Development of salt production technology using prism greenhouse method

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Abstract. The main problem of salt production in Indonesia is low productivity and quality because the technology used commonly by Indonesian salt farmers is traditional method. This research aims to increase production of salt by using the prism greenhouse method. The prism greenhouse method is a salt production system with a combination of several salt production technologies, including geomembrane, threaded filter, and prism greenhouse technology. This research method used descriptive method. The results of this study were the productivity increased threefold, and the quality of salt produced also increased in terms of the content of NaCl from 85% to 95%. In addition, salt production with the prism greenhouse method has several advantages, such as faster harvest time, weather resistance, easy to use, and higher profit than traditional methods.

Keywords: geomembrane, prism greenhouse, salt, threaded filter

1. Introduction
Salt is an important food ingredient in life. Indonesia’s government had the priority program in the field of food sovereignty targeting salt production around 3.6 million tons in 2016. The General Director of Marine, Coastal and Small Islands at the Ministry of Marine and Fisheries Affairs stated that the need for salt of household and industrial consumption is about 3.6 million tons. It consists of 1.48 million tons for household consumption and 2.12 million tons for industrial consumption. However, in real, salt production only reached 144,009 tons or 4.6 percent of national needs [1]. Through the Ministry of Trade, the government imported salt from other countries to meet the need of the salt. Ironically, Indonesia is a leading salt producer country with the second longest coastline in the world of about 99.093 km². In addition, Indonesia has potential salt field of 29,000 ha, which should be able to meet the national salt needs [2].

On the other hand, The Ministerial Regulation no. 125 of 2015 showed that the provisions on the import of salt is contradictory to the government’s priority program, for instances 1) the absence of importer obligations to buy salt from farmer at least 50% of total production; 2) there is no provision on the price determination of salt produced by farmer; and 3) prioritizing the import of salt, either household or industrial consumption. Implementation of salt importing policy is considered not in favor of farmers since salt produced by farmers is commonly low quality.

The salt production is mostly carried out by independent farmers, and only a small number of salt productions is conducted by private companies and PT. Garam, a state-owned salt producing firm. The salt production technology used by Indonesian salt farmers, in general, is still traditional. Traditional
method has been developing in Indonesia since the 19th century. The salt production process in traditional method consist of evaporation, precipitation, and crystallization. The evaporation process spends 7-10 days. After that, the evaporated seawater is transferred into the salt table for precipitation process. This process take 10-15 days, then the precipitated seawater flowed into the salt table for crystallization process. The crystallization process will take 4-10 days relying on the weather [3]. The farmers normally produce and harvest the salt three times a year.

The criteria of salt production using traditional method have relatively low in terms of productivity and quality. The productivity of land used to salt production is 60 ton/ha/year. The quality of salt production contains sodium chloride (NaCl) and other impurities, i.e. magnesium, calcium, etc. The NaCl is around 80-85%, and it is under Indonesia National Standardization (SNI). The color of salt product is russet and the taste is slightly bitter [4]. Because of low quality, the price of the salt product is low. Hence, the development of salt production technology is needed to increase productivity and quality of salt product. Many researchers reported that geomembrane and filtering-threaded technology could increase productivity and quality of salt product.

Geomembrane technology is the method used to produce salt by coating the base of pond with geomembrane plastic. The main characteristics of geomembrane as a liner in salt ponds are economic value, durability, and resistance to degradation by biological, chemical and ultra violet (UV). The benefits of salt production through geomembrane technology are the productivity of salt increased, the evaporation process is shorter, the turnaround time is improved, the harvest and the quality of salt is improved and the long lifetime of geomembrane will reduce the preparation works [5].

Filtering-threaded technology (TUF) is the modified technology of salt production integrating geomembrane technology through the serial plots. The main principle of TUF is the evaporation process of seawater flowed through the serial plots in the salt tables. In addition, natural materials are added as filters to purify seawater [6]. The advantages of implementing TUF are the productivity could attain 80 ton/ha/cycle [7], the color of salt product is white and pure, the purity of salt (NaCl) and price are higher than traditional process products [6].

Although the geomembrane and the filtering-threaded technology are better than the traditional technology, its development still requires more innovative breakthrough and more effective technologies to deal with unstable weather in Indonesia. In 2016, the productivity of salt production throughout area in Indonesia decreased drastically because Indonesia was suffered tropical wet drought, so salt production process needs longer time. Therefore, one of alternative technologies is prism greenhouse. Prism greenhouse is a method to produce salt by using greenhouse model formed a prism structure. The principle of this method is integrating geomembrane and filtering-threaded technology. In this study, we focus on productivity and quality of salt produced through the prism greenhouse method. The study was performed in Sidayulawas village, Brondong District, Lamongan Regency, East Java.

