Optimising Empowerment of Fostered Villages for Increased Income of Tambak Farmers in Bulu Cindea Village

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Optimising Empowerment of Fostered Villages for Increased Income of Tambak Farmers in Bulu Cindea Village

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Abstract. The increase in salt imports by the Indonesian government should prompt coastal communities endowed with extensive marine resources to improve their salt production, subsequently catering to the demands of the industrial sector. The primary objective of the target village empowerment program is to assess the impact of implementing geomembrane technology on the augmentation of revenue among salt producers residing in Bulu Cindea Village, located in the Pangkep Regency. The present study employed descriptive analysis and income analysis methodologies. Descriptive analysis offers a more accurate depiction of the indigenous knowledge and practices used by salt pond producers. The examination of income assesses the earnings of salt pond farmers about implementing the PDB program. The present study examined the potential enhancement of pond farmers' income through implementing the PDB program. This was accomplished by analyzing variance, followed by a t-test, to assess the impact of salt farmers' income on adopting geomembrane technology. The results revealed a statistically significant difference ($p < 0.05$) between salt farmers' income before and after the utilization of geomembrane technology, indicating a positive effect on their overall income. The findings suggest that implementing the PDB program, specifically through geomembrane technology, can enhance the socioeconomic conditions of salt producers residing in Bulu Cindea Village.

1. Introduction

Salt is an essential food element indispensable in domestic settings and a fundamental component in the food manufacturing sector. The current salt production still needs to satisfy the existing market demand. Salt production capacity varies across different regions, affecting the overall supply and demand dynamics [1]. The substantial need for salt necessitates alternative means of meeting the demand beyond relying solely on domestic salt production [2]. The demand for salt by the population surpasses the existing manufacturing capability [1]. Upon examining the state of salt production in Indonesia, it can be deduced that the production of domestic salt, particularly table salt, only coincides with domestic salt

production [3]. Simultaneously, the sector continues to rely on imported goods. To solve these concerns, it is essential for the government to prioritize domestic production for the manufacturing of salt of superior quality and to incentivize domestic salt manufacturers. This is particularly crucial considering the higher demand for industrial salt than table salt [4]. The current productivity levels exhibit a moderate degree of elevation due to the absence of substantial investments in the effective management of natural resources, such as ponds. To effectively tackle these concerns, the government must prioritize domestic production in the manufacturing of premium salt and incentivize domestic salt producers. This is particularly crucial considering the higher demand for industrial salt than table salt [4]. The current productivity levels exhibit a moderate degree due to a lack of substantial investment in effectively managing natural resources, such as ponds.

Given these concerns, the government must prioritize domestic production to foster the creation of premium salt that will incentivize domestic salt manufacturers to utilize it. This is particularly crucial considering the higher demand for industrial salt compared to table salt [5]. As per the Regulation of the Minister of Maritime Economy and Fisheries of the Republic of Indonesia, specifically No. PER.41/MEN/2011 [6], the Indonesian government has implemented various measures to promote domestic salt production for local consumption. These initiatives involve enhancing the People's Salt Business (PUGAR) and exploring the untapped potential of existing salt deposits. PUGAR is a component of the Independent National Program for Fisheries and Marine Communities (PNPM Mandiri-KP/National Program for Independent Marine and Fisheries Communities) [7]. The primary objective of PUGAR is to attain national self-sufficiency in salt production by enhancing both the quality and quantity of salt production. This is intended to meet the domestic need for salt, which has traditionally been fulfilled through imports from foreign nations.

The enhancement of salt quality depends upon the concentration of sodium chloride inside the salt [8]. The sodium chloride level in salt is contingent upon the concentration of seawater utilized throughout the salt production process and the specific geographical source from which the seawater is collected. In addition to this, the quality of salt is significantly impacted by the geographical location in which it undergoes crystallization [9][10]. The conventional method including the utilization of a designated area of land, commonly referred to as a salt table, represents a crystallization environment whereby salt crystal grains are generated [11][12]. The production of salt via this technology is expected to yield substandard quality due to the potential mixing of salt crystals with soil particles, resulting in a deviation from the desired pure white colouration [13]. Hence, there is an urgent need to incorporate novel technological advancements into the salt crystallization process in order to enhance the quality and quantity of salt production. The implementation of geomembrane technology is anticipated to enhance both the quality and quantity of production [14][15]. A geomembrane is a synthetic layer characterized by a low level of permeability, rendering it impervious even to acidic liquids [16]. The utilization of this substance is prevalent in artificial ponds, sanitary landfills, and other similar contexts [17][18]. Implementing geomembrane technology holds significant advantages for salt farmers since it enables the salt crystallization process to be conducted without direct soil contact. The geomembrane has a higher rate of solar absorption compared to conventional technology, hence enhancing crop quality and reducing the duration of the harvest chain [19][20][21]. Bulu Cindea, a village located in Pangkep Regency, is predominantly inhabited by salt pond farmers. The implementation of geomembrane technology in this region is anticipated to transform it into a prominent salt production hub. This technological advancement can directly enhance salt pond farmers' financial prospects by augmenting their income.

