A STUDY ON THE VIABILITY OF SALT-MAKING IN POLYETHYLENE PLASTIC MATERIAL AS A SMALL-SCALE INDUSTRY

By

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INTRODUCTION

Salt is an important mineral needed by a living cell for growth and by a nation for agro-industrial stability. It is very common as it constitutes a part of everything taken and used directly or indirectly by human beings in everyday life. For chemists, it is Sodium Chloride, but to most layman, it is an ordinary white crystal added to a meal, which, if lacking, would spoil a delicious recipe. Furthermore, it is a food preservative used in pickling or salting. The salt used for food preservation constitutes a small percentage of the salt produced in the country. The greater bulk goes to the industry, as in the manufacture of heavy chemicals such as sodium carbonate, sodium hydroxide, chlorine, hydrochloric acid, sodium sulfate and others. Salt is also used in making soap, bleaching powder, dyes, pottery, glycerine and fertilizer, (de los Santos, 1976). Lately, its medicinal use to awaken dull skin and revival of human spirit has been reported by some skin specialists (de los Santos, 1976).

The importance, therefore, of salt can never be over-emphasized. It is regrettable, however, that in spite of the great demand for its varied uses, the technology of improving and maximizing salt production in the country has been very slow, bordering on criminal neglect. The technical or scientific neglect is doubly regrettable if we consider that the raw materials for salt-making are found in almost every province and coastal barrio.

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Salt is found everywhere; in brine lakes and in rocks, but the unlimited and inexhaustible source is the sea.

From time immemorial, the traditional practice of salt-making in the Philippines is by solar energy during summer months of the year, *i.e.*, from February to May. Salt-making is done in specially-built ponds with tiles and other broken China ware flooring, serving as a a fish-cum-salt project. The ponds are used to raise fish during rainy days and for salt production during summer. Among the famous salt-beds of this kind are found in Las Piñas and Parañaque, Metro Manila; Leganes, Dumangas and Manduriao, Iloilo and in some parts of Panay Island. Projects, however, of this kind require a big capital investment so very few people can engage in this business.

Another method of salt-making employing solar energy is in bamboo halves. Bamboo halves are lined side by side on elevated stands and concentrated brine solution are placed in the halves. The process is very laborious since seawater is leached through a pile of gravel and sand and collected in a big container set below the gravel and sand filter. The brine is allowed to evaporate in the big container for a week before it is finally collected and placed in the halves. This process requires a lot of bamboo to accumulate a sack of salt. Despite the difficulty of this process, it is still a common practice today in Miagao, Iloilo where bamboo can be obtained easily.

Cooking or boiling seawater in big containers is another traditional method of salt-making in the Philippines. This is practised in Pangasinan and the Ilocos provinces. The process can be year-round but considering the small amount of salt produced within a period of time and the great bulk of firewood needed, the process is both very inconvenient and uneconomical.

The third method of salt-making in the country is the combination of solar evaporation and boiling by heat by the Ceramar Agro-Marine Industries in Barotac Viejo, Iloilo province and another unnamed company in Mindoro. Due to the continuous process of filtration and settlement employed, a high grade salt containing as much as 92.7 sodium chloride is produced. This procedure requires big capital investment hence the companies are the first of their kind in the country. In addition, the production cost has greatly affected the product making the price higher.

To support the different needs for salt in the country, it became necessary to produce the maximum amount of salt with the least capital investment. This problem can be resolved only if an economical material for salt production can be found and many people can be encouraged to go into the business. It is on this premise that the following study was conducted.

METHODOLOGY

The study was composed of two phases. Phase I was an experimental phase conducted from January 18 to February 15, 1977 and Phase II was conducted from March 14 to May 20, 1977 on a semi-commercial scale which adopted the results obtained from Phase I.

Phase I

Three small compartments using plastic material, gauze no. 6, measuring 2 ft x 3 ft x 4 inches, were laid out on the sandy beach at the back of the Laboratory Extension of the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC) at Bo. Buyuan, Tigbauan, Iloilo. The bottom sand was levelled and stones were lined along the sides of the plastic as support to build a catchment area. Each compartment was filled with 25 liters of seawater. Daily observation on the water salinity was taken by using a refractometer. Temperature and volume were measured until salt was produced.

