Seaweed, so the process of drying the Seaweed determines buyers' interest and price. If you add marketing channels such as digital marketing,

you can increase economic value and increase the turnover of farmers and their partners.

A crucial problem for seaweed farmers who are partners of Bumdesa Tunas Bakemang Olat Rawa (BOR) is that the traditional seaweed drying process is less effective, especially during the rainy season, taking up to 3 weeks, of course this has an impact on mold and results in a decrease in quality. The length of the drying process also creates problems in the queue for the drying process and a decrease in quality.

In addition, the temperature of the drying process cannot be controlled properly so sometimes overheating occurs during the drying process. According to Prasetyo (2008), drying seaweed agricultural products at temperatures that are too high can result in a decrease in quality, especially aroma and taste. So it is necessary to condition the drying room temperature as done by Wijaya (2014), Satria (2015), Rohman (2022), and Surata (2012), to maintain the drying room temperature at an efficient and effective condition, namely 55°C. Panggabean (2017), shows that cabinet-type solar dryers perform better than those using plastic. This research concludes that the cabinet-type solar dryer can improve the quality of dried seaweed in terms of reducing the water content, reducing the dirt content, and the resulting dried seaweed brighter.

Apart from that, another problem faced by Bumdesa Tunas Bakemang Olat Rawa (BOR) partners is that they have not implemented an efficient and effective group management system and a green economy-based marketing system. Obstacles in the value chain of seaweed include processing it into semi-finished goods or finished goods, this process has not been carried out optimally. The development of cracker products has not yet improved the economy and reduced the stunting rate that occurs in Olat Rawa village.

The income generated by farmers from the sale of raw seaweed has not been used to save for health funds, education funds, funds for the Hajj or Umrah, child marriage funds, and old age funds, due to a lack of understanding in increasing added value, relevant price information and the marketing chain for

seaweed which is widespread in Indonesia for both small and large scale industrial use. The activity aims to increase the capacity of human resources in running a seaweed farming business in Nanga Lidam Hamlet, Olat Rawa Village, Moyo Hilir District, Sumbawa Regency. In short, the problems faced by the Seaweed Farmers Group are the drying process which still takes a long time and is often hampered by rain which affects the quality of the seaweed, digital marketing, and the management system in managing the seaweed business and Bumdesa.

## II. METHOD

The training method is the suitability of the communication method used during the training. Training is part of developing capacity, developing clear goals, and developing attitudes that can be implemented with several method options according to the training objectives (Wagonhurst, 2002). Training program design is a training planning design that includes the type of training and methods, training objectives, materials, participant qualifications, trainer qualifications and characteristics, and time per training session (Mangkunegara, 2001).

The activity method was Focus Group Discussion (FGD), Interviews, and Training in a centralized Focus Group with partners, so several problems were found with Bumdesa Tunas Bakemang Olat Rawa (BOR) partners in the Nanga Lidam Olat Rawa Seaweed Farmer group, divided into 3 problems, including (1) HR Management Training; This training is carried out to provide knowledge to employees about their duties and responsibilities within the organization regarding HR management, HR Motivation and Remuneration so that business partners/groups will develop better with good, professional HR management and by market and industry needs. (2) Marketing Management Training; This training is carried out to provide knowledge to employees about their duties and responsibilities within the organization regarding sales, promotions, branding, and managing consumer databases, both digitally and in line with target market objectives, so that business partners/groups will develop further with good marketing management. , professional, and according to market and industry needs. (3) Financial