2. Research Methods

The study was carried out between the months of January and June in the year 2023. The study was carried out at Bulu Cindea Village, located in the Bungoro area of the Pangkajene and Islands (Pangkep) Regency in South Sulawesi, Indonesia. The town of Bulu Cindea is situated in the western region of the Pangkep Regency, exhibiting a highly advantageous geographical location due to its proximity to the provincial capital of South Sulawesi. Bulu Cindea Village is situated inside the

Bungoro Sub-district of Pangkep Regency from an administrative standpoint. The primary emphasis of the study is centered around a salt facility, hence the selection of the study's location was deliberately made in close proximity to a salt pond situated near the shoreline. The research locations are depicted in the following map (Fig. 1).

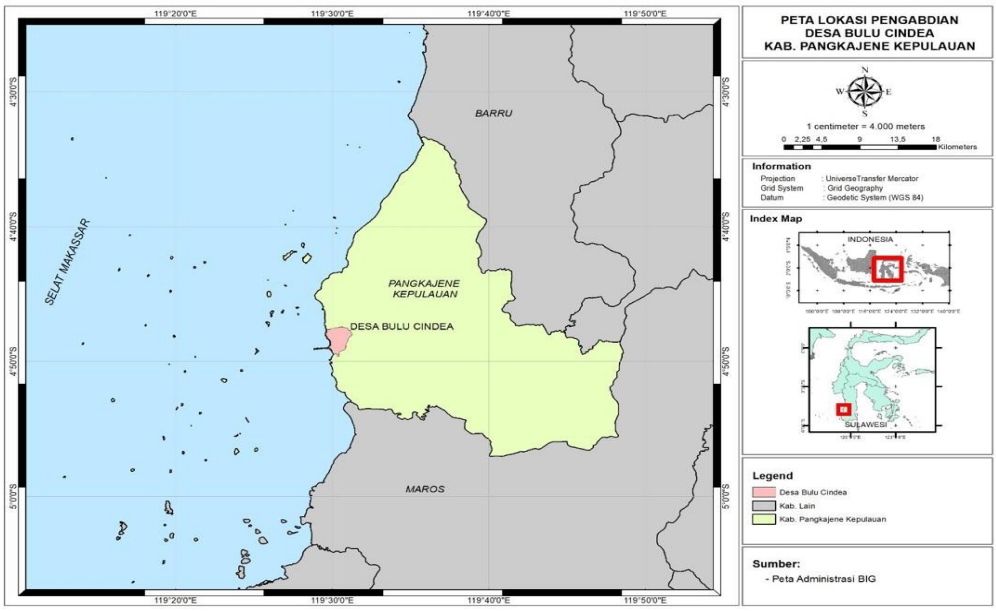

Figure 1. The map of location research at Bulu Cindea Village

The data was gathered using several methods, including observation, interviews, and a literature review focusing on salt farmers operating in salt ponds [22]. The study's sample consisted of 827 farmers, who were categorized into two groups: 65% (538 individuals) were engaged in salt pond farming, while the remainder farmers were involved in rice field cultivation. The sample was picked in a random manner using a simple random technique using the Slovin formula [23], resulting in a final count of 127 respondents. The employed data analysis approaches encompass descriptive analysis and income analysis. The descriptive approach offers a more accurate depiction of the indigenous knowledge held by salt pond producers. The utilization of income analysis serves as a means to ascertain the earnings of those engaged in salt pond farming. The calculation of income is determined by employing the formula as stated in reference [24].

$$TR = P\ X\ Q; TC = TFC + TVC;\ \pi = TR - TC$$

Notes:
TR = Total Revenue (IDR), TC = Total Cost (IDR), P = Price (IDR/Kg), Q = Quantity (Kg), TFC = Total Fixed Cost (IDR), VC = Total Variabel Cost (IDR), dan π = Income (IDR)

The study is conducted by analyzing the pre- and post-implementation revenue levels in relation to the aided village empowerment activities (PDB). The analysis of income disparities between the two time periods was conducted using the paired sample t-test in the SPSS version 16 software. Paired samples refer to a type of sampling design in which the same subjects are subjected to two measurements, one before and one after a specific treatment.