Phase II

This phase consisted of 40 evaporation ponds, 1 m x 5 m x 6 in and 15 1 m x 3 m x 3 in crystallizing compartments. Five of the crystallizing compartments were with wooden frame and with wooden base. To make the compartments of the evaporation ponds deeper, bamboo pegs were staked along the sides of the compartments and nylon twine no. 8 was used to hold the plastic on the twine with the aid of a stapling machine. The evaporation ponds were numbered. Those numbered from 1 to 30 were designated as Evaporation I where new seawater was admitted and Evaporation II numbered from 31 to 40 were used as a storage for highly concentrated water from the crystallizing ponds. As it was difficult to fill all the Evaporation Ponds daily, because seawater was being carried manually, only four compartments were filled daily. From Evaporation Pond I, water was

transferred to Evaporation Pond II after three days. Here they are allowed to stay for another three or four days before finally being transferred to the crystallizing ponds after filtering through a sand filter or a finely woven cloth. In the Evaporation Ponds I, water salinity increased from its initial salinity of 34°/oo to 80°/oo - 100°/oo, while in Evaporation Ponds II, this further increased to as high as 150°/oo to 200°/oo. After this, they were finally transferred to the crystallizing ponds. The depth of water in the evaporation ponds can be increased to the maximum that the plastic can hold, but in the crystallizing ponds water depth was maintained at one inch or no more than two inches.

Harvesting was done manually every afternoon with bare hands or with the aid of any soft material like a nylon brush or a clean thick rubber. Holes which were unavoidable were covered with waterproof plastic tape. Salt was accumulated at one corner of the pond where it was later gathered and stored in a big basket over a leaching container or placed over the Evaporation Pond where it was further dried under the sun for one or two days before storing in sacks in a warehouse.

After harvesting the salt, the remaining liquid in the crystallizing ponds was either discarded (when the liquid is whitish and thick) or again filtered before stock water from Evaporation Ponds II are again added. Cleaning the crystallizing ponds once a week was done to keep the product clean. Compartments with wooden frames were washed in the sea or nearby evaporation ponds and those with semi-permanent stakes were cleaned by draining, washing and bailing out water.

The rains came in late May, 1977 and the plastic were carefully taken and rolled in bamboos for use in the following summer.

RESULTS AND OBSERVATIONS

The results of the study are very encouraging and once again Polyethylene plastic material has shown its versatility. Table I shows the observations on the average rate of evaporation of seawater in relation to atmospheric and ground temperature and increase in salinity during the trial or Phase I of the experiment. Based on the study, the intensity of the solar heat and the weather condition has the greatest effect on the evaporation of seawater resulting in the formation of salt. Salt formation is further enhanced by the ground temperature. When the atmospheric temperature ranges from 26°C to 29°C, and the ground temperature 40°C to 52°C, a daily evaporation of 12-15% of seawater contained in a plastic compartment with a surface area of 6 sq. ft. and with a depth of 2 in can be obtained. Under similar conditions an average salinity increase of 4°/oo in the first three days and a rapid increase of 10°/oo to 75°/oo in the succeeding days until salt crystals were formed had been observed. A sudden rise in salinity and temperature was observed on the fourth day of the experiment. From an initial water temperature of 26°C taken at noon when the salinity was 34°/oo the temperature increased to 39°C and the salinity exceeded 80°/oo. With this prevailing conditions, salt can be produced in seven or eigth days in plastic compartments without transferring any water from one compartment to another. When the salinity of the water approached 200°/oo, thin salt crystals began to appear in the surface which continued to grow thicker and bigger during the later part of the day as the sun's heat increased. However, if the sky becomes cloudy and strong winds appear that will continuously stir the water surface, crystallization is greatly affected resulting in the production of very small and thin salt grains, and finally very small salt production.

A rerun of this phase gave almost the same result.

The application phase of the study was likewise very satisfactory. It was in this phase when water transferred from one compartment to another was effected. Although the water transfer was far from perfect because several persons did the work, a very promising result was obtained, and an average daily harvest of one sack was realized from all the crystallization ponds seven days after the seawater was taken from the sea, and evaporated. This production could have been maintained at a higher level if a stable stock water with the same salinity was available. Table II shows the daily salt production during Phase II of the study. As shown, there were days when production was as low as five gantas per day. This resulted because low salinity water was added to the crystallization ponds. Other factors that affect production are rain showers or a very cloudy sky with strong winds.

Observations on the effectiveness of using two kinds of crytallizing ponds showed that those with wooden frames were more effective aside from being very handy and manageable. The semi-permanent level of the sandy bottom being enclosed in a wooden frame base has greatly contributed in maintaining an even depth of water thereby effecting a more rapid evaporation due to equal distribution of heat on the water surface. Likewise, in cleaning, which is a very important process, the frames which are removable, can just be carried to the sea or the nearby evaporation ponds where all the sediments and other foreign materials can be easily washed off.