Management Training; This training is carried out to provide knowledge to employees about their duties and responsibilities within the organization regarding financial planning and accounting reporting, financial and accounting audits, financial performance evaluation, and final financial reporting as a basis for making decisions to purchase machinery, land (investment), expansion (business expansion). ) and bonus distribution, so that partners will develop further with good, professional financial management and according to market and industry needs. (4) Operational and Production Management Training; This training was carried out to provide knowledge to employees about their duties and responsibilities within the organization regarding Solar Power-Based Seaweed Drying and Management Machines with Intelligent Control Systems, Raw Materials, Distribution Lines, Trading Partners, Product and Service Quality so that partners will develop further with management. Good operations and production, professional and in line with market and industry needs. (5) Training on Designing and Manufacturing Solar-Based Seaweed Drying Machines with an Intelligent Control System; Based on the description above, there is a solution offered to increase efficiency and maintain the quality of Seaweed, namely by using a drying machine and processing Seaweed by a solar energy source. Drying Machine Technology is designed to work automatically according to the optimal temperature for drying Seaweed, namely 55 C. This drying machine uses an intelligent fuzzy logic control system to control the temperature and humidity of the air in the drying machine. The application of this drying technology can shorten drying time from 1-2 weeks to 1-2 days with a machine capacity designed to reach 100 kg. Meanwhile, to creation of Bumdesa Tunas Bakemang Olat Rawa (BOR) which has a good management system, will be done through socialization and training (workshops) related to business management systems, packaging, and digital marketing for this business group. This activity aims to provide insight and experience regarding the operation and repair of seaweed drying machines at Bumdesa Tunas Bakemang Olat Rawa (BOR). Apart from that, a manual book or manual for the operation and repair of this Seaweed Drying Machine was created.

### III. RESULTS AND DISCUSSION

#### • RESULTS

##### Design of a Hybrid Seaweed Drying Machine

The working principle of the drying machine offered in this service activity is that energy is absorbed from sunlight during the day using a solar collector and the principle of the greenhouse effect, whereas if the weather is cloudy or rainy and at night heat energy is obtained from electricity. Providing sufficient air circulation (inlet and outlet) allows the dryer to work optimally. This heat energy from solar and electricity is delivered using the forced convection method with the help of a blower into the drying chamber. The solar drying machine technology that will be used was developed from a drying machine designed as shown in Figure 1.

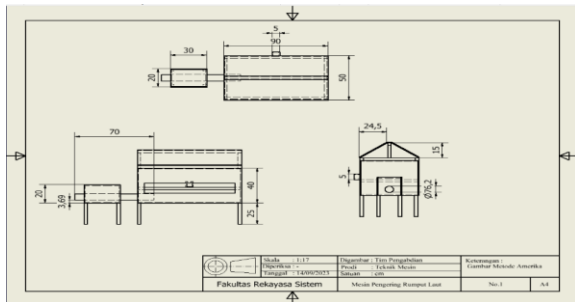


Figure 1. Seaweed drying machine label.

#### • Drying Machine Innovation

Seaweed drying and processing machines are equipped with temperature and humidity control technology in the drying room so that the temperature and humidity of the drying room are constant at optimal conditions. The control system used is based on fuzzy logic which functions to control the amount of solar power entering the drying room. Apart from that, the control system will also regulate the opening of the drying room ventilation, so it is hoped that by using this technology the drying process will always be optimal and cause the quality of the Seaweed to always be maintained. In addition, to avoid interruptions in the electricity supply to the control system on the machine due to limited electricity supply at the service location, the drying machine is equipped with solar energy/greenhouse effect

