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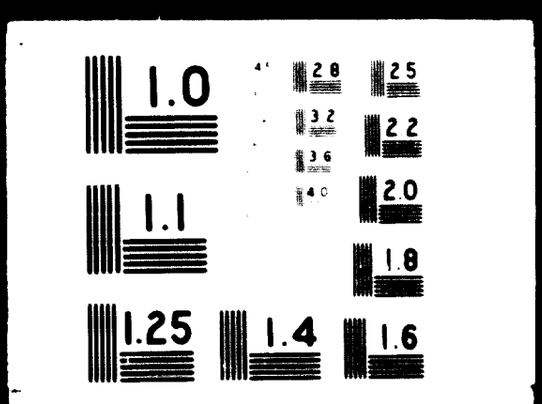

D02809

Distr.
LIMITED

ID/WG.21/4
20 August 1968

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Expert Working Group Meeting
on Modernization and
Mechanization of the Salt Industries,
based on Sea Water in the Developing Countries

Rome, Italy - 25-29 September 1968

A SUMMARY OF THE SALT INDUSTRY IN TAIWAN 1/

prepared by

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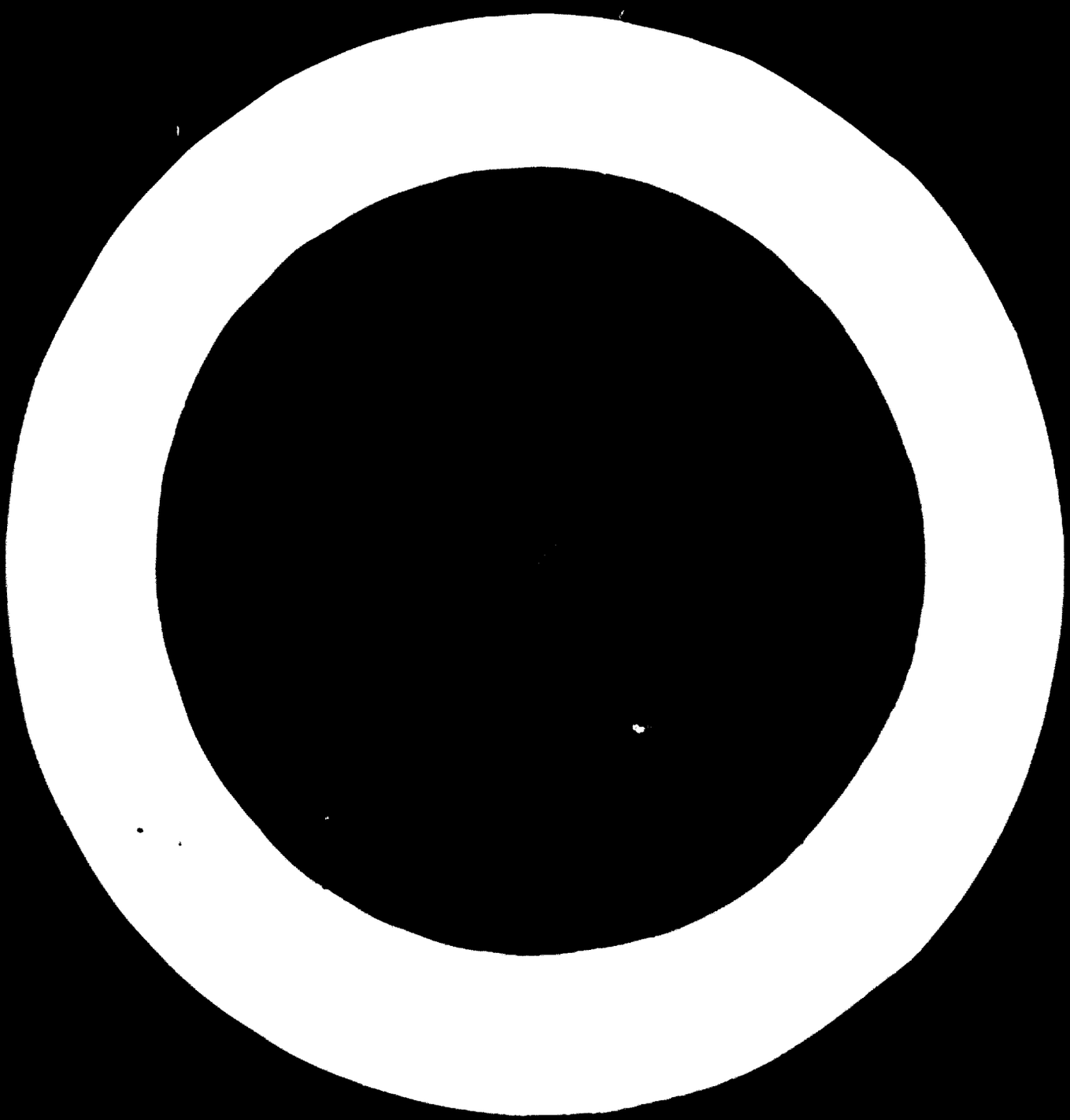
1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO.



