A Qualitative Study of Salt Production in the Kinniya Saltern: Technical and Socioeconomic Insights

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Abstract

The socioeconomic conditions of salt farmers influence the salt production, which consequently affect the quality of the salt produced. Hence, this study investigated the technical and socioeconomic aspects of salt production in the Kinniya saltern. Thirty-one salt farmers were interviewed face to face using a pre-tested structured questionnaire. The results show that a higher proportion (49%) of the salt farmers were poorly educated, thus resulted engaging in small-scale operation to sustain their livelihood. The salt farmers used 3-step (87%) and 2-step (17%) traditional methods. The farmers mainly used mechanical pumps in bringing feed water out of a lagoon system that could be contaminated by the anthropogenic activities. The production capacity was 250 kg per harvest and the annual estimated production was less than 7.5 tons per year. The quality of the salt was primarily determined with the indicators of visual inspection, color changed. The produced salt was mostly used in production of dry fish (100%), animal hide processing (48%) and in some instances human consumption (45%). The study concludes that the socioeconomic conditions of salt farmers, the production methods they use, and the quality of salt produced are closely interconnected. This suggests that improving farmers' socioeconomic conditions is essential for enhancing the production process and overall salt quality. The study also highlights the necessity of technical training, establishment of standard production procedures, and quality control mechanism to enhance efficient and safety salt production applications at the Kinniya saltern.

Keywords: Kinniya saltern, lagoon, Saltpans, Salt production, Socioeconomic conditions

I. INTRODUCTION

Common salt, chemically known as sodium chloride (NaCl), is one of the most essential raw materials globally, with widespread applications in both food and non-food sectors. Despite its consumption in small daily amounts as a food additive, salt plays a critical role in human health and industry, making it an indispensable element in daily life (Tan et al., 2022).

In Sri Lanka, salt production is particularly suited to the country's coastal regions—especially along the Eastern, Northern, North-Western, and parts of the Southern coasts—where the climate features long dry periods and flat terrain. These conditions, combined with free access to seawater and solar energy, provide a natural advantage for solar salt production. Unlike agriculture, which involves high input costs such as land preparation, seeds, agrochemicals, and labor, solar salt manufacturing is considerably low-cost and therefore holds significant economic potential (Efendy et al., 2024).

Traditionally, salt in Sri Lanka has been produced through the solar evaporation of seawater or natural brine, a method that has been used for centuries in coastal regions around the world (Vyas et al., 2022). This practice, passed down through generations, involves collecting seawater into shallow salt pans where sunlight and wind naturally evaporate the water, leaving behind crystallized salt (Sircoulon & Holland, 2016). This low-impact, eco-friendly process continues to be the most common method of salt production due to its sustainability and simplicity.

The solar salt manufacturing process typically involves moving brine between soil-based evaporation beds through open canals. This is done by gravity flow, which is maintained by creating level differences between beds.

However, because the system is exposed, it is vulnerable to contamination from suspended solids and other impurities. As a result, the final salt product often contains various compounds such as magnesium chloride ($MgCl_2$), calcium chloride ($CaCl_2$), magnesium sulfate ($MgSO_4$), calcium sulfate ($CaSO_4$), and organic matter (Lukum et al., 2021). Even with quality control measures, variations in the evaporation process frequently result in inconsistent product quality (Mensah & Bayitse, 2006). To meet acceptable standards, salt must adhere to strict chemical composition criteria. For edible salt, a minimum of 94.7% sodium chloride is required, while industrial salt must contain at least 98.5% NaCl. Other parameters include a maximum of 0.2% sulfate (SO_4), 0.06% magnesium (Mg), 0.1% calcium (Ca), and 3% moisture (H_2O) (Lukum et al., 2021).

Salt is indispensable across various domains. In human nutrition, it serves both physiological needs and enhances food flavor. In livestock farming, salt is essential as a dietary supplement (Masters et al., 2001). Industrially, salt is the foundation for producing numerous inorganic chemicals such as caustic soda, chlorine, soda ash, sodium sulfate, and hydrochloric acid (Bommaraju, 2007). Beyond chemicals, it supports a wide range of industries including soap and detergent production, dyeing, textile manufacturing, leather processing, water treatment (especially in resin regeneration), and food preservation. It is also found in everyday health products such as saline solutions, toothpaste, and antiseptics (Mensah & Bayitse, 2006; Kilic & Kilic, 2005). Additionally, salt is widely used in factory cleaning and food canning, underlining its economic importance in both local and global markets.