On the other hand, the crystallizing ponds without frames and with a semi-permanent position, being staked to the ground, require more time in bailing water in and out during cleaning. Also, the high sides blocked the sunlight during early morning and late afternoons, thus affecting crystallization process. Maintaining the sand bottom as level as possible is difficult because during harvesting of salt, the bottom sand oftentimes slides down.

Salt production can be easily calculated from wooden framed crystallization ponds. From a compartment measuring 1 m x 8 m x 2 in, four to five gantas of salt can be produced daily if the sun is hot and the stock water placed has a salinity of 200°/oo or higher. Cleanliness of both the stock water and the pond should be maintained. As much as possible a double filtration of the stock water should be made before placing it in the crystallization ponds to minimize foreign materials that may have combined with the product and to reduce other chemicals which may have settled on the bottom during the process of evaporation. It was observed that at the crystallization ponds, after harvesting salt twice, a heavy-whitish liquid composed of carbonates and sulfates was left which should be discarded. If this liquid is continuously evaporated, a transparent, thin, long and sharp crystal resembling broken glass is formed which is not even salty and very painful to the hands during harvesting.

The author was not able to have a chemical analysis of the product made but the product is very white and very acceptable to the public. It is similar in texture to salt produced in the traditional method and places. A trial weighing of the salt showed that one ganta weighed approximately 2.25 kg after one day of drying.

COMMENTS AND RECOMMENDATIONS

Salt-making in polyethylene plastic materials can be a very promising smale-scale industry during summer months. It could be started with a small capital of about ₱200.00 by a family living near the sea, particularly on the sandy accretion or on any type of soil where water from the sea can be diverted. Waterless fishponds during summer, necessitating high maintenance costs of pumping in water are best suited for this type of industry. In this particular case, the canal can serve as the evaporation ponds and the plastic material can serve as crystallization ponds which can be laid out inside the dry ponds.

The process of effective water transfer from one compartment to another to maintain a steady salinity of the water stock for the crystallization ponds should be followed and undertaken closely. This will help to stabilize the daily production rate.

Cleanliness in all ponds should be maintained, particularly in the crystallization ponds. The product will be greatly affected by this process. A double filtration of the stock water before placing it in the crystallization ponds should be done to minimize as much as possible foreign materials that may have combined with the product.

In the study undertaken, the process of water transfer was not perfect, nevertheless an average daily production of one sack of salt was realized and a total of about 65 sacks was produced within a 60-day period from a 300-sq m area.

The capital investment was recovered with a very marginal profit. However, had the project been started earlier a bigger profit could have been obtained.

For those who wish to go into the business the following recommendations and guidelines are hereby given. Also, a prospectus showing costs has been prepared.

1. Select an area where sunlight is available during most part of the day.

2. Clear the proposed area of any sharp objects that may puncture holes on the plastic and level the sand bottom as much as possible.

3. Use polyethylene plastic material not thinner than gauge No. 6.

4. Place bamboo pegs at the four corners of the proposed evaporation ponds then tie polyethylene twine around the pegs. Layout the plastic compartments for the levelled sand and fold up-outward the plastic and staple the edges over the nylon cord. Layout additional bamboo pegs along the sides of the folded plastic to support the plastic when it is filled with water. This is for the evaporation ponds only.

5. Use framed crystallization ponds with wooden frame base for ease in maintaining the bottom level and during cleaning.

6. Use nylon twine no. 8 to hold the plastic in place and to produce a catchment area.

7. Fill evaporation ponds with maximum depth of water it could hold and the crystallization pond with no more than 2 in of stock water.

8. Filter stock water on a sand filter before placing it in Evaporation Ponds II and through a fine cloth before placing it into the crystallization ponds.

9. Transfer water from the first evaporation pond to the second evaporation pond when salinity is about 80°/oo to 150°/oo and to the crystallization ponds when the salinity is 190°/oo to 200°/oo or more.

10. Fill the crystallization ponds during late afternoons or early mornings before the sun rises.

11. Avoid adding water to crystallization ponds when salt is starting to form especially so if the stock water to be added has a lesser salinity. This will stop crystallization.

12. Clean crystallization ponds after two or three harvests and wash away "bittern" or remaining liquid which will form sharp and non-salty crystals. The remaining liquid consists mostly of carbonates and sulfates.