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GENERAL INFORMATION

1. The Taiwan Salt Works, the sole producer of commercial salt in Taiwan, is a governmental enterprise. It operates 4174 hectares of salt fields, all along the south western coast. It also maintains two salt-washing plants and two by-product plants producing washed salt, refined salt and various by-products.

2. The yearly production of salt varies from 400,000 to 500,000 metric tons. The sodium chloride content of salt is now set at above 90 per cent for the first grade and 85 per cent for the second grade, both on the wet basis.

3. In the past about one quarter of the salt produced was for domestic consumption and the rest was for export. However, now on account of the continually increasing domestic demand, especially in the chemical industries, salt is no longer exported from Taiwan.

4. Salt produced may become insufficient to meet the domestic demands unless some measures are taken to increase salt production on large scale.

PRODUCTION

Climatic conditions

5. Taiwan, being situated in a subtropical zone, encounters annual rainfall varying from 1,300 to 1,800 mm with occasional typhoons. The daily evaporation during the dry season is 7 to 9 mm and 3 to 5 mm at other times. The climatic conditions in Taiwan is not entirely favourable for solar salt production. Salt recovery in Taiwan is thus radically different from any other countries because there is no season of zero rainfall. Even during the salt-making season, heavy rains may still occur. This dictates a different operating system, which is described below.

Structure of salt fields

6. The salt field is divided into numerous small sets. The unit set of a salt field is laid out in three parts: evaporating ponds, concentrating ponds and crystallizing ponds. The area distribution of the whole unit set of the salt field the area of evaporating ponds is 60 per cent; for the concentrating ponds, 18 per cent; for the crystallizing ponds, 10 per cent; and the rest (12 per cent) being the total area of canals, ditches, and dykes.

Types of salt fields

7. According to the structure of the bottoms of crystallizing ponds, the salt fields are of two types, tile bottom and mud bottom, the difference between them

being that the bottoms of the first kind are covered with broken fragments of ceramic tiles that have been rolled in while those of mud-bottom ones are of clay. The standard area of each unit set of the mud-bottom type is 50,400 m^2, and that of tile-bottom type, 12,400 m^2.

Difference in outputs of two types of salt fields

8. The yearly output of a hectare of salt field is about 90 to 110 (metric tons) of salt for the mud-bottom type and 130 to 150 tons for the tile-bottom type. The difference in outputs of the two types of salt fields is chiefly attributable to the difference in the beds of the crystallizing ponds. Beds of the mud-bottom type must undergo cleaning and rolling after harvesting three or four times, while those of the tile-bottom type can be operated continually.