A notable example of salt production in Sri Lanka is the Kinniya Saltern, located in the Trincomalee District. Preliminary observations at this site indicate that salt farmers often do not follow recognized or standardized production practices. Instead, they adopt informal methods that are convenient and practical given their personal and economic circumstances. These choices, while functional, may compromise product quality. Socioeconomic factors are believed to significantly influence the selection of production techniques. Moreover, the quality of salt produced in Kinniya is directly affected by factors such as the quality of seawater used, the methods and procedures applied during production, and the technologies (or lack thereof) employed (Sumada et al., 2017).Given these observations, the present study was undertaken with three primary objectives: to identify and document the current salt production methods used in the Kinniya Saltern; to assess the socioeconomic conditions of the salt farmers; and to propose practical recommendations to improve production efficiency and enhance the quality of the salt produced.

II. METHODOLOGY

The ERC (Ethics Review Committee) approval was obtained for the study from the ERC of the Faculty of Technology (ERC/FT/2023/02).

A. *Study area*

Kinniya Saltern is located in the Kinniya Divisional Secretariat (DS) Division in Trincomalee District, Sri Lanka. Its coordinates are 8° 29’10.04” North and 81° 09’49.28” East. Trincomalee has a tropical climate with a hot season and no cold season. The average yearly temperature is about 28.5°C, and the monthly temperatures vary by around 4.5°C.

The area receives an average of 1569 mm of rainfall each year. The driest month is June, which gets about 341 mm of rain. Most of the rain falls during the Northeast Monsoon season (from December to February). From May to September, the weather is mostly dry. This dry season, lasting about five months, is ideal for salt farming in the Kinniya Saltern.

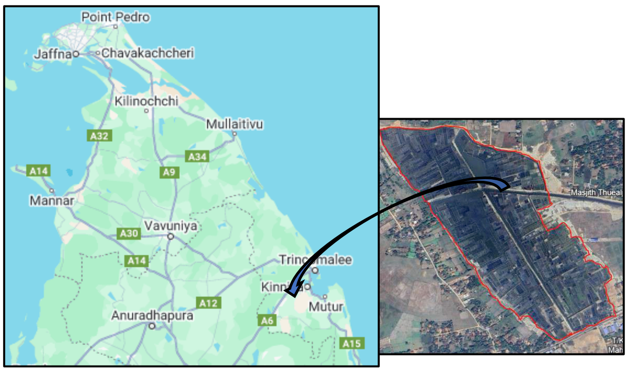

Figure 01: Kinniya saltern and its location

B. *Sample size and sampling*

There were 226 farmers registered in Kinniya DS with salt production in Kinniya saltern. Out of the total salt farmers, 31 farmers were randomly selected for the study.

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C. Data collection and analysis

Primary data collection was done using questionnaires which consisted both closed-ended and open-ended questions. Questionnaire consisted questions related to socioeconomic characteristics of salt farmers such as education level, experience in salt production, main income source, and monthly income and production related characteristics such as methods of salt production, land area of salt production, mechanisms of water collection to saltpans, production capacity, factors used to assess the quality of salt, and the uses of salt were also studied. The questionnaire was pre-tested with 10 farmers and the survey was carried out after modifying the questionnaire based on the results from the pre-testing. The questionnaire was filled by face-to-face interviews with the salt farmers. Secondary data collection was performed by visiting the DS office in Kinniya. Data were analyzed using SPSS software (Version 25) and presented in tables and graphs.

