Technical consultancy on situation analysis of universal iodisation production, distribution and marketing in Cambodia

Final Report

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23rd June- 13th July 2003

Table of Contents

Page

1. INTRODUCTION:

Iodine Deficiency Disorder (IDD) refers to all ill effects of iodine deficiency in a population, and can be prevented by ensuring that the population has an adequate intake of iodine. IDD can only be eliminated once and for all if control programmes are constantly maintained. In other word, iodine must be provided continuously to population living in iodine deficient environment. A successful salt iodisation programme at the national level depends upon the implementation of a set of activities by various sectors.

- Salt producers, salt importers, quality controllers, distributors and food manufactures
- Government Ministries of Industry, Planning, Health, Education, Communication, Commerce, Finance, Legislation and Justice
- Concerned civic groups and NGOs
- Nutrition, food and Medical scientists and other key opinion makers

In Cambodia, even though initiatives were taken to introduce iodized salt for human consumption under the universal salt iodisation project with the target to achieve 100 percent iodization of salt and eliminate IDD by year 2000, (Subsequently revised to 2005), the progress of iodization is very slow and still in the initial stage due to managerial and technical reasons.

This report is prepared based on the Terms of Reference given to me and the request made in the introductory meeting on 23rd June 2003 chaired by H.E. Kim Saysamalen with the participation of representatives from UNICEF, GTZ, MOP, MOIME and other connected officers.

I worked closely with National Sub-Committee for Iodine Deficiency Disorder (NSCIDD) members and visited the provinces, met with salt producers and wholesalers, and Provincial Directors. At the markets, I met salt sellers, community and household members, and collected valuable information and studied the situation of universal salt iodization in Cambodia.
Herewith, I submit my observations and recommendations for consideration.

2. PRESENT SITUATION AND MAJOR CONSTRAINTS

2.1 Production of solar salt

Cambodia has introduced the strategy of universal salt iodization to achieve virtual elimination of iodine deficiency disorders by the year 2005.

It is estimated that the Cambodia's annual requirement of salt is around 80, 000 m.t. as shown in the table below.

The total country requirement of salt (Table 1)

Purpose	Quantity in metric ton
Iodization –human consumption	43,000
Iodization –animal consumption	27,000
Industrial needs, fish curing	10,000
Total	**80,000**

The total production area of solar salt at Kampot province is 4,098 hectares and the annual production is around 70,000 m.t. The yield per hectare is only 18.5 m.t. which is very low when compared to other countries (Sri Lanka, India) where 90 -100 m.t of salt is produced per hectare.

The drawback in salt production is due to the following problems:

- The ratio between crystallized area and evaporation area, reservoir and condenser is not following the accepted technical specifications.
- Systematic brine circulation is not carried out
- Brine density and the brine level in every stage is not monitored and controlled daily
- Bittern is not eliminated after the collection of common salt
- Collection of thin formation of salt, not allowing to mature
- Meteorological data is not observed

Common salt (solar salt) is manufactured in Cambodia by using the ancient and conventional methods. Modification is needed using modern salt technology to optimize solar salt production capacity and have good quality solar salt for the purpose of improving the quality of iodized salt.

The solar salt production for last five years (Table 2):

Year	Production in metric ton
1999	50,000
2000	25,000
2001	11,000
2002	72,000
2003	36,000

As indicated in the table 2 above, there is shortfall in solar salt production in 2003, achieving only half of production in 2002. This is likely to lead to salt importation by salt traders.

It is recognized that solar salt manufactured in Kampot province is the first stage in the production process of iodized salt. Solar salt is the raw material, and iodine has to be added to produce the end product, iodized salt. Hence, the cost of iodized salt is very much influenced by the cost of solar salt. The first focus for cost reduction of iodized salt production should start from optimizing solar salt production process in Kampot Province. Special attention has to be paid to manufacture good quality solar salt at the lowest cost possible in this province. The average annual production of solar salt is around 70,000 m.t. with available resources. The present solar salt production is insufficient to meet the country's demand. It is necessary to analyze the situation of solar salt production and the views and aspirations of salt producers, as a necessary step in implementing actions to strengthen salt iodization.

The factors influencing the manufacture of solar salt are:

i. Evaporation area (land)
ii. Weather condition
    a. Sun shine
    b. Rain fall

c. Wind velocity
d. Humidity

iii. Brine control
iv. Physical resource
v. Human resource
vi. Technical management

Annual salt production in a particular year depends on the above factors on the same year. In order to know the reason for the large discrepancies from year to year, the above factors must be analyzed individually in detail for every year. But in Kamport most importance particulars like meteorological data, daily brine density record etc. are not available to have a detailed study. The system of maintaining such record may be started from this year for future reference.

In Kampot province, there are nearly 180 salt producers engaged in solar salt production in 6 production areas, having different distances form Kampot town. During our study visit, we were able to meet only a few producers, some individually and others in groups of two or three persons at the Salt Board office. There was representation from all the salt production areas namely; Boeng Rung I&II, She-Sor, Boeng Touk, Treuy Koh, Kampong Trach and Kep Town. I handed over a questionnaire prepared by myself to the salt producers, in order to obtain information to assess the present situation.

Details on the manufacture of solar salt have been mentioned in earlier part of the report and plenty of information in this respect is available. I am of the view that my duty is to add and elaborate some more technical advice and information to show how solar salt could be economically produced with high quality to suit for salt iodization. (Refer to annex 1).

Present situation:

- Salt producers manufacture salt in very ancient methods
- Three grades of salt are produced (grade 1, 2 & 3)
- Production area is not utilized to the maximum
- Systematic brine circulation is not carried out
- Quality of salt produced is inferior and not suitable for direct iodization (need processing)
- Production area map is not available
- Daily brine testing in every step in the production process is not carried out, records are not maintained
- Bittern elimination facilities is not available
- Soluble and insoluble impurities are very high
- Salt producers lack knowledge of modern technology of solar salt production
- Productivity is low
- Selling at different rates of price for their salt

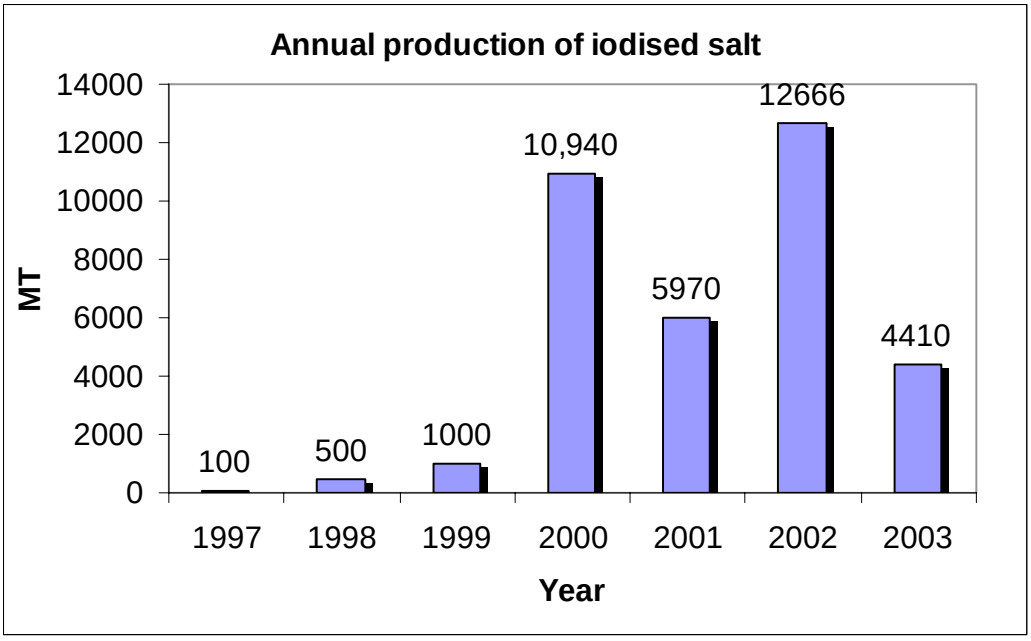
  - Grade I - 3000 riel/ 70kg
  - Grade II - 2500 riel /70kg
  - Grade III - 2000 riel/70kg