13. Have a storage tank for concentrated seawater which could be easily covered in case of rain to insure daily harvest of salt. When rain comes discard water in the crystallization ponds and replace it with water from this storage tank.

14. For bigger scale projects, the use of a water pump is highly recommended. A six horsepower pump can be used to pump seawater to the storage tanks.

15. When the rainy season comes, roll up the plastic on a bamboo or any round object to avoid folds which may cause holes. This plastic can still be used the following season.

LITERATURE CITED

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1969 The Chemistry and Fertility of Sea Waters. The syndics of the Cambridge, University Press, Cambridge, Massachusetts.

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Table 1. Water evaporation in relation to atmospheric and ground temperatures and increase in salinity*

Date	Air Temperature °C	Water Temperature °C	Ground Temperature °C	Salinity °/oo A.M. °/oo	Salinity °/oo P.M. °/oo	Volume of Water (Liter) A.M.	Volume of Water (Liter) P.M.
1/18/77	26	26	40	34	38	25	21
1/19/77	27	25	42	38	42	21	19
1/20/77	27	25	42	42	46	19	16
1/21/77	27	27	49	46	56	16	13
1/22/77	27	39	49	56	80	13	8
1/23/77	29	39	52	80	124	8	4
1/24/77	27	39	50	124	208	4	2
1/25/77	26	39	49	200	Salt was produced - 1 liter (Total crystallization)		

* No water transfer from one compartment to another was done.

Table 2. Daily salt production during Phase II of the study covering the period from March 21 to May 20, 1977

Date	Production (Gantas)	Date	Production (Gantas)
3/21/77	5	4/21/77	50
3/22/77	15	4/22/77	25
3/23/77	10	4/23/77	75
3/24/77	5	4/24/77	50
3/25/77	12	4/25/77	50
3/26/77	10	4/26/77	40
3/27/77	15	4/27/77	25
3/28/77	8	4/28/77	50
3/29/77	15	4/29/77	40
3/30/77	20	4/30/77	40
4/1/77	48	4/31/77	50
4/2/77	25	5/1/77	50
4/3/77	35	5/2/77	25
4/4/77	8	5/3/77	70
4/5/77	40	5/4/77	25
4/6/77	30	5/5/77	40
4/7/77	25	5/6/77	0
4/8/77	30	5/7/77	0
4/9/77	60	5/8/77	5
4/10/77	5	5/9/77	7
4/11/77	20	5/10/77	5
4/12/77	60	5/11/77	5
4/13/77	20	5/12/77	40
4/14/77	20	5/13/77	3
4/15/77	20	5/14/77	50
4/16/77	5	5/15/77	5
4/17/77	25	5/16/77	25
4/18/77	60	5/17/77	25
4/19/77	10	5/18/77	10
4/20/77	40	5/19/77	0 (shower)
		5/20/77	0
Total			885 gantas or 65 sacks

PROSPECTUS FOR A 300-SQUARE METER SALT BED USING POLYETHYLENE PLASTIC MATERIAL

(3-month period operation)

A. MATERIALS AND OPERATING COST

10 rolls polyethylene plastic, gauge 6, 1 x 50 m at ₱145 per roll	₱1,450.00
10 pcs. bamboos, ₱3.50 each	35.00
6 rolls nylon twine, no. 8 at ₱12.00 per roll	72.00
2 kgs. straw, ₱10.00 per roll	20.00
20 bx. staple wire, small at ₱1.00/box	20.00
2 stapling machine, small at ₱7.00 each	14.00
60 pcs. lumber, 1 x 2 x 8, at ₱3.20 per piece	192.00
2 pails, ₱12.00 each	24.00
2 buckets, 4 gal. capacity	24.00
5 laborers for 3 days during layouting at ₱6.00/day each	180.00
2 pcs. bamboo baskets, ₱3.00 each	6.00
1 maintenance laborer for 3 months at ₱150.00 per month	450.00
1 sand filter	10.00
Total investment	₱2,142.00

B. HARVEST AND SALE

1. Harvest of 1 sack/day in the first month .... 30 sacks
2. Harvest of 2 sacks/day in the following 2 months .... 120 sacks

   Total harvests in 3 months .... 150 sacks

3. Sale of 150 sacks at ₱27.00/sack .... ₱4,050.00

   Less: Total investment 2,142.00

C. NET PROFIT OR GAIN .... ₱1,908.00

NOTE:
1. The plastic can still be used for the following season.
2. The capital investment will be less if operated and managed by the family members.
3. Most of the materials used are serviceable for years, so less capital can be expected the following year and more profit can be realized.

might become far more extensive in the future for the rapid urbanization, industrial growths and population expansion.