Lamongan is one of the regency in Indonesia that has the potential of salt producing area. The potential area of salt production reaches 350 ha with total salt production reaches ~30,000 tons per year. However, the salt production in 2016 only reached 80 tons although it was higher than the previous year. The productivity of salt in Lamongan should be able to be improved every year. The central of salt productions in Lamongan located in the district Brondong, including Lohgung, Labuhan, Sedayulawas, Brengkok and Sidomukti villages.
2. Research Method

The research was conducted on January 3\textsuperscript{rd} to February 28\textsuperscript{th}, 2017 in Arifin’s salt pond located in Sedayulawas, Paciran, Lamongan, East Java, as described on Figure 1.

![Map of research on salt producing technology](image1)

**Figure 1.** Map of research on salt producing technology.

This study used the descriptive research with observational and survey methods [8]. The survey performed include measurements of water or brine temperature, physical observation and interview. The physical observation was carried out to know the salt producing process using prism greenhouse method as showed on Figure 2.

![The schematic of salt producing technology in the prism greenhouse method](image2)

**Figure 2.** The schematic of salt producing technology in the prism greenhouse method.
The interview conducted to tabulate the problems faced by farmers during producing salt in the prism method, especially to increase productivity of salt. The productivity can be determined by comparing the area with yield of production. The quality of salt can be measured by titration using Volhard’s method [9].

3. Results and Discussion
The salt producing technology in Indonesia was much less developed since 19th century. Nowadays, with increasing concerns of salt production, the development of salt producing technology is urgently required. One of the alternative technologies is prism greenhouse method. The prism greenhouse method is an integration of pre-existing salt producing technologies included geomembrane [6] dan filtering-threaded technology [7]. The process of salt production using the prism greenhouse method is (1) banker I, as a reservoir pond, to collect seawater with concentration of 7-8 °Bé (°Baumé); (2) filtering-threaded pond, as an evaporation pond, to evaporate seawater until reach concentration of 20-22 °Bé; (3) banker II, as a precipitation pond, to precipitate seawater with concentration 25-27 °Bé; and (4) prism greenhouse, as a crystallization pond, to crystallize seawater. The process of salt producing technology in the prism greenhouse method can be seen on Figure 3.

![Figure 3. The salt producing technology in the prism greenhouse method.](image)

3.1. The productivity of salt production
The productivity is very important to determine the sustainability of salt production. The salt productivity describe the ability to produce a lot of salt by using a narrow field. In this study of productivity, we compared traditional to prism greenhouse method, as described on Table 1.

| Parameters                  | Traditional Method | Prism Greenhouse Method |
|-----------------------------|--------------------|-------------------------|
| Productivity (kg/ha)        | 30                 | 100                     |
| Sodium chloride (NaCl) (%)  | 85                 | 95                      |
| Color                       | Slight brown       | White                   |
| Product price (IDR/kg)      | 250-300            | 500                     |

The Table 1 showed that the salt productivity with prism greenhouse method generated salt around 100 kg/ha. It was threefold higher than using traditional method of 30 kg/ha. The prism greenhouse method indicated this technology more effective in producing salt than others. Santoso [9] reported that the salt productivity using filtering-threaded technology could increase twofold than conventional method. The increase of productivity in prism greenhouse method occurred because of integration between geomembrane and filtering-threaded technology, so the process of making salt through evaporation, precipitation, and crystallization pond could produce salt in the shorter period.
3.2. The quality of salt production

The quality of salt production is determined to know the characteristic of salt. The characteristic can be analysis by comparing color and sodium chloride (NaCl) concentration. The color of the salt produced by using prism greenhouse method is significantly whiter than the salt produced by traditional method, as shown on Figure 4 and 5.

Figure 4. The salt produced by prism greenhouse. Figure 5. The salt produced by traditional.

Furthermore, the purity of salt (NaCl) produced by using prism greenhouse method is 95%, which is higher than traditional method of 85%. The purity was effected by the filters located on the filtering-threaded pond, so that the NaCl produced by prism greenhouse method is significantly higher purity than traditional method. Because of higher purity, the salt produced by prism greenhouse is more expensive as described at Table 1. Hence, the salt producing technology using prism greenhouse technology has significant impact both on product quality and quantity. In addition, salt production with the prism greenhouse method has several advantages, such as faster harvest time, weather resistance, easy to use, and higher profit than traditional methods.

4. Conclusion

The salt producing technology using prism greenhouse method could beconcluded that the productivity and quality was significantly higher than traditional method. As the results, the price of salt produced by prism greenhouse method also more expensive than traditional method. The prism greenhouse technology is suitable for producing salt in Indonesia to attain national target of salt product.

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