#### • Partner Locations Maps

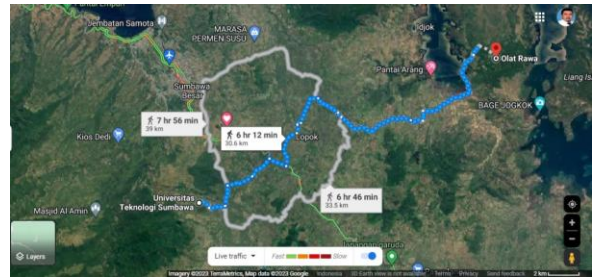


Figure 2. Partner Locations

The location of Sumbawa University of Technology to Bumdesa Tunas Bakemang Olat Rawa (BOR) is around 30.6 km. Olat Rawa Village has an area of 36.04 km<sup>2</sup> or 19.29 km<sup>2</sup> of the area of Moyo Hilir sub-district, there is one (1) beach, with an area of 524 km<sup>2</sup> of rice fields, not 2,681 km<sup>2</sup> of rice fields, the village government is led by a village head, 4 village officials, 4 hamlets, 4 RWs, 12 RTs, with a population of 1,632 people, the population density of 45 people per km<sup>2</sup>, 433 households, with an average family member of 3.73 people. Supporting clean beaches has great potential for developing seaweed cultivation in this village. Olat Rawa Village has the potential to support seaweed production for both domestic and international markets, but it is only sold traditionally (raw), there is no increase in added value so it is difficult for farmers' welfare to be improved. Annual seaweed production ranges from 500 tons to 1,000 tons, so the supply of raw materials is very abundant, creating a market potential estimated at Rp. 500 million per year, but so far this has been a potential loss for seaweed farmers for years. This machine could be a big step in achieving equal welfare for seaweed farmers in Olat Rawa Village.

• Discussion

- 1) Socialization of the activity agenda and delivery of initial science and technology materials used in community service activities



Figure 3. Socialization of the activity agenda and delivery of the initial science and technology materials used in Community Service Activities.

Socialization of the activity agenda and delivery of initial science and technology materials used in community service activities was carried out with participants: 1 Chair of the Seaweed Farmers Group, Mrs. Susilawati, and 1 Director of Bumdesa Tunas Bakemang, Olat Rawa Village (BOR) on behalf of Mrs. Kamariah, A.md. Beliau has been involved in proposing the beginning, however, currently, he no longer serves as Director of Bumdesa Tunas Bakemang Olat Rawa (BOR). This activity aims to transfer innovation in developing the added value of seaweed through the application of solar-powered seaweed drying and management technology with an intelligent control system based on a green economy. This activity was carried out on September 10, 2023, at Mrs. Kamariah's residence, and on September 12, 2023, at the Orange Building, Batu Alang Faculty of Economics and Business, Pernek Moyo Hulu with seaweed farmer and processor Mrs. Susilawati. The reason for this being done in these two places is because the partners are busy during the corn planting season, cleaning the fields in preparation for planting so it is quite difficult to invite them to meet on the same occasion, besides the locations between the hamlets are up to 30 km apart with road access that is still not fully paved. from inland areas to the coast.

- 2) Assistance in making drying equipment and training on the seaweed drying process.

In the activity of making Seaweed dryers, students were assisted operationally by coordinating with the implementation team. The process of making a seaweed dryer will last for two months, namely September 14 to October 2, 2022, which is located at the Mechanical Engineering Workshop at Sumbawa University of Technology. Several obstacles caused the process of assembling this tool, due to waiting for the dryer components to be purchased from outside the region (Sidoarjo, Surabaya, Jakarta).



Figure 4. Assistance in making seaweed drying equipment

Training on the Use of Seaweed Drying Equipment on October 3 2023 with the speaker Putu, one of Mr. Mietra Anggara's student assistants, M.T. which conveys the construction of drying equipment, mechanization of the grass drying process using a drying device. This activity was attended by representatives from the Seaweed Farmers Group totaling 4 people, and aimed to enable seaweed farmers to make drying equipment independently and understand how to dry seaweed using a dryer with a biomass energy source. At the end of the activity, there was a dialogue session to evaluate the level of understanding of the activity participants. The results of the activity were that partners were able to make 1 complete set of drying equipment and the implementing team handed over 1 set of this equipment.





Figure 5. Assistance in using drying equipment/machine

3) Business Management Training (HR, Finance such as Cost Calculations, Prices, Profits and Reporting)

Business Management Training was held on October 3 2023 at the Olat Rawa Village Multipurpose Building, with speaker Abdul Salam, S.E., M.M. Present at this activity were 6 members of the Seaweed Farmers group. This training was held at 9.35 – 10.30 WITA. training materials, namely: cost calculations, prices, profits and reporting, access to funding for MSMEs, and the Business Canvas Model (BMC). At the end of the session, an FGD was held with a focus on discussing the one-man show concept in organizational management, administrative reporting, and understanding of products and markets. The output of this activity is that partners can understand access to capital, increase welfare/income, orderly and neat financial reporting, create superior products, and generally increase the capacity of Seaweed Farming Groups.