III. RESULTS AND DISCUSSION

A. Socio-economic characteristics of salt farmers

Table 01: Socio-economic characteristics of salt farmers

Characteristics	**Percentage (%)**
Gender of salt farmers	
Male	97
Female	3
Education level of salt farmers	
Primary	49
GCE (O/L)	29
GCE (A/L)	19
Higher National Diploma (HND)	3
Experience in salt production	
1 – 3 years	3
4 – 5 years	13
6 – 10 years	29
Over 11 years	55
Main income source of farmers	
Salt production	61
Agriculture	26
Running a shop	13
Monthly income of salt farmers in SLR (From salt production)	
1,000.00 – 4,000.00	3
5,000.00 – 10,000.00	27
11,000.00 – 15,000.00	40
Above 15,000.00	30

1) Gender of salt farmers

Table 01 shows the important socioeconomic characteristics of the salt farmers of the Kinniya saltern. 97% of those involved in salt production were males and the rest 3% were females. The salts production is a male dependent operation in Kinniya saltern. The traditional salt production involves with heavy manual tasks such as saltpan preparation, bagging the salt and carrying the salt bags which may be difficult for females. The present finding is supported by Tran et al. (2022) where they found that 82.9% of the salt farmers were male due to its nature involving heavy work. Despite these tedious manual activities, the involvement of 3% of females in salt production is noteworthy in the Kinniya saltern.

2) Education level of salt farmers

According to the results (Table 01), 49% of the salt farmers obtained only primary education, while 29%, 19% and 3% completed their education up to GCE (O/L), GCE (A/L) and Higher National Diploma (HND) respectively. As a higher proportion of the salt farmers are poorly educated, thus engaged in self-income generating salt production activities to sustain their livelihood and none of the salt producers employed in private or government sectors. Tran et al. (2022) stated that for traditional salt farming activities, poor education is not an obstacle, however, the poor education may have an impact on producing good quality salt and recognizing climate change impacts. It is important to note that the poor education may hinder the salt farmers to have an understanding about how the salt production will affect their health and wellbeing, and how it will have impact on the surrounding environment and the subsequent social and economic impacts. Delos Reyes et al. (2021) found that 31% of the salt producers were high school graduates engaged in small and medium scale operations in the Philippines.

3) Experience in salt production

The experience of salt farmers in salt production is also depicted in Table 01. 55% of the total salt producers were found with the experience of more than 11 years. This indicates that the majority of the farmers continue salt production for long time. However, 16% of the salt producers have 5 or below 5 years of experience and they may be considered as new comers. Delos Reyes et al. (2021) found that most of the salt producers

(63%) had the experience of 16 or above 16 years. As we found in the present study, a small portion of the salt producers are new comers and they obtain the saltpan for lease and produce salt. Thus, this kind of lease-based production always paves the way for new comers. Further, the lease-based method paves the way for hiring labourers to do salt production.

4) Main income source of salt farmers

Salt production emerged as the primary source of income of the largest portion (61%) of the sample. This indicated that the majority of salt farmers relied predominantly on salt production activities for their livelihood. However, the salt production is a seasonal income generating activity which lasts for four months and discontinued during the rainy season and it is also interrupted during the inter-monsoon seasons for a shorter period.

By discussing with salt farmers, we found that they do odd jobs during the rainy and inter-monsoon seasons. Hence, the main income sources of 26% and 13% of salt producers were agriculture and small-scale retail business respectively and salt production was an additional income generation activity. Overall, the seasonality nature of the salt production has resulted diversification of income sources, mainly among the small-scale salt farmers compared to the industrial scale producers. This argument is further confirmed from their monthly income from salt production, from which 70% of the farmers earned less than Rs. 15,000.00 per month (Table 01). This diversification of income sources reflected the multifaceted economic activities within the salt farming community at Kinniya saltern to sustain livelihood. The findings in the present study are supported by the notion that farmers diversify their income sources to manage the risks posed by climate shocks subsequently affecting their welfare (Antonell et al., 2022).

B. Salt production related aspects

Salt production characteristics of farmers in the Kinniya saltern were examined, and the findings are summarized in Table 02.