- Selling salt in volumetric basis (one sack), it may contain 70-90 kg depending on the density of salt.
- Salt producers have no community or association
- They do not get help from the Salt Board or Government
- No one from government or Salt Board visited salterns to inspect or provide guidance, instructions or support
- Salt board is not functioning and the office is always closed. During our visit we request to open the office to organize a meeting with the salt producers there.
- Salt producers are willing to iodize salt in group with assistance of UNICEF and Government

2.2 Production of iodized salt

Iodized salt production last 7 years

Year		**MT**
1997	-	100
1998	-	500
1999	-	1,000
2000	-	10,940
2001	-	59,70
2002	-	12,666
2003	-	4,410 up to May



It is observed that iodized salt production was increasing from 1997 to 2002 (except in 2001) and there is sudden drop in 2003. Hence, action should be taken to accelerate the production and sales of iodized salt to achieve the expected target in Cambodia.

2.2.1 Iodized salt produced with use of salt iodization plant (SIP) Mr. Bun Barang

Visited the production site with Mr. Bun Barang. There are three new Salt Iodisation Plants (SIP) with production capacity of 5-9 m.t. per hour complete with power generators. Two old SIPs with production capacity of 5 m.t. per hour were under repair. The new plants are kept in a salt storage hut (barns) without having the basic hygiene facilities.

No plants were operating when we arrived at the site. We requested the factory to start running the machine. The following observations are:

- Using inferior quality of salt for iodization
- Salt is iodized without processing (washing, drying, crushing)
- No regular iodine checking
- No record of iodine content (PPM)
- No crusher is provided to the plant
- SIPs are not working continuously
- Quality of finished product is not satisfactory, high percentage of soluble and insoluble impurities
- Iodized salt produced is bagged in 50 kg polystyrene bags without having inner lining
- Average monthly production is between 120-150 m.t.
- Average no .of days for SIP operation per month is –10 days
- The road approaching to the plant is very bad

2.2.2 Iodized salt refinery (Noun Houn) at Kampot

Location: Along the main road toward Kep Town, 3 km from Kampot Town and easily accessible.

Process: Well-organized continuous process consisting of washing, grinding (Crushing) drying and iodizing

Environment: Refinery is housed in the new building under good hygienic condition.

Production Capacity:

Production	**Iodized salt**		
	Refined Powder	*Refined Crystal*	*Total*
One hour	5	15	20
One day 6 hours	30	90	120
One month 25 days	750	2250	3000
One year 12 months	9,000	27,000	36,000

Out put can be increased if the plant is worked in two shifts (12 hours per day) in case demand increases.

Quality: External appearance seems to be satisfactory to meet the required quality. It has been checked in the laboratory for chemical parameters.

Price: Ex-factory price

1. Iodized salt powder (grinding) 140 riels/kg in 50 kg bags
2. Iodized salt crystal (processed) 100 riels/kg in 50 kg bags

2.2.3 Iodized salt produced by thermal boiling - Phnom-Penh and Other provinces

Total annual production	-	7,000 m.t.
Total No. of producers	-	30 families

Provinces		Families
Phnom Penh	-	11 families
Kandal	-	5 families
Kampot	-	4 families
Kampong Speu	-	1 family
Kampong Cham	-	3 families
Battambang	-	5 families
Siem Reap	-	1 family

Process: Solar salt is dissolved in fresh water and made into a saturated solution and it is allowed to settle. Then the clear solution is fed into the pan evaporator where salt is crystallized in powder form. Paddy husk or sawdust is used as fuel to boil the salt solution. Wet salt is allowed to dry naturally and iodine is mixed. Salt mixers donated by World Health Organization (WHO) are not being used and kept aside, idling and getting corroded. Salt is mixed with iodine by hand which is not uniform. Production site is not clean and hygienic. Iodine level varies from 16 - 110 PPM (result taken from MOIME). The standard PPM of iodised salt is 50-60 PPM.

No records maintained for iodine level at the production site and there is no proper packing

2.3 Quality control

In all three production sites;

- Quality control is not adapted any where in the process of solar salt and iodized salt production.
- Iodine level is checked by using test kit randomly in the iodized salt production places but not regularly and records are also not maintained
- Iodine testing by titration method was done by the MOIME until March 2003 and now it is suspended for some time due to operational problems. (Iodine testing has been done by titration at the MOIME from January to July 2003).
- This MOIME laboratory does not have required chemicals and some apparatus to carry out the full analysis of salt
- No laboratory facilities are available in Kampot (production area) to analyze chemical parameters of salt.

2.4 Distribution and Marketing:

There is no properly functioning distribution channel for iodized salt in Cambodia. Iodized salt producers are producing the iodized salt and selling based on market demand and profit motive. There is no plan for distributing to the required places. The followings are shortcomings of the distribution systems.

- No systematic distribution
- No sales unit in the production area
- No sales unit in the provincial level
- No check point in the outlet
- No monitoring by the health department in the provincial level
- Middle man is getting more profit
- Prices are not proportionate to distance
- Different prices in the same province
- Some consumers do not know the difference between non- iodized and iodized salt
- Limited awareness promotion in TV & other media

3. RECOMMENDATIONS

3.1 Improve quality of solar salt

- **Long-Term action**

  The quality of solar salt producing in Cambodia does not meet required standard for salt iodization. This is mainly due to salt producers not following the correct method of crystallization according to the acceptable general procedure adopted by salt producers in other countries. The following system is to be adopted to improve the quality. (Refer to annex 1)

3.2 Increase productivity of salt fields

- **Long-Term action**

  In Cambodia the production area, reservoir, condenser, crystallizers are not used to the maximum. If the correct density and brine levels are maintained together with timely elimination of bittern in the process, it is not difficult to increase the productivity. The salt producers generally lack modern technology of salt production and need training. It is advisable to arrange a knowledgeable and experienced salt expert to demonstrate the modern method and to implement the system in the salt field in Cambodia. At the start it may be a pilot project basis and can be extended to other fields.

  Manufacturing of solar salt system has to be modernized and improved to obtain quality salt with less cost of production for salt iodization. In this way, the existing production area will produce more than 200,000 m.t. of solar salt, which is more than the country local

consumption and gives the opportunity to have the salt export, which will pave way to earn the foreign exchange.