Present practice

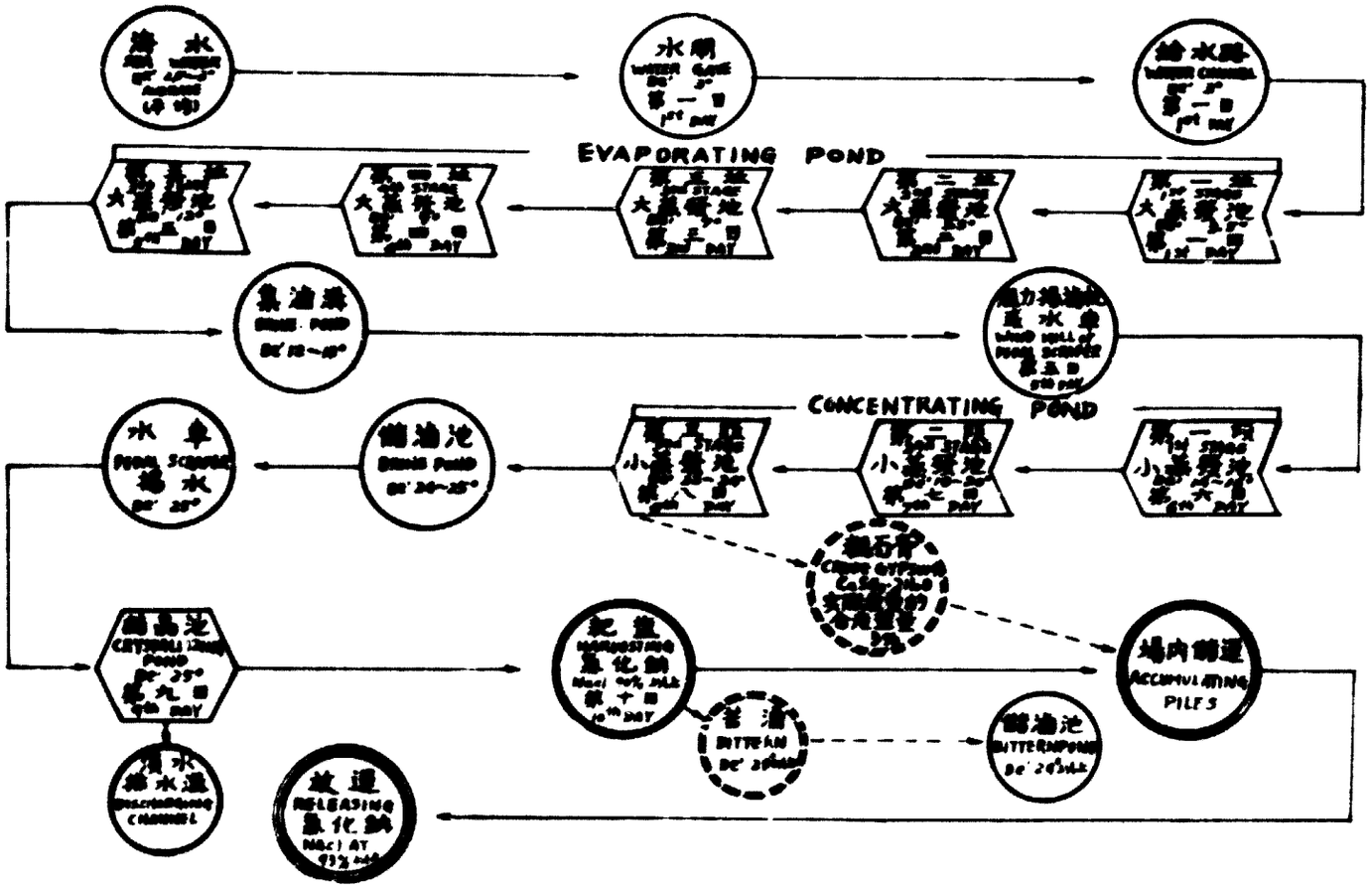
9. A flow sheet for a tile-bottom salt field is shown in figure 1. The brine is fed, usually by gravity, to the large evaporating ponds. These ponds have mud bottoms with slightly decreased levels and serve for the primary evaporation of sea-water. They bring it up to about 12° Baumé (Bé). This step accomplishes about 60 per cent of the total evaporation. Next come the concentrating ponds at a higher level so that the brine must be pumped to them by windmill, and through which the brine flows by gravity. These second concentrating ponds bring it to 24°-25°Bé, which represents 90 per cent of the total evaporation. The brine flows, also by gravity, to the crystallizing ponds.