Figure 6. Business Management Training

4) Digital Marketing Training (Digital Marketing Management Systems and Operations such as Raw Materials, Distribution or Supply Chain)

Digital Marketing training activities were carried out on October 3, 2023, at the Seaweed Farmers Group Office with speaker Irawan, M.E. This activity was attended by six members of the Seaweed Farmers group. This training is held at 10.30 – 12.00 WITA. The training materials are digital product marketing through social media, e-commerce, promoting products in WhatsApp groups, Facebook groups, etc. attracting customers to buy products. The training ended with a discussion.

The training activity on determining selling prices was carried out on October 3, 2023, in the Olat Rawa Village Hall, with speaker Abdul Salam, M.M. This activity was attended by 10 members of the Independent Young Farmers group. This training was held at 13.00 – 14.00 WITA, with material namely: the importance of determining product prices such as calculating production costs, salary costs, availability of seaweed raw materials for sustainable production and delivery of goods to various regions in Indonesia and the amount of profit that will be charged to products, as well as packaging support in supporting product sales and the introduction of tools for packaging design, taking product photos and important factors in good packaging.



Figure 7. Digital Marketing Training and determining selling prices for seaweed products.

The expected output from this activity is increasing the capacity of seaweed farmers to have their seaweed brand and directly market seaweed to consumers via e-commerce such as Shopee, Tokopedia, or other digital media after going through the process of obtaining business permits, distribution permits, BPOM, Halal and other things required by consumers.

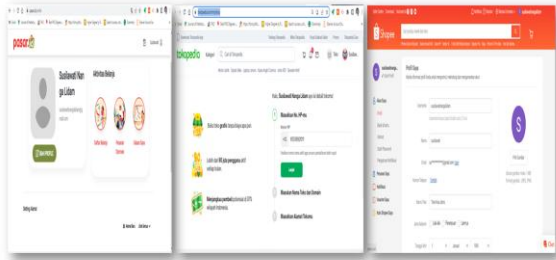


Figure 8. Example of a Seaweed Online Store

In this activity, the speaker gave an example of attractive packaging with the brand name of seaweed which had previously been conveyed by the team. Apart from that, participants are expected to be able to market seaweed products using e-commerce which can help reach a wider market.



Figure 9. Seaweed Product Sticker Design

Increasing the capacity of social capital and human capital through FGD (Focus Group Discussion), Problem Solving, Training on Business Management and BUMDESA, Sales Price Determination Management, digital marketing management, Training on the operation of hybrid seaweed drying machines with participants from Seaweed Farmer groups and Bumdesa Tunas Bakemang Olat Rawa (BOR), the aim is to increase the implementation of natural resource capacity through the transfer of appropriate technology, appropriate value,

appropriate markets from human and social capital from farmers and village-owned managers and the effectiveness of collaboration between campuses and the business world which accelerates the increase in added value seaweed products in encouraging the welfare of seaweed farmers. At the end of the activity session, questions and answers were held, and solutions and innovative ideas were exchanged in the sustainable management of seaweed natural resource capital. The final result of this activity is that partners can independently create a hybrid seaweed drying machine complete with solar power, heating and temperature control, and adjusting production capacity. Then FGD for training on cross-sectoral collaboration concepts (farmers, Bumdesa, village government, markets) on business management, financial reporting, financial performance audits, understanding product innovation, digital marketing and distribution, and product safety or suitability.

The development of the BOR business unit from the Savings and Loans sector was then expanded to Gas Shops, Agricultural Medicine Shops, and Basic Food Shops to attract a wider range of consumers from farmer group products, both seaweed farmer groups, fishermen groups, and superior village products. This strategy It is hoped that it will be able to increase income or additional income per store by an average of around 5-10% per month.

#### 5) Machine use training and partner capacity building activities

The seaweed dryer is produced and has been tested for drying dried seaweed, chips, and seaweed candy, drying seaweed is more hygienic and free from fine sand around the beach where partners live so that the seaweed resulting from this drying contributes to increasing production and partner turnover. Apart from that, after the trial process, solar power worked well so it continued with the handover of 1 set of drying equipment, packaging, packaging, and product stickers.