3.3 Location of production site of iodized salt, Kampot province

Salt iodization sites must be located at Kampot province near to the salt fields. Any new iodized salt producers should be encouraged to put up their plants in Kampot province as this province meets the criteria as a production site as mentioned below:

- Continuous availability of raw material (solar salt)
- Minimum transport distance from iodized salt production site to site where raw material is available.
- Adequate Space to discharge the waste
- Situated away from the thickly populated area
- Easy access and transportation of raw material and the finished product (iodized salt)
- Close to salt field to obtain high density brine for salt washing

3.4 Improve quality of iodized salt produced by SIP - Mr. Bun Barang

- **Immediate Action**

Mr. Bun Barang to use Mr. Noun Houn Factory for iodizing salt: Mr. Bun Barang is one of the shareholders in Mr. Noun Houn factory. He wishes to get involved and support the IDD Control project. I had discussion with him and he is found to be favorable to sell his solar salt to Mr. Noun Houn's refinery factory. Once this arrangement is finished, an agreement with Mr. Bun Barang is also necessary, i.e. he has to stop forthwith his unprocessed iodized salt production by SIP, until he builds his washing tank and drying pan. He is also required to help Mr. Noun Houn to market the iodized salt to his customers and others as in the past.

- **Long-Term Action**

Instructions must be given to Mr. Bun Barang to improve the iodization system using the SIP by building washing tank and drying pan to process the salt before iodization. If he does not agree, these SIPs may be removed from his site and handed over to other salt producers who are willing to iodize after processing the salt.

The iodized salt produced by salt iodization plant is taking place only in one salt field belonging to Mr. Bung Barang. At present, the quality of solar salt used for iodization is not acceptable. It doesn't serve any purpose without washing the salt before iodization. Because the salt is clearly visible with the insoluble impurities, consumers will have tendency to wash it before using to make the salt clean. This will wash the iodine in the salt. If we compel the consumers to use this salt without washing, we are forcing the public to eat the salt along with the impurity presence in the salt. It is recommended that Mr. Bun Barang should follow the procedures mentioned below to produce good quality of iodized salt for human consumption.

1. Select good quality of solar salt (Grade I)
2. Wash it with high density brine in a washing tank manually to minimize the insoluble impurities to less than 0.5 percent
3. Dry it in an open solar drying pad adjoining to washing plant and allow it for at least 2 days to reduce the moisture to less than 4%. It is important to check it daily before iodization process
4. Crush the dry salt in stainless steel roller crusher, to reduce the particle size up to 3 mm to make the efficient iodization and uniform blending
5. Crushed salt is transported to the iodization chamber by an open belt conveyor. While the salt is in the conveyor, if any impurity is seen, it can be picked out by hand to improve the quality further.
6. Iodize salt with potassium iodiate (KIO_3) to meet the standard p.p.m. specified
7. Iodized salt should be packed in 50kg pp bags with polystyrene liner or in 1kg opaque packets. (The iodization layout is in Annex 2)

The following operational control to be adapted to produce the good quality iodized salt using salt iodization plant (SIP).

1. The KIO_3 solution should be prepared by dissolving at the rate of 4-5 grams in 100 ml of distilled water (preferably) and by filtering it through a fine clothe, so that any un-dissolved crystals and extraneous matters do not clog the nozzles. The solution so prepared should be analyzed to make sure that the concentration is between 4 to 5%.

2. It is advisable to check the nozzles each day, take out the nozzles once a week and clean them by immersing in boiling distilled water for 30 minutes. The nozzles may also be replaced every year. This is needed, because in the spray mixing process, there is always the danger of the nozzles getting clogged due to the evaporation of the KIO_3 solution and formation of crust of KIO_3.

3. The essence of the Spray-Mixing process lies in ensuring that the flow of salt from the conveyor belt is uninterrupted and steady. The spray should cover the entire width of the sheet of salt falling into the chamber. The movement of the conveyor belt needs to be even. Care should be taken to ensure that the air pressure is maintained at the desired level (25 psi) so that spray is uniform.

4. Samples of iodized salt are to be collected by the chemist at regular intervals as it flows out of the chutes and analyzed to determine the level of iodine content. The chemist provides timely advice to the plant operators to take corrective measures, as needed, by adjusting the flow of salt/spray. The Chemist should be very alert, as delayed communication of results of analysis to the plant serves no purpose.

5. Iodized salt should be collected into bags directly as it flows out of the chutes instead of allowing it to fall on the ground. As the crystals will still be moist with the spray that they have received, they may pick up dust and dirt.

Price of different quality salt (1 kg packet) in Phnom Penh

Producers	Iodized salt (riel/kg)		Non-iodized salt (riel/kg)	
	Refined	Crystal	Refined	Crystal
Thermal salt	300	200	200	150
Bun Baraing	-	170 Unprocessed	-	84 In bulk 70kg
Noun Houn	230	190 Processed	190	150

6. The iodine content in iodised salt will be lost if it is exposed to sunlight directly. Hence to avoid this situation iodated salt should be packed in the opaque packets. At the same time iodised salt is packed in 1Kg packets for the purpose of easy handling, effective distribution, avoiding adulteration and attractive marketing.

7. All non-stainless steel parts of the plant should be regularly cleaned with cloth to brush away salt particles and given a coat of anti-corrosive paint at such intervals as may be necessary. Similarly, all the bearings should be well greased so that the operational efficiency of plant is maintained. Jammed rollers and slow-moving belt conveyor would give erratic results in the process of iodisation.

3.5 Increase the quantity of iodized salt produced by salt refinery in Kampot – Mr. Noun Houn

- **Immediate action**

The present condition of this refinery is suitable for the production of iodised salt and has already been mentioned in the early part of my report under situation analysis.
With due consideration of iodized salt production in three systems and the price of their products based on at Phnom Penh as per above table, quality and production capacity. It is recommended to encourage Mr. Noun Houn factory to increase quantity of iodized salt production with the available systematic salt refinery at Kampot. He has signed an agreement with the government /NSCIDD to produce and supply of 20,000 m.t of iodized salt in the year 2002, continuously without any interruption or any price changes when he was given the SIPs. This commitment may be need to be discussed and reactivated again to help address the constraints in the situation.

If the major problem of iodized salt production is solved by the above arrangement, sufficient market facilities should be created by formation of a marketing taskforce consists of Ministry of Commerce, NSCIDD, PNCC, Provincial Department of health and Salt Board.

Since some consumers are used to refined iodized salt and small industry already exists, along with the other grade of iodized salt, this product should also be promoted to have a wider distribution and to satisfy the consumers' options and create competition to achieve our ultimate goal of universal salt iodization. At the same time the distribution of non-iodized refine salt should be stopped.

Inadequate number of SIP

Salt Field	Distance from Kampot (km)	Annual Production (mt)	No. of SIP (5-9mt/h)	Annual Output Capacity (mt)
Boeng Raing I&II	03	20,000	3*	38,000
Seh Sor	06	7,000	-	-
Boeung Tug	08	5,000	-	-
Troy Koh	07	24,000	-	-
Kampong Trach	45	14,000	-	-
Kep Town	25	6,000	-	-

* Another 2SIPs capacity of 5mt/h are also available at the same site in the Bun Baraing's salt field , but under repair.