10. In good salt-making weather, the salt is harvested every other day. Since the brine depth is kept at 30 to 35 mm, the salt is harvested after adding fresh saturated brine to wash it. This is done by scraping the bottom with a bamboo pusher so that the salt is scraped into a pile in the centre of the pond for drainage for about one hour. The salt is then loaded into baskets, carried to tracks along the nearest roadway, and loaded on flat-cars that are pushed by hand to some central station. After the harvesting is finished, the bittern, at 29° to 30°Bé is discarded or conveyed through ditches to waste or to storage.

11. In salt fields of the mud-bottom type, a flow sheet for which is shown in figure 2, the sea-water, usually at about 3°Bé, is first led into big reservoirs at high tide by an intake water-gate and then pumped through supply canals into the evaporating ponds. From this point, the routine of operating ponds, of harvesting salt and of discharging bittern is the same as with fields of the

Figure 1

台湾製塩総廠
TAIWAN SALT WORKS
瓦盤塩滝製塩流程図
FLOW SHEET OF SALT PRODUCTION (TILE BOTTOM)



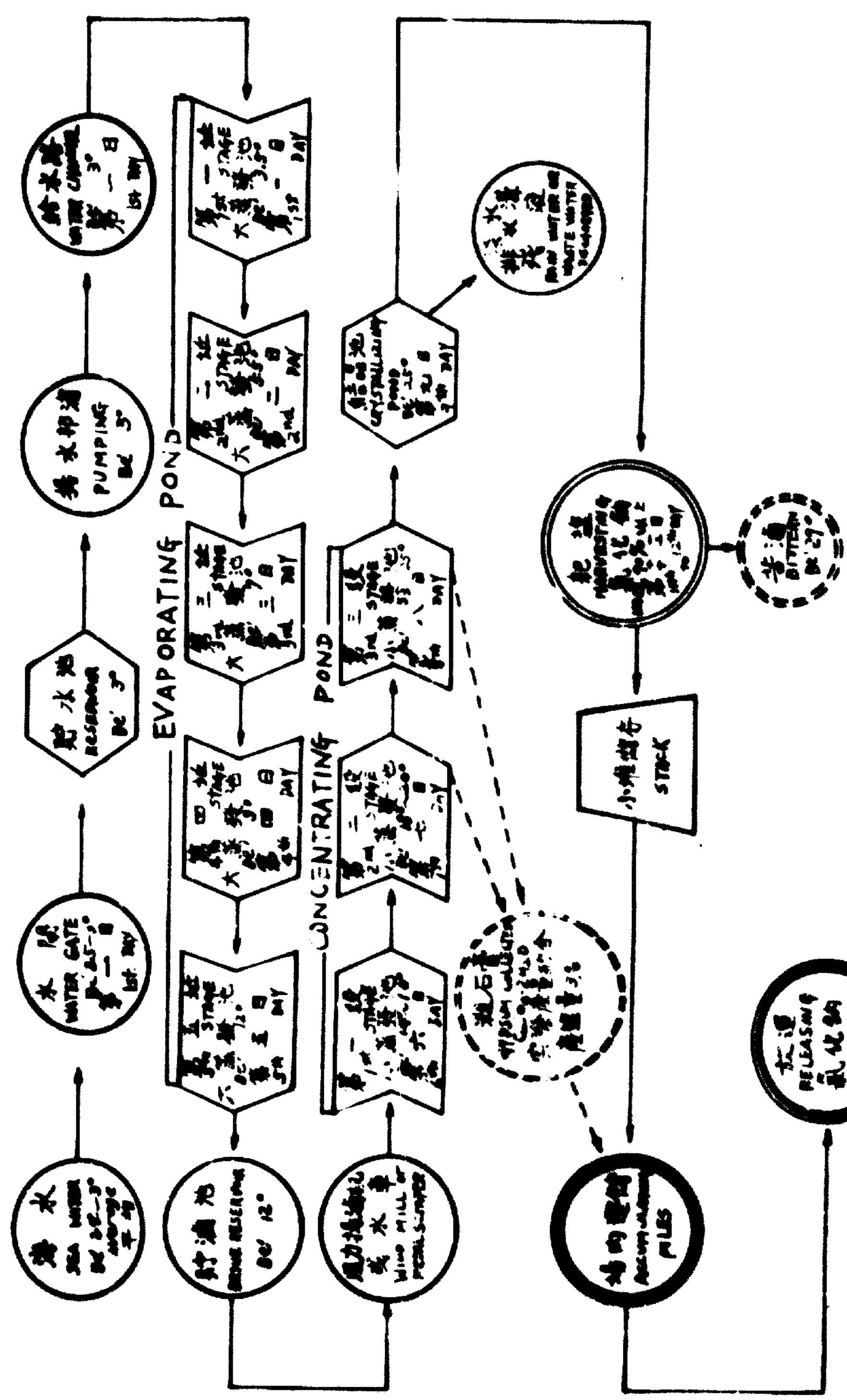


Figure 2

台灣製鹽總廠

TAIWAN SALT WORKS

土盤灘製鹽流程圖

FLOW SHFET OF SALT PRODUCTION (mud bottom)

tile-bottom type except that the brine in mud bottom of the crystallizing ponds is fed with depth at 40-45 mm.

Seasons for solar salt production

12. Owing to the fact that salt harvesting is closely related to climatic conditions, the salt-producing seasons are accordingly divided into three different periods. The period from March to May is known as the brisk season. Production at this season constitutes about 45 per cent of the total output for the whole year. During the rainy season from June through September, the production is slack, producing only about 11 per cent of the annual output. The output of the period from October through February of the next year, known as the common season, accounts for about 44 per cent of the yearly figure.

Salt production from 1950 through 1967

Years	Area of salt fields in operation (hectares)	Output (metric tons)	Average output per hectare (metric tons)
1950	4,281	172,571	40.31
1951	4,275	280,888	63.36
1952	4,256	308,939	72.54
1953	4,258	158,755	37.28
1954	4,257	362,477	25.14
1955	4,262	415,992	97.60
1956	4,263	295,038	71.55
1957	4,263	359,862	84.41
1958	4,263	409,878	96.15
1959	4,263	392,593	92.09
1960	4,263	404,606	94.93
1961	4,302	359,403	91.91
1962	4,302	543,583	126.36
1963	4,209	563,937	133.98
1964	4,174	550,124	131.80
1965	4,174	507,265	121.53
1966	4,174	374,317	89.68
1967	4,174	478,387	114.62