Figure 11. Equipment handover activity

The team activities that we carry out get the enthusiasm of the people of Nanga Lidam Hamlet, Olat Rawa Village, the drying time also really determines the final result of the seaweed including the quality, price, and target market so that post-harvest seaweed is immediately or even awaited by regular buyers. Therefore, below are the results of the evaluation and monitoring that we carried out by distributing satisfaction surveys and feedback from this activity, namely with four key points, namely materials, sources, tools and materials, places of activity and consumption as well as recommendations from Nanga Lidam farmers. List as follows:

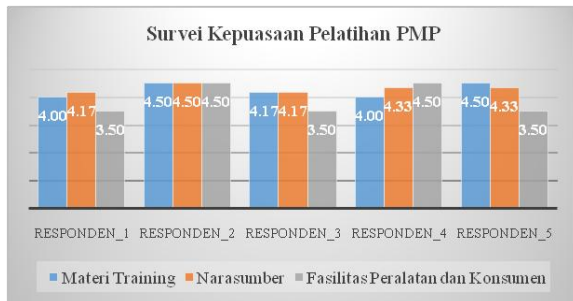


Figure 12. Training satisfaction survey

Based on this data, the majority of participants gave an average score of the highest 4.5 and the lowest 3.5, this means that the training material for business management and Bumdesa, pricing management,

business permit processing training, marketing digitalization material, training material for using tools, is useful. to increase partner seaweed businesses in Nanga Lidam hamlet in the future. On the other hand, the participants wanted technical training related to seaweed management in increasing productivity, analyzing quality raw materials, managing market potential to reach a wider market, and all participants wanted further training that could encourage an increase in the scale of the chips and candy business. This seaweed is a superior product of Olat Rawa village and increases the diversification of its Bumdesa businesses. So, the material presented is by the conditions and expectations for the development of this seaweed business, although the training facilities and media are quite complete because access is quite far from the government center with transportation routes via unpaved dirt roads. The high level of satisfaction is reflected in the maximum score of 4.5 in almost every indicator measured.

Around 90% of respondents said that the training materials and dryers using solar energy and heat from electrical energy were very useful and suited the participants' needs (green economy). The majority of respondents felt that it was very useful to take part in training on business management, digitalization of marketing, and use of tools and 90% of respondents said that the resource persons were precise and easy to understand the material they presented. Most of the respondents felt satisfied with the equipment and consumption facilities during the training so that the material and resource persons could be accepted and recommended to other parties who needed the same thing and with this, the training participants made progress in terms of knowledge and new methods which could later encourage improving quality and income for partner farmers. The conclusion is that around 95% of respondents felt satisfied and benefited from business management training, sales price determination management, business permit processing, marketing digitalization, and use of the drying equipment/machine that was made and were willing to recommend resource persons to local governments, organizations, and others. On the other hand, the participants gained new enthusiasm and encouragement to cultivate and produce higher quality which had an impact on increasing sales and



welfare of these farmers. What is more important is that they can meet domestic seaweed needs and be export-oriented to Indonesia's seaweed trading partner countries.

#### CONCLUSION AND RECOMMENDATIONS

The achievements of this Beginner Community Service (PMP) are (1) partners understand and there is an increase in the productivity capacity of processed seaweed products, adding product variants and packaging that is more targeted at the target market segment, (2). Mitra applies and can manage the business, making a hybrid seaweed drying machine powered by solar and electricity, increasing seaweed production, and commitment to increasing community-based businesses, as well as a commitment to preserving natural resources, the environment, and sustainability of partnerships in community-based service programs (PBM).

In the future, this research recommends the need to add a filter to collect or drain water from the process of drying seaweed, chips candy, or other products such as fish, etc., develop a similar model, and at the same time develop it, this drying tool can be applied widely but also continues to go through a thorough testing phase. according to the characteristics of the goods or products to be dried using this tool.

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