Other salt producers are also requesting SIP for iodization

3.6 Support salt producers in Kampot and avoid monopoly of the salt trade

- **Immediate action**

Most of the salt in the Kampot province should be iodized in more than one refinery to avoid monopoly. Salt producers should be able to provide continuous supply of solar salt to the refineries under the supervision of Salt Board. Purchasing price of solar salt in the refineries and selling price of iodized salt at the refineries should be fixed within a reasonable price range in consultation with NSCIDD and the Salt Board, and these prices should prevail for one year without changes for easy marketing.

The salt produced from Kampot province, Kep Town and Kampong Trach can be iodized using the SIPs. The SIPs that are in excess and are not in use at Kampot may be given to these places and the necessary instructions should be given to iodize the salt after processing. The process and the quality control have to be followed as mentioned early in this report.

3.7 Improve production methods of iodized salt produced by thermal (boiling)

- **Immediate action**

The present system of thermal salt production is not economical, as a lot of energy (heat) is lost during the process, which also reflects in the cost of production. The quality also has yet to be improved. The crude salt is dissolved in water and the solution is simply boiled to get the salt. But it has to be chemically treated to eliminate soluble impurities such as calcium carbonate, ($CaCo_3$) calcium sulphate ($CaSO_4$), magnesium sulphate ($MgSo_4$) by adding barium chloride ($BaCl_2$), soda ash (Na_2Co_3), Sodium Hydroxide (NaOH), then it has to be filtered before feeding into the pan crystallizer. It is recommended that all the small producers must get together and form an association and put up a systematic recrystallizer plant with high capacity (5 m.t./per hour). This arrangement will help them to produce with less cost of production than at present with more purity.

Encourage all the thermal salt producers to use the iodine mixer donated by WHO and create the competition among them until the mass production of iodized salt in refineries is stream lined.

3.8 Reorganization of the Salt Board

- **Immediate Action**

The existing Salt Board should be reorganized and entrusted with responsibilities to work closely with salt producers and the NSCIDD members. In addition to committee members, a working team consisting of four members should be appointed to work full time and monthly salary paid for them to get efficient output. The finance for their salary and maintaining of salt board can be generated from the sales of salt, i.e. a nominal service charge could be recovered from wholesalers when the salt is being sold from the salt fields. This cost may be reflected in the selling price, but it will not be visible once we organize the proper sales monitoring system with avoiding middleman profit.

The above committee members (four) at provincial will be assigned duties related to salt production, quality control, salt issues & distribution (salt field) and coordination respectively.

A constitution for the salt board should be established in consultation with the NSCIDD.

Market price in different provinces (riel/kg)

Province	Iodized salt		Non-iodized salt		Price different	
	Refined	Crystal	Refined	Crystal	Refined	Crystal
Kampot	400	N/A	300	200	100 (25%)	-
Phnom Penh	500	400	400	300	100 (20%)	100 (25%)
Kampong Speu	500	400	400	300	100 (20%)	100 (25%)
Battembang	500	N/A	500	300	0	-
Bantey Mean Chey	700	500	400	300	300 (43%)	200 (40%)
Siem Reap	700	600	500	400	200 (28%)	200 (33%)
Poipet (Khmer salt)	800	N/A	400	300	400 (50%)	-
Poipet (Thai salt)	1000					

3.9 Distribution, marketing and pricing

- **Immediate action**

Distribution of iodized salt is one of the important subjects in the universal salt iodisation. Availability of adequate stock of iodized salt is important to improve the process of distribution. Production and distribution are interrelated functions, depending on each other. Production of iodised salt should be activated to meet the demand. Iodized salt production in Kampot in the refinery as well as by use of SIPs must be closely watched.

The salt board and PNCC/DOIME (Kampot) will maintain daily/monthly records of production figures. This document should be kept available in the Salt board office and DOIME office for easy monitoring by the sales unit.

It is observed that there is no price control structure and increase in price of salt proportionate to the distance from the production area. Consumers are finding it difficult to purchase the required salt at a reasonable price. In some areas, iodised salt, especially crystal, is not available. To avoid this situation, attention should be paid to the following areas:

- Steady pricing policy should be implemented by analyzing of market survey
- Direct market arrangement to bring down the selling price
- Avoiding middle man profit
- Continuous monitoring by authorized team and feed back to the NSCIDD for corrective actions
- Cost of production can be reduced by
  - Increasing productivity
  - Large scale production
  - Packing 1kg packets at the production site itself

3.10 Establish Sales unit and distribution channel (Transport)

- **Immediate action**

A Sales unit must be established at the iodized salt production area especially in Kampot and Phnom Penh to monitor production details, to set uniform and reasonable prices in consultation with producers, to promote sales by appointing area sales officers in every province and to coordinate the transportation of salt to province. This unit consists of members of Salt Board, DOIME and provincial department of commerce.

A tender shall be called for transporting salt to provinces. The successful tender transporter is responsible for transportation of iodized salt to the respective destination at stipulated intervals requested by the authority.

The following also need to be established or strengthened to ensure efficient distribution:

1. Effective IEC by the working group
2. Priority supply for IDD high prevalence area
3. Monitoring team, inclusive of health department at provincial level
4. Establish authorized salt dealers in provincial level
5. Contract transport for every province to transport salt regularly at a fixed rate per km.

3.11 Legislation

The regulation and the law are important tools to control the activities, and are directly of national interest. In Cambodia, as there is no strict rule and regulation on universal salt iodization, and iodized salt production and use could not achieve the set targets. Therefore, early actions may be taken to implement the legislation on universal salt iodisation.

- Only iodated edible salt is allowed for human and animal consumption
- This applies to manufacture, storage for sale, exposure for sale, transport and import
- This regulation does not apply to salt used for – industrial, agriculture, medicinal or similar purposes

3.12 Future Technical Assistance

- Provide advance technology to improve quality and quantity of salt production and salt iodization to salt producers
- Continue technical guidance on solar salt manufacturing in Kampot by experienced and knowledgeable salt expert
- Allocate reasonable budget for monitoring and evaluation by the NSCIDD and PNCC
- Follow up consultancy assessment and recommendation and also supervise the construction of pilot salt crystallizer and the system implementation
- The follow up visit may be after six months, 4 – 6 weeks during the peak of the salt manufacturing session preferably from later part of December 2003 to January 2004.

4. Conclusion

The required resources and facilities are available in Cambodia to manufacture solar salt and to produce quality iodized salt. At present, these resources are not properly organized and placed to achieve the maximum output. With the introduction of modern technologies and the improved managerial and technical capacity of relevant personnel through training and motivation, the industry will flourish by meeting the country's iodized salt demand. Further, this industry has the potential to play an important role in the country's economy by way of earning foreign exchange through salt export.

During the time frame given to me, I visited several provinces and production areas, studied the present situation, and I submit the recommendations to the best of my knowledge and experience. In addition, as I explain in my report, there are some more details that could not be included in this report due to time constraint. I will provide such details, as and when necessary on your requests.