Mangrove swamps declared by the Bureau of Forest Development, thru the Land Classification Committee, as available for fishpond purposes are released to the Bureau of Fisheries and Aquatic Resources for administrative disposition for lease to qualified and interested applicants for a period of 25 years, renewable for another 25 years. Under the concept of managed disposition, the leasee thereof is further required to submit a semi-annual report of his development, operation and production under oath.

Under Section 24 of Presidential Decree No. 704, the leasee/permittee is given a period of five years to fully develop the area in commercial scale, the period to begin from the execution of the lease contract, otherwise, the unimproved portion thereof shall be segregated and declared open and vacant to other qualified and interested applicants. Should the lessee fail to develop or abandon the area covered by the lease, the lease agreement shall be cancelled and the area declared vacant to other qualified and interested applicants or reverted to the public domain. This concept assures the development of the area in a given period of time and at the same time a management tool to check against the practice of speculation.

STATUTORY PROVISIONS AND INSTITUTIONAL CONSTRAINTS ON THE CONSERVATION AND UTILIZATION OF MANGROVES

Some specific provisions on the conservation of mangroves are found in Presidential Decree No. 705, otherwise known as the Forestry Reform Code of the Philippines. Under Section 3 of the above decree, mangrove is a term applied to the type of forest occurring on tidal flats along the sea coast, extending along streams where the water is brackish. This definition provides the aquatic environment where mangroves are known to grow and converted into fishponds for the culture of fish. To the aquaculturists, however, ecological consideration, layout and soil composition are some of the basic requirements in the development and design of the project to obtain optimum productivity of the area and its rational use.

In the development of fishponds from swamplands, the law provides a strip of at least 40 meters wide along shorelines facing rivers, lakes and other bodies of water, and a belt or strip of not less than 100 meters facing bays or the sea be excluded from fishpond development to protect the shoreline from destructive forces of the sea, strong winds and typhoons. These strips of mangrove forests bordering numerous islands cannot be alienated or cleared for fishpond operation as long as they are not declared alienable and disposable lands of the public domain. This is one of the reasons why titling of fishponds had been stopped to avoid circumvention of the legal prohibition against alienation of foreshore lands.

Under Presidential Decree No. 950, every holder of a lease agreement is under obligation to plant trees extending at least twenty (20) meters from each edge of the bank of the river or creek. Under the said decree, any person who cuts, destroys or injures naturally growing trees or planted trees of any kind on banks of rivers or creeks without any authority from the government agency concerned is liable to a fine and/or imprisonment at the discretion of the court.

The increasing utilization of mangroves has spawned two conflicting interests in the exploitation and development of the same. The advantages and disadvantages of silviculture and aquaculture on the multiple uses of mangroves should be studied in the light of the policy on economic development. The recommendation of the Philippine delegation to the Indo-Pacific Fisheries Council conference held at Wellington, New Zealand in 1977 on the alternative uses of mangrove is of imperative value to the Workshop.

LEGAL STRUCTURES

The present Bureau of Fisheries and Aquatic Resources (BFAR) started in 1907 as a mere Division of Fisheries in the defunct Bureau of Science. The significance of the Division's delicate functions were brought to the fore and given substance by the passage of Fisheries Act No. 4003 in 1932 which compiled all laws and regulations relative to fisheries. From then on, the Division had undergone various transformation and developmental reorganizations. It was known once as the Fish and Game Administration under the Department of Agriculture and Commerce in 1933; Philippine Fisheries Commission under the Department of Agriculture and Natural Resources by virtue of Act No. 3512 in 1963; Bureau of Fisheries upon reorganization of the executive branch of the government in 1972; and finally as Bureau of Fisheries and Aquatic Resources (BFAR) under the Department of Natural Resources (DNR), now Ministry of Natural Resources (MNR) by virtue of Presidential Decree No. 461 signed on May 17, 1974.

NOTICE

Please note the new ISSN of the Philippine Journal of Fisheries. For the last two issues, we have used the ISSN assigned by the National Centre for the International Serials Data System (ISDS) in the Philippines for another publication of the Bureau — the Fisheries Newsletter. We hasten to make the necessary correction. We regret the inconvenience and the error.

The EDITORS