13. The above table reveals that the output rises from year to year. The factors influencing the increase are as follows:

(a) Expanding the evaporating area by reclaiming idle land to acquire sea-water of high concentration.

(b) Repairing of the salt fields twice a year by rolling the bottoms of evaporating ponds with machines or stone rollers for enhancing their efficiency on the one hand and avoiding the loss of brine through seepage on the other.

(c) Dredging of the canal system for rapid filling of fresh sea-water and and emptying of waste liquor.

(d) Drenching of the evaporating ponds with bittern once or twice a year during the period of repair in order to kill the crabs, insects and the like that make holes that cause seepage of brine.

LOCAL METHODS OF THE RECONDITIONING OF PONDS

Necessity for reconditioning

14. The ponds should be reconditioned for production of salt in thin layers every three to five years, because after long operation the surface soil becomes soft and rough, causing both the decrease in the quantity and the degradation of the quality of salt production. The reconditioning of the ponds is a very important work.

Methods of reconditioning

(a) Surface layer

15. The surface soil of ponds should be a mixture of about four parts of sand and six parts of clay for evaporating and concentrating ponds and with seven parts of sand and three parts of clay for crystallizing ponds. The mud mixture is sticky when moistened and should be mixed evenly and compacted with roller.

(b) Treatment of surface soil

16. The mud mixture should first be thoroughly dried by exposure. If moistened through occasional rain, it should be re-dried before it is raked level. Then the soil is chemically treated with brine at 5° to 8° Bé. The brine-soaked mud should then be thoroughly mixed, usually by foot-stamping. It can also be done partly by tillers or tractors, but a final foot-stamping is still considered necessary to ensure that the surface of ponds is smooth.

(c) Levelling

17. Levelling is another important task. Level testing and compacting by rollers are carried out at the same time. First, the soil surface should be raked level with the optimum water content and pressed again by stamping. The

ponds are then filled with a thin layer of brine above 10°Bé. The level of the surface is checked visually. The process from supplying of brine to rolling of surface should be repeated twice more. The brine to be filled in the pond should be 16°Bé for the second operation and 21° to 22°Bé for the third. After the completion of the third operation, the surface would show no footprint when walked upon. It can then be used in salt production.