I take this opportunity to thank H.E. Kim Saysamalen and the representatives from UNICEF, GTZ, WHO, NSCIDD and all others who helped me in several ways to make my consultancy service a success. I regret my inability to mention them here by their names.

Thank you.

TERMS OF REFERENCE FOR A TECHNICAL CONSULTANT ASSISTING THE ELIMINATION OF IODINE DEFICIENCY DISORDERS (IDD) PROGRAMME ON SITUATION ANALYSIS OF UNIVERSAL SALT IODIZATION PRODUCTION AND DISTRIBUTION IN CAMBODIA

1. Introduction

Iodine Deficiency Disorders (IDD) is a major public health problem in Cambodia. The results of the 1996/1997 goitre survey were alarming with an average of 12% of school age children found to have evidence of goitre and with, in nine out of the 24 provinces, goitre rates as high as 20% to 39%.

Considering the extent of IDD problem and the unique opportunity to iodize most of the salt in a single location (Kampot province where 80% of salt is produced in country), the Royal Government of Cambodia (RGC), with UNICEF/WHO and HKI support at the beginning, launched a national programme to combat the problem in 1995. Under the overall coordination of the National Council for Nutrition, a National Sub-Committee for Control for IDD (NSCIDD) was established with the task of working towards the 1990 World Summit for Children goals to eliminate IDD in Cambodia by the year 2005 though Universal Salt Iodization (USI) programme. The NSCIDD is under the chairmanship of the Ministry of Industry, Mines and Energy and Ministry of Health and consisting of representatives from the Ministries of Planning, Rural Development, Education, Information, Women's Affairs and Commerce.

Progress towards USI has been carried out but the iodized salt production still cannot meet the annual requirement for human consumption. The Cambodia Demographic and Health Survey 2000 reported that only 14% of household use iodized salt countrywide.

Major underlying constraints to the programme implementation continued to be the low production of iodized salt and price difference between iodized salt and non-iodized salt as well as the lack of effective enforcement of compulsory salt iodization.

2. Objective of the Consultancy

The aim objective of the consultancy is to assist the Kingdom of Cambodia to achieve the goal of elimination of IDD by 2005. This will include:

1). To do a situation analysis including financial analysis on iodized salt production, distribution and marketing.

2). To make recommendations and define outline of main activities to be implemented on how to improve the production and quality of iodized salt including the quality monitoring mechanism and packaging.

3). To make recommendations and define outline of main activities to be implemented on how to improve the distribution and the marketing of iodized salt throughout Cambodia as well as on how to overcome the obstacles of higher price for the iodized salt.

4). To define the nature and the level of technical assistance, if needed to the producers, wholesalers and the NSCIDD concerning production, distribution and marketing of iodized salt to achieve USI.

3. ***Specific Duties***

Working closely with the National Sub-Committee for Control of IDD (NSCIDD) the main salt producers, distributors and wholesalers as well as partners, the consultant will:

a). Review existing national data, policies, guidelines and plans relevant to IDD elimination programme.

b). Review the current salt production mechanism with the salt producers and analyze the situation and issues of the production of iodized salt, the channels of iodized salt distribution and its marketing.

c). Review and analyze what is the additional production cost of iodizing the salt and how this is reflected into the marketing price.

d). Review and make recommendations, based on the above situation analysis, for main activities to be implemented to improve the production including the quality control of iodized salt from the production to the consumer level.

e). Review the salt distribution channels and identify the main issues related to the price difference between the iodized salt and non-iodized salt.

f). Make recommendations to be implemented on how to improve the iodized salt distribution and to deal with the higher prices of iodized salt.

h). Make recommendations on the future level of additional technical assistance, if needed, to:

- Assist the NSCIDD and salt producers to improve and increase the production of iodized salt;
- Support the main salt producers and wholesalers to improve the distribution mechanism and marketing of iodized salt.

4. Expected outputs

- A situation analysis report with clear picture of the current situation concerning production, distribution and marketing of iodized salt including financial data and related issues as well as clear recommendations and outline of main activities to be implemented to reach USI by 2005.
- A debriefing Session to NSCIDD and to main stakeholders at the end of the consultancy for immediate feedback to the report.

5. Management of the consultancy

The consultancy will be managed by the NSCIDD with report to GTZ-FSNPSP Team Leader, UNICEF Programme Officer Health and Nutrition and WHO Nutrition Officer.

IDD Consultant Schedule
(Mr. Ehamparam)

Date	Time	Appointment/Activities	Where	Who involved	Transport
22 June	*10:25*	*Arrival*	*PP Airport*	**Heng**	*GTZ*
23 June	9:00	Peter Kaufmann	MoP	Narith	GTZ
	10:00	Briefing to H.E. Kim Saysamalen,	MoP	MOP, NSCIDD, GTZ, UNICEF, WHO, HKI	GTZ
	14:00	Mrs. Sineth for cash disbursement	GTZ Office		GTZ
24 June	8:00	Salt producer and wholesale	PP	Keahak, Khan	GTZ
25 June	8:00	Salt producer and wholesale	Kampong Speu	Keahak, Khan,	GTZ
26 June	8:00	Laboratory and market	PP	Keahak, Khan,	GTZ
26 June to 2 July	8:00	Salt producer and wholesale	Kampot	Keahak, Khan, Borat	GTZ & NSCIDD
3-4 July	8:00	Salt producer and wholesale	Kep	Keahak, Khan Borat	NSCIDD
5-6 July	8:00	Salt producer and wholesale	Bantey Mean Chey	Borat, Teng, Dara	GTZ
7-9 July	14:00	Salt producer and wholesale	Siem Reap	Borat, Teng, Dara	GTZ
10 July	8:00	Preparing draft report	MoP		GTZ
11 July	14:00	Debriefing/draft report for H.E. Kim Saysamalen	MoP	MOP, NSCIDD, GTZ, UNICEF, WHO, HKI	GTZ
12 July		City Tour	Phnom Penh	Narith	Taxi
13 July	Open	Check out	PP Airport		Taxi