The permissible level of inaccuracy is set at 5% (0.05), corresponding to the alpha value of 5%. The test findings may possess statistical significance if the p-value is less than 0.05. However, the test findings are considered statistically insignificant if the p-value is more than 0.05.

3. Results and discussion

3.1. Characteristics of Research Locations

Bulu Cindea Village is situated within the Bungoro Sub-district of Pangkep District, sharing its borders

with the village of Bulu Cindea. The northern boundary of the area is demarcated by the Labakkang Sub-district, characterized by its extensive shrimp farming ponds and salt ponds. To the south, it shares a border with Bori Appaka Village. The western boundary is defined by the Liukang Tuppabiring Sub-district, encompassed by the vast expanse of the ocean. Finally, the eastern boundary is formed by the village of Bowong Cindea, renowned for its salt production activities. The village of Bulu Cindea exhibits considerable potential due to its abundant fisheries resources, particularly in the realm of salt production. The total size of the pond is measured to be 429.5258 hectares.

Bulu Cindea settlement is situated inside the Bungoro Sub-district and has four distinct hamlets. These four hamlets, numbered from left to right: 1) Majannang Hamlet, 2) Bujung Tangaya Hamlet, 3) Jollo Hamlet, and 4) Biringkassi Hamlet, are dispersed over a 7 km^2 region and are situated 7 km from Bungoro District [25]. This community is situated along the seacoast and has diverse species, showcasing significant biodiversity within its boundaries.

According to projections, it is anticipated that the population of Bulu Cindea Village would reach 5119 individuals in the year 2022. This population will be further divided into two distinct groups: males, 2540 individuals, and females, 2579 individuals. The majority of the village community comprises individuals engaged in pond farming and fishing activities. The table presented below (Table 1) provides an overview of the various aspects of the lives of the village community.

Table 1. The population of Bulu Cindea Village, Bungoro Sub-district, Pangkep Regency in 2022

No	Type of Livelihood	Total (Head of Family)	Percentage (%)
1.	Farmer	827	55,47
2.	Trader	200	13,41
3.	Fisherman	385	25,82
4.	Breeder	65	4,36
5.	Government employees	14	0,94
	Total	1.491	100

Source: Population data of Bulu Cindea Village, August 2022

According to the data presented in Table 1, it can be observed that around 55.47% of the populace residing in Bulu Cindea Village depend on agricultural activities as their primary source of income, with a majority of them being involved in salt farming. Furthermore, it is worth noting that a significant proportion of the population, specifically 18.42%, is engaged in salt trading as a livelihood. The majority of the villagers possess a level of education that extends to high school completion. The population data is displayed in Table 2 as presented below:

Table 2. The population of Bulu Cindea Village, Bungoro Sub-district, Pangkep Regency, based on education level in 2022.

No	Level of Education	Total (People)	Percentage (%)
1.	Collage Graduate	67	4,57
2.	Senior HS Graduate	132	9,01
3.	Junior HS Graduate	352	24,03
4.	Elementary School Graduate	423	28,87
5.	Not finished Elementary School	491	33,52
	Total	1.465	100

Source: Population data of Bulu Cindea Village, August 2022

According to the data presented in Table 2, a significant proportion of villagers, approximately 28.87%, possess a primary school education. Additionally, a considerable portion, up to 33.52%, have yet to complete their elementary school education. On the other hand, only 4.57% of villagers have

successfully attained an undergraduate level of education. According to the findings from interviews conducted with local community members, a significant proportion of individuals who have attained educational qualifications up to the undergraduate level are offspring of individuals engaged in salt pond farming activities. This study demonstrates that the revenue generated by salt pond farmers positively contributes to the overall well-being of rural communities.

3.2. Description of Research Respondents

The present study encompassed a sample population consisting of individuals engaged in salt pond farming inside the Bulu Cindea community. There are 425 residents that decide to pursue farming, including 225 salt farmers. The sample population of individuals engaged in salt pond farming, who were selected as respondents by a random sampling method, consists of 127 individuals, each possessing the following sample identities:

Table 3. The condition of the sample population of villagers based on age level, education level, and experience as salt pond farmers in 2023.