THE REFINING OF SALT

18. The Taiwan Salt Works operates two washing plants and one refining plant for the production of washed and refined salt. The yearly outputs of the two washing plants total 110,000 metric tons, and that of the refining plant, 4,000 metric tons. Although for the time being salt production is just sufficient for domestic needs, the market demand is increasing continually, there is no doubt that it will soon be inadequate. To meet the ever-increasing demand for high quality salt, a project for building a new washing plant and a new refining plant is under way.

BY-PRODUCTS

19. The two chief by-products of salt fields are crude gypsum and bittern. Crude gypsum is precipitated out in course of concentration of sea water from 16°Bé to 22°Bé. It is ready for sale after a simple washing process. The bittern is drawn from the crystallising pond after the salt has been harvested. It must be properly processed in plants to produce several valuable by-products such as gypsum, magnesium hydroxide, dead-burnt magnesite, anhydrous sodium sulphate and refined Glaubers' salt.

SALT LABOURERS

20. Both labourers and contracted labourers are used in the Taiwan salt industry. The wages of the former are paid on basis of working days and adjusted from time to time according to fluctuation of prices of commodities; those of the latter wages are reckoned by tons of salt produced, varying with working area, kinds of salt fields and grades of salt produced.

21. According to the statistics of December 1967, we have altogether 4,801 labourers, 479 of the hired and 4,322 under contract, with a total of around 14,161 family members.

22. It is obvious that the success of the salt industry in Taiwain depends largely upon the endeavours of salt labourers. Thus, to improve salt quality and increase production, the interests of the salt labourers must be properly safeguarded. After the retrocession of Taiwan, the Government organized the Committee of Welfare of Salt Labourers to improve the living conditions of the salt labourers. As a result, salt labourers now earn reasonable wages.

DIFFICULTIES ENCOUNTERED IN SALT PRODUCTION IN TAIWAN

Lack of good ways to store the brine in the course of concentration during times of frequent rain

23. During heavy rainfall the brine remaining in the ponds becomes so diluted that it must be drained and replaced with fresh sea-water to start the concentration process all over again. Both the time lost for such interference and the loss of discarded brine affect salt productivity very seriously.

Seepage loss of brine in the course of concentration due to sandy soil

24. The surface layer of the bed of the crystallizing pond is usually built with soil of 30 per cent clay and 70 per cent sand. After long operation, this surface layer is gradually washed off by salt harvesting and rain. It gradually becomes sandy and is easily permeable by brine.

Lack of modernized brine feeding equipment

25. The existing pedal pump and windmill pump cannot efficiently supply the brine in time. This not only roduces the output but also affects the quality of the salt. It is necessary to install electric pumps with high efficienty. This cannot be done, however, until the small-unit, one-family sets of ponds are combined into large centralized units.

Lack of mechanization in harvesting and piling

26. In order to prevent the loss incurred by frequent rain, salt must be harvested as soon as it is produced in a thin layer. At present, both the salt-harvesting and piling tasks are performed entirely by human labour. There is an urgent need to devise machines such as light harvesters and portable conveyers for these purposes.

PLANS FOR FUTURE DEVELOPMENT

27. The following measures to be taken for future development of salt production in Taiwan are suggested

(a) Research to improve the equipment to store the brine in the course of concentration during rain to minimize the loss from dilution.

(b) Adoption of brine-feeding equipment entirely operated by electrical power.

(c) Research on the management of salt labourers and payment systems of salt labourers' wages in order to increase the salt production and to decrease its cost.

(d) Mechanization of the processes of salt-field reconditioning and salt harvesting and piling.