1) Methods of salt production

In general, salt production involves the processes such as (i) stabilization to remove large particles in seawater and as a reservoir of feed, (ii) evaporation, (iii) concentration, (iv) crystallization (Susanto et al., 2015). Though, the four-step salt production is the accepted method, in Kinniya saltern two-step such as (i) sea water collected from reservoir and evaporation, (ii) crystallization and three-step methods such as (i) sea seawater collected from reservoir and evaporation, (ii) concentration, (iii) crystallization. According to the Table 02, 87%, practiced a three-step method while, a smaller proportion, comprising 13%, utilized a two-step method for salt production. In Kinniya saltern, salt farmers use seawater sourced from a narrow lagoon, not directly from the sea. This 4.15 km-long lagoon is fed by Thambalagamuwa Bay, which connects to the sea through Koddiyar Bay. The lagoon flows through mangroves, marshlands, and villages on both sides before reaching the saltern. Therefore, it is highly likely that the feed water may contain materials other than salt, which could affect the salt quality. Therefore, it is important that salt producers apply recommended method for salt production.

2) Factors influencing the salt quality

Salt farmers in Kinniya use a combination of quality indicators and management practices to assess and ensure the quality of salt (Table 02). Among the quality indicators, visual inspection and color consistency were the most commonly used, each mentioned by 25% of farmers. Through visual inspection, farmers assess characteristics such as the appearance, color, uniformity, crystal size, and shape of the salt. In terms of management practices that influence salt quality, saltpan cleaning (24%) and controlled water usage (18%) were significant. These practices are essential for maintaining hygiene in the pans and reducing contamination during production. Salt cleaning, used by 7% of the farmers, also contributes to improving salt purity by removing physical impurities after harvesting. Although only 1% of the farmers reported monitoring production parameters (e.g., salinity levels, evaporation rates), this remains a critical practice for achieving consistent and high-quality salt production.

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Table 02. Technical aspects of salt production in Kinniya saltern

Aspects	Percentage (%)
Methods of salt production	
2 – step	13
3 – step	87
Land area of salt production (m2)	
< 500 m^2	0
500 – 1000	55
1000– 2000	42
2000 – 3000	3
Mechanisms of water collection to saltpans	
Bucket	6
Pumping	94
Production capacity (kg/harvest)	
< 1, 250	68
1, 250– 2, 500	32
Salt quality parameters	
Saltpan cleaning	24
Water usage	18
Salt sample testing	25
Salt cleaning	7
Color	25
Monitoring parameter	1
Uses of salt (Multiple option question)	
Consumption	45
Animal hide (skin) processing	48
Dry fish production	100
Coconut fertilizer	29
Chicken feed production	22
Swimming pool cleaning	3
Other purpose	10

3) Uses of salt

Table 02 shows the diverse uses of harvested salt at Kinniya saltern, each farmer sells the salt for different purpose. The salt from Kinniya saltern is extensively used for dry fish production, whereas al the salt farmers either sell fully or partially for this purpose. Dry fish production is one of the important economic activities in the Kinniya coastal areas which create a significant demand for local salt at a reasonable price. This usage also highlights its critical role in preserving fish products. According to FAO (2021), salt used for dry fish production should be food grade, further no contamination with dirt, oil, or other extraneous materials. Despite, we found that no mechanism is in place to assure that the salt produced is in food grade quality. Another 45% of farmers indicated the use of harvested salt for consumption. Though there is no state regulated mechanism in place to assure the quality of salt, still the salt is used for consumption. The study suggests that educating the farmers on the production of salt with accepted quality while instituting regulatory mechanism to inspect and control quality. Moreover, it was found that the salt is used for animal hide processing (48%), as a component of coconut fertilizer (29%), as an ingredient of chicken feed production (22%), and for industrial purposes (10%), and swimming pool cleaning (3%).

4) Land area of salt production

The land plot size used by salt farmers are shown in Table 02. Accordingly, the largest plot size was around 3000 m2 (0.3 ha) and the smallest plot size was around 500 square meters (0.05 ha). Further, majority of them (55%) are operating plots with the size of less than 1000 m2. These figures show that salt farmers in Kinniya saltern produce salt at subsistence level to support their livelihood during the production season.

5) Mechanisms of water feeding to saltpans

In the context of salt production, collecting water from the water source is a critical initial step. According to the Table 02 most of the farmers, accounting for 96%, utilize pumps for water collection. This method is quick and saves time and labour, however, it incurs an additional cost for salt production. A small group of farmers, comprising 4%, continue to manually collect water using buckets. This manual approach may be preferred due to limitations in resources such as plot sizes and financial conditions.