No	Category	Respondents (People)	Percentage (%)
Age (year)			
1.	15-30	39	30,71
2.	31-46	58	45,67
3.	47-62	27	21,26
5.	>62	3	2,36
	Total	127	100
Education Level			
1.	Collage Graduate	2	1,57
2.	Senior High School	13	10,24
3.	Junior High School	45	35,43
4.	Elementary School	44	34,65
5.	Not finished Elementary School	23	18,11
	Total	127	100
Experience as a salt farmer (year)			
1.	<10	23	18,12
2.	10-15	48	37,79
3.	>15	56	44,09
	Total	127	100

Source: Population data of Bulu Cindea Village, August 2022

Table 3 reveals that 58 respondents, or roughly 45.67% of the total, were still in the 31-46 year age range. The data suggests that most participants between the ages of 15 and 30 (30.71%) and 47 and 62 (21.26%) fall within the productive age range, possessing the necessary physical and psychological capabilities to effectively engage in salt farming activities. According to the educational attainment of the inhabitants of Bulu Cindea Village, it was found that 18.11% of the participants still needed to complete their elementary education. Additionally, 34.65% successfully completed elementary school, while 35.43% attained education up to the junior high school level.

The correlation between this condition and the educational attainment of the village community, as indicated by the respondents in this study, is notable, with a predominant representation of individuals with primary education. The educational attainment of the residents in Bulu Cindea Village is consistent with the observations made among the salt farmers who participated in the research. Specifically, a significant majority of the respondents, around 44.09%, have been engaged in salt farming for over fifteen years. This phenomenon exhibits a strong correlation with acquiring knowledge within official educational establishments [26], hence augmenting one another

through the integration of diverse information derived from our practical experiences as pond farmers in the village of Bulu Cindea.

3.3. Salt Management Mechanism in Bulu Cindea Village

A technological advancement facilitating the augmentation of salt production has been discovered. The continued reliance on traditional salt production methods in various places suggests that not all salt-producing areas in central Indonesia have adopted modern technological advancements in this industry. In the past, the salt pond farmers residing in the village of Bulu Cindea employed a traditional approach to regulate salt application within their vicinity. The utilization of traditional management approaches may yield more favourable outcomes. The salt management system in Bulu Cindea Village is characterized by a semi-traditional approach, which incorporates a blend of technologies that have been enhanced by implementing geomembrane technology. The geomembrane system has been specifically engineered to facilitate salt production, employing a foundation composed of black tarpaulin material (see Figure 2.). The primary objective of technological advancements in salt production is to enhance the quality of salt by creating cleaner environmental conditions and increasing yields. This is achieved by using methods that prevent water used in the salt-making process from seeping into the ground, prolonging its usability (see Figure 3). Before entering the salt table, the seawater undergoes a filtration procedure. Additionally, a tarpaulin is utilized to ensure the preservation of salt quality and expedite the production process. The process of seawater evaporation is facilitated through the utilization of solar energy. The process involves the collection of seawater into a designated holding pond, followed by the subsequent transfer of the water to the plots where it is exposed to direct sunlight for seven days to facilitate evaporation. The crystallization rate from saltwater to aged seawater is accelerated due to the excellent heat absorption of black plastic under sun exposure [27]. Upon completing a ten-day storage period, the subsequent batch of salt will be gathered following the development of salt crystals.

Figure 2. Use of geomembrane technology in salt ponds in Bulu Cindea Village, Bungoro Sub-district, Pangkep Regency

Figure 3. Salt production using geomembrane technology in Bulu Cindea village, Bungoro Sub-district, Pangkep Regency

Since 2019, the people of Bulu Cindea Village, especially traditional salt farmers, have switched to using geomembrane technology to produce community salt. Geomembrane technology is versatile in various areas of the Pangkep Regency. Before pond farmers used this trend as the basis for salt production in ponds, geomembranes were also widely used in fishponds, sewage systems, and waterways. Geomembrane is made of HDPE (High-Density Polyethylene) polymer for good strength [28][29]. The various advantages of using this technology include more intensive absorption of solar heat resulting from the black colour effect of the geomembrane material[30]; the raw material for making salt in the form of seawater is not easily absorbed due to the shrinkage of the bottom of the salt pond, which is mostly just compacted soil [31]; the crystallization process takes more time[13]; and it is more efficient in terms of production time [32]. The salt produced is whiter and cleaner because it is not contaminated with impurities from the pond's bottom soil [33]. Salt farmers in the village of Bulu Cindea carry out salt production activities during the dry season (September–December).