(e) Renovation of washed salt plants to meet the increasing demands and

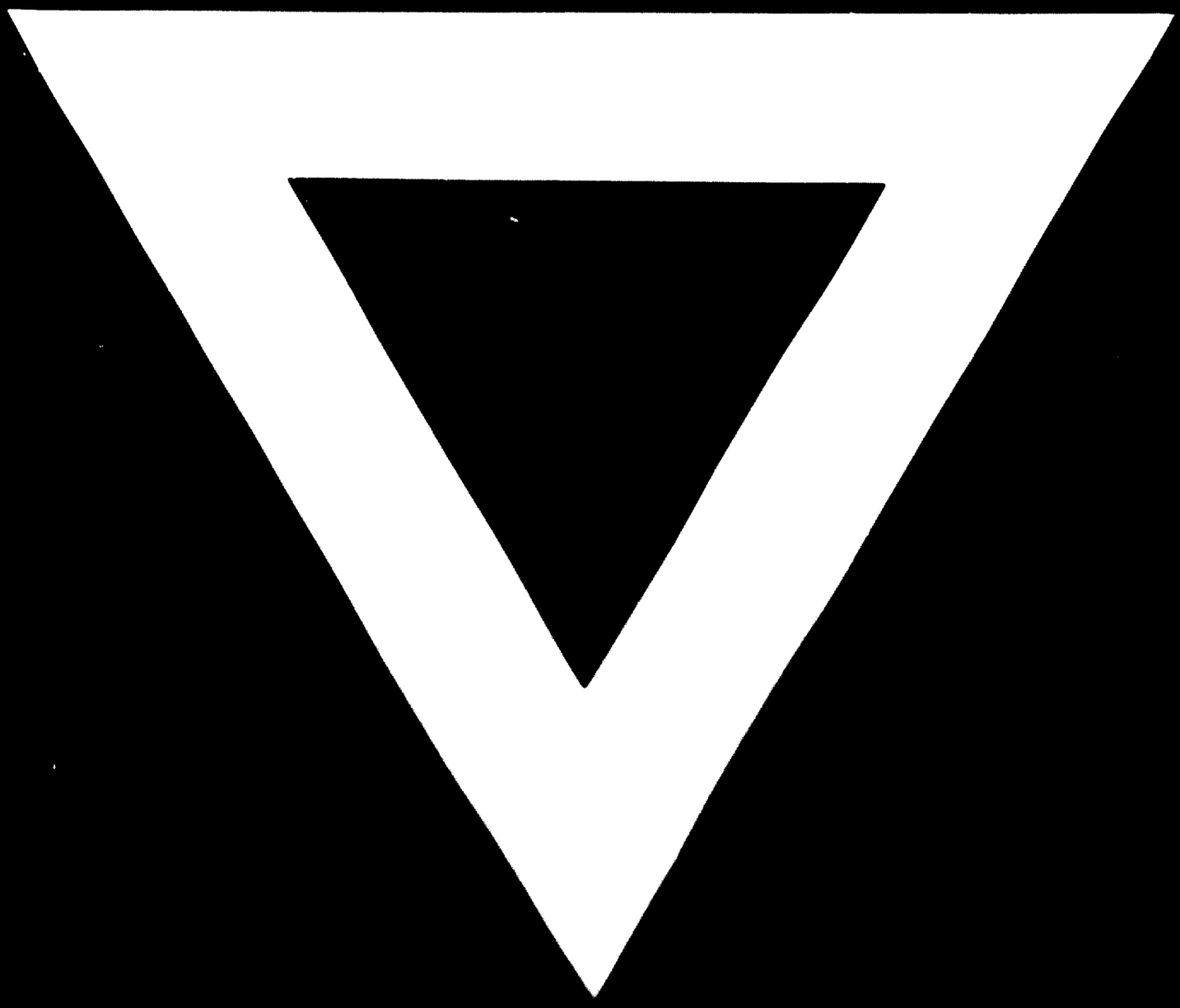
(f) development of new salt fields on tidal lands in order to increase salt production to meet increasing demand.

CONCLUSION

28. The important tasks confronting Taiwan at present are?

(a) To take effective advantage of such time as is available after intermittent rain, because time thus saved is time added to producing salt, and

(b) to equip the entire salt fields with suitable machines to do the jobs of salt-field maintenance and reconditioning and material handling in harvesting and piling, because these machines will not only keep the salt fields in good condition but also will reduce labour cost in salt production.



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