Persons met during consultancy visit

1. H.E. Kim Saysamalen, Under Secretary of State, Ministry of Planning and Chairman of IMTC.
2. H.E. Chap Nhalyvoud, Governor, Siem Reap Province.
3. Mr. Peter Kaufmann, Team Leader, GTZ-FSNPSP.
4. Mrs Tania Goossens-Allen, Food Security Advisor, GTZ-FSNPSP.
5. Dr. Nyunt Nyunt Yi, Project Officer, Health & Nutrition, UNICEF.
6. Mr. UN Sam Oeurn, Senior Project Assistant, Health & Nutrition, UNICEF.
7. Mr. Sek Sopheanarith, Project Assistant (Nutrition), GTZ-FSNPSP.
8. Mrs. Khiev Bory, Director of Social Planning Department, MoP.
9. Mr. Mam Borath , Deputy Director of Social Planning Department, MoP, Secretary of NSCIDD.
10. Mr. Lun Say Teng, NSCIDD Member, Head of Primary Health Care, MRD.
11. Mr. Touch Dara, NSCIDD Member, Technical Assistant of NNP/MoH.
12. Mr. Ping Sivlay, Chairman of NSCIDD, Industrial Standard Director, MoIME.
13. Mr. Ven Keahak , Production Supervisor, NSCIDD.
14. Mr. Ek Sokhan, NSCIDD Member.
15. Dr. Lim Kain Eang, Provincial Health Director, Kampot.
16. Mr. Edwin De Korte, Agriculture Advisor, DED-Kampot.
17. Dr. Philippe Longfils, Health & Nutrition Advisor, GTZ-RDP, Kampot.
18. Mrs. Jenny Busch-Hallen, Technical Officer for Nutrition, WHO.
19. Mr. Seng Lay, Deputy Director of Provincial Planning Department, Kampot
20. Mr. Som Loas, Provincial Planning Department, Kompong Speu.
21. Mrs. Lay Navin , Laboratory Chief, MoIME.
22. Mr. In Sam Bo, Deputy Chief of Laboratory, MoIME.
23. Mr. Kim Keomara, Deputy Chief of Laboratory, MoIME.
24. Mr. Noun Houn, Salt Producer, Kampot.
25. Mr. Bun Barang, Salt Producer, Kampot.
26. Mr. Um Chhun, Former Chief of Salt Board, Kampot.
27. Salt Board Officers.
28. Solar salt producers in Kampot province
29. Thermal iodised salt producers in Kampot, Phnom Penh, Kampong Speu, Kampong Cham, Battambang, and Siem Reap.
30. Wholesalers in Kampot, Phnom Penh, Kampong Speu, Kampong Cham, Battambang, and Siem Reap.
31. Mr. Sok Kimcheourn, Official of Provincial Department of Industry, Mines and Energy, Kampot.
32. Mr. Much Chun Harn, Department Director of Industry, Mines and Energy, Kampot
33. Mr. Nget Soeurn, Director of Planning, Kep.

Manufacture of common salt

Introduction

The process of obtaining common salt and other marine chemicals, which are dissolved in seawater or natural brine, is entirely by gradual evaporation and fractional separation of solids at different densities (concentration). The method by which common salt is produced is very much practiced in our country even before the chemistry of salt was established. This method is utilized to different degree depending upon the prevailing climate conditions, the geographical location of the sources and the advancement of technical knowledge and its application. In western hemisphere where prolonged dry whether is uncommon, solar evaporation of seawater or natural brine is not feasible and salt is produced by dry mining of salt deposits or artificial evaporation of brine. In tropical country like India and Sri Lanka, where long dry whether exists, manufacture of salt by solar evaporation is adopted, and salt of very good quality and quantity has been produced.

Location of salt works

There are many factors to be considered, and for successful venture nearly all the following conditions must be fulfilled at least partially.

a) Proximate to an abundant supply of good brine from the sea, saline lake, underground brine, with in reasonable distance.
b) The site should be in a region of low rainfall giving a substantially long rain-free period of good sunshine, strong wind and low humidity, that is in short, favorable meteorological condition ensuring an adequate evaporation rate.
c) The soil should be of a dense and impermeable clayey nature, which will not allow any seepage, or at least the permeability should be very low.
d) The area should be free or protected from floodwater and, preferably, have small catchment area.
e) A large area is required that is comparatively flat and cannot be used for a more competitive purpose like farming.
f) Availability of transport and / or shipping facilities, and proximity to markets.
g) Availability of labours, especially in the case of a salt works utilizing labour intensive operations.

h) It should be possible to dispose of bitterns such that it will not re-enter the area.

i) Supply of fresh water for drinking and washing.

In actual practice it is not generally possible for a site to fulfill all these conditions, but some compromises may be achieved, provided always that the salt produced is marketable at a reasonable price.

Beaume & Density

The physical factor, which is monitored and controlled in the salt manufacturing process, is density of the brine. The density is measured using a Beaume Meter in 'Degree Beaume' (Be). The Beaume units give the approximate percentage salinity of an aqueous sodium chloride solution. For example the density of a 5% sodium chloride solution would yield 5^{o} Be. Consequently the density of fresh water, which does not contain any sodium chloride, will be 0^{o}Be.

The above ^{o}Be scale generally agrees with not only a pure sodium chloride solution but also multi component inorganic solution in which the dissolution of the solute does not cause any appreciable increase of volume. Hence the density of seawater of which the composition was given earlier, since it contains 3.5%solide, will be 3.5^{o}Be'.

The liquid heavier than water, the relationship between specific gravity

And Beaume scale is given by formula:

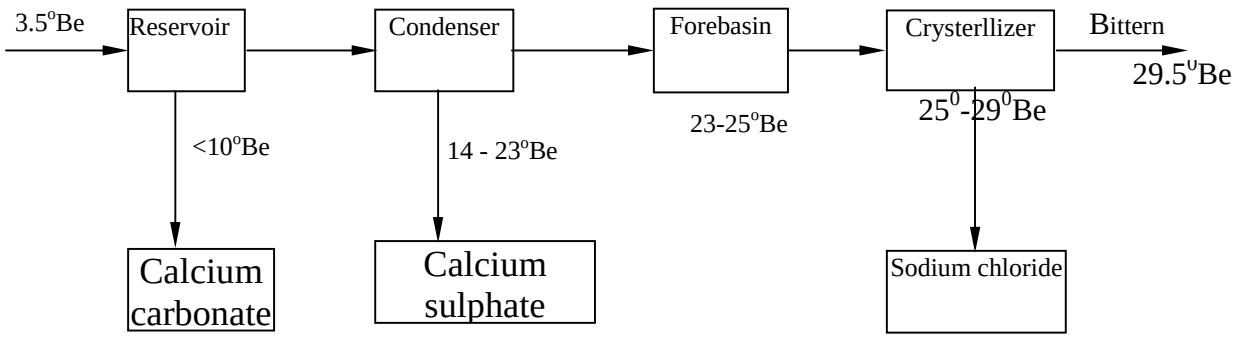
$$\text{Specific gravity} = \frac{143.3}{143.3 - B}$$

B-reading of Beaume hydrometer in degree Beaume

The quantity of salt presence in 100g of seawater at 3.5^0Be

Species	Concentration (g/100g)
Sodium Chloride	2.783
Magnesium sulphate	0.238
Magnesium chloride	0.353
Calcium sulphate	0.118
Potassium chloride	0.051
Other salts	0.010
	3.543

Flow diagram of salt manufacturing



°Be-Reading of Baueme hydrometer

Brine control and elimination of bittern in the process of salt manufacturing.

The process of solar salt manufacture is a process of fractional crystallization applied to the mixture of salt in sea-brine and the controlled of the brine at required densities in the process of evaporation. It is known that sea water contains a number of salts besides sodium chloride or common salt. Thus seawater when evaporated becomes saturated with respect to sodium chloride in the proportion of sodium chloride to water being only 21.3%w/w.