3.4. Differences in Income of Salt Farmers

The present study examines the income of salt pond farmers subsequent to the adoption of geomembrane technology, as well as their income before introducing this technological innovation. Research on the financial aspects of installing geomembrane technology was conducted for one season, specifically from December 2022 to June 2023. The income analysis on geomembrane technology was conducted by computation of earnings within salt farming communities. The income of the salt pond farmer can be determined by calculating the difference between the total revenue (TR) and the total cost (TC). The revenue salt pond farmers generate in a given season is determined by multiplying the total salt production by the prevailing price per unit (Rp). The table presented below displays the production quantities according to the number of salt pond farmers in Bulu Cindea Village.

Table 4. Salt production in Bulu Cindea Village in 2023

No	Category of Production (Kg)	Number of Salt farmers (People)			
		Before	%	After	%
1.	High (≥ 4800)	0	0	25	19,68
2.	Medium (4001-4750)	23	18,11	88	69,29
3.	Low (≤4000)	104	81,89	14	11,02
	Total	127	100	127	100

According to the data presented in Table 4, the population of salt pond farmers before adopting the geomembrane system was distributed across the medium and low categories. Within the medium group, around 18.11% of the total respondents, or 23 individuals, were salt pond farmers who reported a production range of 400-4750 kg. Around 81.89% of the respondents, or 104 salt pond farmers, reported achieving production levels below 5000 kg within the low group. When implementing the geomembrane system technology, a majority of the participants (69.29%) reported achieving production levels within the specified category, while 25 respondents (19.68%) reported achieving output levels in the high category (≥ 9800). Based on the analysis, it can be inferred that implementing the geomembrane system technology will lead to ideal production outcomes. The utilization of this technology is expected to yield superior production outcomes compared to the conventional system. Specifically, the resulting sodium chloride (NaCl) content is measured at 99.96%, with a moisture content of 0.04%. Additionally, implementing this technology is anticipated to reduce the time required for harvesting in the Jeneponto regency [13]. Based on the findings of a study conducted by the cited source [34], the use of geomembrane technology in Jeneponto regency has the potential to enhance salt production. Table 5 below presents the income of salt pond farmers, which is derived from the quantity of output and the price of salt (Rp/kg), based on the production data provided.

Table 5. Salt farmer income in Bulu Cindea Village in 2023.

No	Category of Revenue (IDR)	Number of Salt farmers (People)			
		Before	%	After	%
1.	High (≥ 21.120.000)	0	0	34	26,77
2.	Medium (17.600.000-20.900.000)	28	22,05	69	54,34
3.	Low (≤17.500.000)	99	77,95	24	18,89
	Total	127	100	127	100

According to Table 5, the total revenue of salt pond farmers prior to the adoption of the geomembrane technology fell within the medium and low-income brackets. The majority of salt pond farmers exhibit moderate (22.05%) to low (77.95%) levels of revenue, ranging from IDR 17,600,000 to IDR 20,900,000 per season, equivalent to a monthly basis. Subsequently, following the implementation of geomembrane technology, most salt pond farmers (54.34%) were classified within the high category (26.77%). Following the implementation of the geomembrane technology, there was a notable increase in the revenue of salt producers. However, the expenses related to salt production in the pond continued to impact this revenue.

The analysis of variance using the t-test revealed a significance value of less than 0.05 ($0.002 < 0.05$), indicating a statistically significant difference in the revenue of salt pond farmers before and after implementing geomembrane technology. The disparity in revenue observed in the analysis findings can be attributed to the utilization of geomembrane technology. This technology offers enhanced salt quality by preventing its mixture with the soil and facilitating a faster production process. In the context of salt pond farming, it is observed that farmers employing geomembranes typically allocate a limited period of 5 to 10 days for maintenance activities prior to the harvest [35][36]. Hence, it is imperative to ensure the continuous advancement and refinement of geomembrane technology to achieve optimal and sustainable economic outcomes for individuals.

4. Conclusions

Enhancing the well-being of the inhabitants of Bulu Cindea Village, with a particular focus on salt pond farmers, will play a crucial role in advancing the adoption and implementation of geomembrane technology within the salt pond farming sector. The production value can attain a maximum of 69.29% on a medium size and a maximum of 19.68% on a high scale. This method can significantly enhance the revenue of salt pond farmers in the medium category by a maximum of 54.34% and in the high category by a maximum of 26.77%. The analysis of variance using the t-test revealed a statistically significant difference ($p < 0.05$) in the revenue of salt producers before and after implementing geomembrane technology. It is imperative to sustain and advance the progress of geomembrane technology to provide economic and socio-cultural advantages for the inhabitants of Bulu Cindea Village.

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