6) Production capacity

The production capacity range of salt farmers are shown in Table 02. The first harvest is typically carried out 4 to 5 weeks after the initial preparation and flooding of the salt pans, while subsequent harvests take place every 4 to 5 days, depending on weather conditions such as sunlight and temperature. The majority of salt producers, constituting 68%, produced less than 1, 250 kg per harvest. This indicates that the production is not at satisfactory/optimum level. Conversely, 32% of salt producers achieved a higher production, ranged between 1250 kg to 2500 kg per harvest. Hence, a minimum of six harvests is achieved per production season (April or May to Augst or September), and can be increased further with the favorable climatic conditions.

Salt production using traditional solar evaporation methods usually ranges from 60 to 120 tons per hectare each year, depending on the season and water quality (Prabawa and Bramawanto, 2021). However, kinniya salt farmers work on a much smaller scale and produce less than 7.5 tons annually. This big difference is mainly because many farmers have small plots, limited access to good water, equipment, and modern techniques. They often rely on manual methods, which are less efficient. Additionally, financial challenges, lack of technical knowledge, and changing weather conditions also limit their production. So, while the method can yield a lot, small-scale farmers usually produce much less because of these challenges.

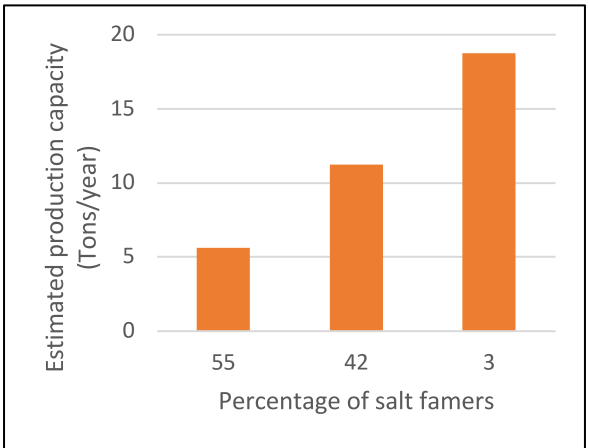

Figure 01: Estimated production capacity

We estimated the unit production rate with the collected data and it was 12.5 tons/ha on average per harvest thus 75 tons/ha per season. The salt production under the conventional methods with solar evaporation vary from 60 – 120 tons/ha/year depending on the seasonal factors, and feed water quality (Prabawa and Bramawanto, 2021). The results of the present study showed that only 3% of the farmers had 0.2 ha to 0.3 ha of saltpan area with an estimated production capacity of 15 – 22.5 tons/ha/year. Majority of the salt producers (55%) had an estimated production capacity of 3.75 to 7.5 tons per year (Figure 01). Accordingly, the majority of the salt farmers were small-scale producers with the production capacity of below 7.5 tons per year. Overall, the results indicate that though their production capacity is low (small scale producers) and suggest that the salt farmers need to be educated on the production process of acceptable quality salt and the production of salt for various uses.

IV. CONCLUSION

The findings of the current research indicate that salt production in the Kinniya Saltern is primarily at a subsistence level. Most producers are small-scale operators with relatively low output per season. Production is carried out using either two-step or three-step methods, often without sufficient technical knowledge or training. Additionally, salt quality is assessed using only basic indicators such as appearance or color uniformity. There is currently no formal or institutionalized system in place to ensure that production meets recognized food-grade standards. Nevertheless, the produced salt has found numerous applications in many places, such as in the manufacturing of dried fish, animal hide processing, among others, as well as being consumed by humans. The salt farming is seasonal in nature and the farmers are in need of diversifying their income sources. However, there is potential to enhance the productivity of the salt farms by utilizing for fish culture during the off season. Although production per unit is at an average level, overall yields remain low due to small plot sizes and the continued use of traditional practices. The study has highlighted that technical assistance is required to better the salient production activities, to implement quality confirmation, and foster sustainable possession of resources at the saltern in Kinniya.

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