The hydrometer used gives approximately the percentage of salt in the brine (if it is not too concentrated.) Thus sea brine, which contains 3.5% of dissolved salts, gives a reading of 3.5^0Be. When sea brine is evaporated a small quantity of calcium carbonate and iron carbonate deposits as thin slime and this could be held in the primary condensers in the saltern system. The evaporation proceeds calcium sulphate or Gypsum deposits. This deposition commence at 12^0Be-14^0Be

In the form of thin dirty crystalline crust. However about 15% of gypsum remains in the brine and deposits along with salt till about 30^0Be.It has been observed that when 25^0Be brine is evaporated to 30^0Be, the quantity of gypsum precipitated in that range is 0.28g.If an equivalent quantity of lesser density of 22^0Be is evaporated to 30^0Be density then the quantity of gypsum deposit is increased by a further 0.16g,while if 20.6^0Be brine is evaporated, the quantity of gypsum is increased by 0.34g. This therefore indicates the importance of irrigating the salt beds or deep tank with only saturated brine or brine of at least 25^0Be without using lesser density brine. The preferred practice therefore would be to allow the brine to remain in the fore basin are (if avaible) or irrigation from condensers or deep tanks till a trace of salt deposited that is the density should be reading25.5^0Be and then only admit this brine in the case of shallow crysterlliser. Further more it has been found that the rate of evaporation decreases as the density increases and last stage of evaporation from 28.5^0Be to 30^0Be it has much slower rate of evaporation than between 25^0Be to 28^0Be.Hence it is desirable to discard all mother liquor at 28.5^0Be and use fresh saturate brine, therefore in normal practice irrigation of crysterlliser bed or maintaining deep tanks for salt under “brine cover” it is best to irrigate them with saturated brine and to keep on irrigating with saturated brines as the level of the brine falls in the bed or deep tanks through evaporation, keeping in mind to maintain the saturated brine at 25.5^0Be and discarding the mother liquor beyond 28.5^0Be . Discarding the high density mother

liquor (Bittern) quickly and refilling with fresh saturated has an effect to the salt to be harvested in that the salt is being washed in the fresh brine itself for better quality of salt.

Specification of common salt

The quality of salt required should not contain more than 6.0% by wt. of moisture and not more than 1.00% by wt: of insoluble and 1.0% by wt: of soluble and not less than 98.0% by wt: of Sodium chloride.This requirements are not difficult to attain provided the requisite precautions and conditions as outlined above are observed.

Moisture	6.00%
Sodium Chloride	98.00%
Insoluble	1.00%
Soluble	1.00%

Quality of Salt

What is 'Quality' in Salt?
In its purest Common Salt should not contain anything other than Sodium Chloride - except some moisture. However, production of 100 percent pure salt is impossible by the Solar Evaporation method. The salt produced, therefore, contains Various impurities - both physical and chemical, apart from moisture. The quality of salt is mainly reckoned in terms of its Sodium Chloride content, particularly for edible purpose.

Physical characteristics

- It should be crystalline solid, white, pink or light gray in color and free form visible contamination with clay, grit and other extraneous adulterants and impurities.

Moisture content

- Shall not be more than 4 percent of the weight of the undried sample.

Sodium Chloride content, as Na Cl.

- Shall not be less than 96 percent on dry basis.

Matter soluble in water (other than Sodium Chloride)

- Shall not be more than 3 percent on dry basis.

Matter insoluble in water

- Shall not be more than 1 percent on dry basis.

How to achieve the above standards.

Chemistry behind salt manufacture : Stated in simple terms, extraction of salt from sea water (or any other brine, for that matter) is fractional crystallization of the dissolved salts. The solubility of the dissolved salts differ at a given temperature and the rate of solubility increases with the rice in temperature. But, the solubility of common salt , Na Cl, is fairly constant between 0 to 100 C (32F to212F) the increase being only by about 1.5 percent. Solar evaporation method of separation of salts takes advantage of the differing solubilities of the various salts. When sea water is subjected to solar evaporation, the volume of the solution diminishes and the density increases, so much so, the salt which reaches its saturation point earlier, separates out. The separation of the salt concerned continues and with further evaporation the saturation point of another salt is reached. This process goes on until it is not possible to reduce the volume of the brine further by mere solar energy alone. It should, however, be remembered that it is impossible to ensure that the crystallization of one salt is complete before another salt starts separating out form the diminishing solution. There is, therefore, always a contamination of one salt with another, although such contamination could be kept at a minimum by control of operations.

How do the above principles apply to salt production?

When sea water containing a number of salts evaporated, the first salt to reach saturation point is Calcium Carbonate (Ca Co3) when the density reaches 7degree Be', (for explanation of the beaume metre, see below). Calcium Carbonate continues to separate out till the density rises to10 Be', but the separation is not complete till 17 Be', when Calcium Sulphate starts crystallizing out in the form of Gypsum, Ca So3 2H2O. Similarly, the separation of Calcium Sulphate is not complete even by 25.5^{o} Be, when Sodium Chloride begins to separate, having reached its saturation point. Thus, when Sodium Chloride begins to crystallize, there is still certain amount of Calcium Sulphate in the solution, which now crystallizes along with Sodium Chloride. The precipitation of Calcium Sulphate is not complete until after 30 degrees Be'. Under the traditional system of parallel feeding of crystallizes practiced in India and Sri Lanka, it is difficult to produce a salt completely free from calcium sulphate. While theoretically a solution of pure Sodium Chloride should reach saturation point at 23.50 degree Be', in practice, the saturation point is reached even earlier, owing to the

presence of other salts in the solution. As the separation of Calcium Sulphate is not complete at 23.5 degree Be', i.e., the density at which Sodium Chloride reaches saturation point in practice, the salt crystallizing out at this density will be highly contaminated with Gypsum.

On the other hand, Sodium Chloride continues to crystallize even beyond 32 degree Be'. But, as the concentration reaches 29 degree Be', other salts present in the solution start separating, thereby contaminating the Sodium Chloride.

Therefore, if we charge the crystallizes with 25.5^{o} Be', brine and do not allow crystallization to proceed beyond 29^{o} Be' the salt which will separate out between these two limits should be free from most of the impurities.

For the production of salt containing as little as possible of other impurities, the primary consideration is, therefore, the proper control of the density of brine at various stages. This is done with the help of the Beaume meter.

The Beaume Hydrometre :

The Beaume Hydrometre is specially designed for determining the density of solution of common salt. It gives a fair indication of the Sodium Chloride content of solutions, which contain other salts also. The zero point of the Beaume metre is fixed by immersing it in distilled water at 60 degrees F. The Hydrometre is then immersed in a solution containing 15 parts by weight of Sodium Chloride and 85 parts by weight of water, at the same temperature and the point unto which the Hydrometre sinks is marked 15. The intermediate distance is equally divided and marked. Each division is called a Beaume degree (Be').

Thus, if the Beaume metre reads 12 when immersed in a salt solution of unknown concentration, it means that the solution contains about 12 parts by weight of salt and 88 parts by weight of water or 12^{0} Be ' is the density of the solution. In other words, 100 parts of the solution contains (12/88 x 100) 13.64 parts of salt.
The stem of the Hydrometer is marked beyond 15^{0} Be', by extrapolation.

At low concentrations, the Beaume Hydrometer gives an almost accurate assessment of the Sodium Chloride content of brines but at higher densities, as the brine gets enriched with other salts also, the reading does not represent the Sodium Chloride content alone.

Every salt manufacturer should possess a Beaume Hydrometer and periodically test the concentration of the brine in the various compartments of the salt work, to follow the progress of evaporation.

Control of operations

Intake of brine: Ensure that the brine is freed of floatsam by allowing it to pass through a suitable drill before entering the Reservoirs.

The Reservoirs: The depth of brine in the Reservoirs should be maintained at about 18 inches and replenished from time to time, to provide sufficient brine for feeding the crystallizes ultimately. The dividing bunds in the reservoirs should be adequate enough to provide a sufficiently large area of exposure. The brine leaving the reservoirs may be routed through a long and wide channel so that by the time it reaches the 1^{st} stage condenser, the density would have risen to 6 degree Be '.

Filling up the reservoirs should be taken up early in the season so as to have a 6 degree Be ' brine ready on hand by the time repairs to the condensers is completed. Periodical inspection of the Reservoir bunds should be under taken to detect and plug leakages if any.

Condensers : The Condensers are to be prepared with more care, by leveling out uneven portions, clearing away bushes etc. The bunds/ridges compartmentalizing the condensers should be properly maintained so that the brine follows a ziz-zag course as it travels from the 1^{st} stage to the 3^{rd} stage condensers.

As Gypsum starts separating from about 17^0Be' and its recovery is beneficial, the 3^{rd} stage condensers need greater care.

Careful attention should be paid to the bunds so that there is no loss by leakage of high-density brine.

Crystallizers : The crystallizer beds are prepared by :-

- skimming out the stagnant slush & allowing the bed to dry partially;
- puddling by treading with feet till compacted;
- leveling and hardening by using wooden rammers;
- spreading a thin layer of concentrated brine, allowing it to dry to form a thin layer of salt and ramming the salt back into the bed with a layer of coarse of fine sand to prevent clay particles getting loosened;
- a light roller (1/2 tonne) may also be used to further leveling & hardening the bed.

When the crystallizer beds are ready, they should be charged with 25.5 degree Be', brine from the pickling ponds and the density should not g beyond 29-29.5 degree Be'. Drain off the bitterns after each harvest.

The salt crust should not be exposed and should always be kept under brine, to prevent dust settling on the salt crystals and getting encased while they are still growing.

The breaking of the salt crust and gathering it on the ridges is a skilled job. For, it should be ensured that the bed is not trampled more than necessary and not injured with the raking instruments.

Some tips for improvement in the quality of salt

Dos.....

1. In selecting the site for salt manufacture, ensure that the soil is impermeable and is free of borer worms, crabs etc.
2. Follow a scientific lay out, depending on the initial density of brine;
3. prepare the condenser and crystallizer beds with greater care to recover gypsum and produce salt with clay etc.
4. To increase the bearing strength of the crystallizer bed, spread a layer of 0.06 (weight/weight) solution of Manganese Sulphate in 25^0 Be' brine after puddling, grow a thin film of salt and tamp it back into the bed and roll with light roller.

5. Try to maintain a base layer of salt in the crystallizes till the end of the season to avoid disturbing the actual bed.
6. Rake each fresh crop on alternate days to keep it loose so that while it is collected the base salt is not disturbed.
7. Protect the ridges/sides of crystallizer bunds with brick lining to prevent collapse.
8. Pick out nuggets of mud/clay from the salt before heaping.

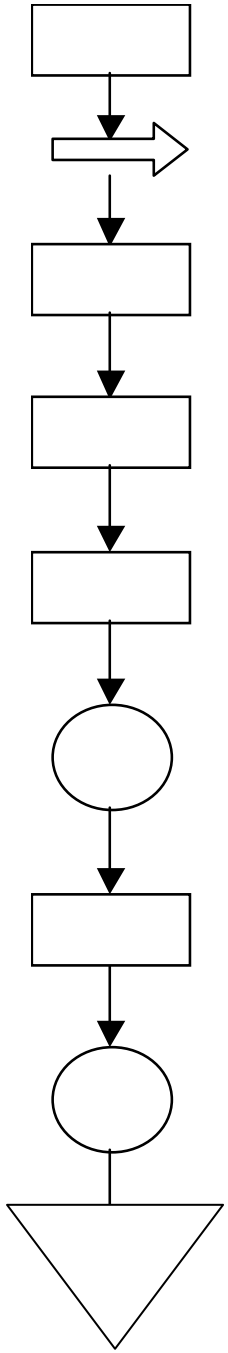
Don'ts.....

1. Do not feed the crystallizers with a brine of less than 25.5^0Be'. In one cubic metre of 23^0Be' brine there is still 400 gms. of calcium sulphate and even at 25.5^0Be' there is still 200 gms. of it.
2. Do not allow mixing of brines especially at high concentrations i.e. above 16^0Be' Diluting has the effect of increasing the Calcium Sulphate content in the salt.
3. Do not allow the concentration of brine in the crystallizers rise above 29.5^0Be'. The salt will get contaminated with Magnesium.
4. Do not use weak brine for sprinkling on pan beds before tamping.
5. Do not expose the salt crop but keep it always submerged.

EXTERNAL MONITORING FOR QUALITY CONTROLL

Levels	Locations	Parameters	Method	Frequency	Responsibility	Records
Production	Factory	Iodine	Test kit	Half an hour	Operator	Plant record
		Iodine	Iodine checker	Three times per day	Lab assistant	Laboratory record
		Iodine	Titration	Once a week	Chemist MOIME	Laboratory record
		Full report for salt	Analytical method	--do -	-do-	-do-
Sales	Kampot	Iodine	Test kit	Every truck	Salt board officer	-do-
		Iodine	Iodine checker	daily	PNCC Provincial	
Transport	Vehicle	Iodine	Test kit	Random	DOIME Provincial department of health	Laboratory record Field book
Storage	Whole sale stores	Iodine	Test kit	Daily	PNCC department of health	Field note book
Retail shop	Market	Iodine	Test kit	Random (mobile)	PNCC ,Department of health	Field note book
		Iodine	Iodine Checker	Once a week	PNCC Department of health, mobile officer Department of health	Lab record at DOH
Consumer	House hold	Iodine	Test kit	Daily	Mobile officer of DOH	Field note book

QUALITY CONTROL CHART FOR SALT IODIZATION

FLOW CHART	ACTIVITY	PARAMETER	EQUIPMENTS OR METHOD	FREQUENCY	RESPONSIBILITY	RELATED DOCUMENT
	Salt from saltern	Composition salt from heap	Laboratory test	Once a week	Lab assistant	Analytical Report
	Conveyance					
	Washing by manually or mechanically	Moisture Insoluble	Laboratory test Oven Balance	Daily	Lab assistant	Laboratory testing book
	Crushing	Granule size (3mm-4mm)	Seives	Daily by batch	Lab assistant	Partical size records
	Iodization	Iodine content	Iodometric titration	Daily	Lab assistant	Laboratory testing book
	Testing for iodine	Iodine content	Spot test Titration method	Every half an hour	Lab assistant	Laboratory testing book
	Packeting in retal packs	Weight	Electronic balance	Once per 10 packets (randomally check)	Supervisor	Plant record book
	Testing for chemical parameter Finish product	Iodine content Moisture Nacl,$Caso_4$ $Mgcl_{2,}$	Titration method	Once per batch	Lab assistant	Laboratory testing book
	Storage	Iodine content	Titration	Once per month after production	Lab assistant	Stores record book