University of Notre Dame,
PAHO and CDC

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Part I. **Some Technical, Operational, & Supply Aspects of the Double Fortification of Household Salt with Iodide & DEC in Haiti in Preparation for the Manufacture and Distribution of Iodide/DEC salt for a Community Pilot Trial.**

Part II. **Investigation in the Gonaïves Area of Haiti of the Potential for the Development of the Production of Washed Crude Salt, Suitable for Fortification with Iodide and DEC.**

Prepared by:

Mr. Trevor A. W. Milner
Fluoridation Engineering Consultant
for
University of Notre Dame, PAHO and CDC

Division of Health Systems and Services Development
Regional Program on Oral Health

May 2001

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1. Background

The Regional Lymphatic Filariasis program under the leadership of PAHO, the University of Notre Dame, and the CDC have been involved over a number of years in various initiatives directed towards the elimination of Lymphatic Filariasis in Haiti. One such initiative will be to carry out a pilot trial to test the feasibility, logistics, effectiveness and economics of the provision of DEC salt nationally in Haiti. The plans are for 2 communities totaling 70,000 persons to be involved in the pilot project.

It is planned that this trial will be cross-programmatic as it is expected that the DEC salt will be iodized. Hence linkages into the IDD elimination program will occur and the production, distribution and marketing of iodized salt will also be tested. In addition the iodine in the iodine/DEC-fortified salt will be used as a surrogate to measure and track the movement of DEC throughout the community.

The terms of reference of this consultancy activity was therefore to observe the production process for double fortification and advise on the appropriate production methodology of DEC/iodized salt at the producers facilities. In addition the reasons for the lack of supply of good quality crude salt was to be examined, and possible solutions recommended.

Whilst in Haiti the terms of reference were extended to visit and examine the production of a number of crude salt producers with a view to making longer-term recommendations to ensuring the sustainability of crude salt of appropriate quality for double fortification. These findings are detailed in a separate report.

2. Activity Schedule

Tues April 24th PM: Arrive Port au Prince, Haiti.

Wed April 25th AM: Visit to Lolita factory. Fortification process and machinery observed.
PM: Visit to Citi Soliel salt receival and warehousing system.

Thu April 26th AM: Meeting with Ralph Midy of UNICEF, discussion of strategies for salt improvement for fortification with iodine. Plans made to extend terms of reference to visit crude salt producers.
PM: Meeting with Dr. Joseline Marhône of the Haitian Ministry of Health. Discussions centered on arrangements for pilot trial.

Fri April 27th PM: Travel to Gonaïves. Meet with president of COPSIG, salt cooperative.

Sat April 28th AM: Visit salt producers in and around Gonaïves.
PM: Return Port au Prince.
Sun April 29th AM: Wrap up meeting with UNICEF. Depart Haiti.

3. Discussion of Activities

3.1 Visit to Lolita Plant

The Lolita Food Packaging Plant is operated by Mr. Jean Claude Merine. It repackages and distributes a range of food products, namely milk powder and sugar. The operations involve receival and storage of the raw and packaging materials, packaging of the food products, storage of the packaged products and distribution. The operations are organized, hygienic and efficient. The fortification, packaging and distribution of iodized and DEC fortified salt would fit very well into their operational mix. Jean Claude Merine is knowledgeable and completely cooperative. At present a brand of salt packaged in cartons, "*Mamas*" is imported and distributed by Lolita.

Photo 1: View of Lolita's packaging floor

Two of the 3 salt iodizing machines purchased by UNICEF are located at the Lolita plant. They are Glostra continuous iodizing machines of capacity 9 ton per hour. These machines are part of an agreement between the Haitian Ministry of Health and UNICEF known as the "supplier" and Lolita known as the "producer". Under the agreement that is of a 5-year duration, automatically renewable every 5 years, the "suppliers" will extend the use of the machines, iodide chemicals, laboratory facilities, marketing support and training to Lolita. In turn Loilta will ensure the production, distribution and marketing of good quality iodized salt on the Haitian market.

In August 1999 the machines were commissioned and a test batch of iodized salt made and distributed on the Haitian market. The salt was very well received and demonstrated that the potential for a successful USI program exists in Haiti. Unfortunately, since then the test batch production of the salt has halted. The main reason given has been the unavailability of consistent

supplies of washed salt suitable for iodization. This has proven to be somewhat frustrating for the producer. Following on discussions with UNICEF as to how to resolve this problem, a crude salt availability and quality survey will be undertaken. This survey will identify the producers with suitable quality salt, and the quantities available.

One obstacle to consistent supply appears to be the price of crude salt. Presently Lolita pays up to U$69/ ton at the producer's location for crude salt of the appropriate quality. As the price of salt fluctuates throughout the year this might not be a sufficiently high price to guarantee all year availability.

Tests were performed with the machines and various measurements taken along with specifications of the motors and gearboxes. These machines operate by delivering a curtain of salt from the feed hopper, via a rotary feeder mechanism, to a screw conveyor/mixer below the hopper. Whilst falling, the salt is sprayed by a mist of KIO_3 solution, or, KIO_3/DEC solution, by a spray nozzle.

The sprayed salt is conveyed up an incline by the screw conveyor and falls into sacks at the discharge end. This further conveyance of the salt provides mixing of the sprayed salt.

The key to the proper functioning of the machines is to ensure the proper spraying of the fortification solution unto the salt, and to ensure the correct proportion of fortification solution to salt throughput. This proportion can be approximated initially by calculation, but has to be fine-tuned and final adjustments made by sampling and analysis during production.

The process flow for the fortification of salt is shown in Fig 3.1. Its description is as follows: Washed salt is transported to the plant in 80kg sacks and stockpiled. These sacks are emptied 2 to 3 at a time into the machine crude salt hopper. Prior to that the KIO_3/DEC fortification solution would have been prepared in the Fortification Solution Tank, according to the formulation required. The dosage pump setting is set at the calculated value as described in the table in **Appendix III**. Final adjustment and fine-tuning of the dosage pump setting has to be done after analysis of the first 2 or 3 sacks of fortified salt.

With the hopper filled and the fortification tank and dosage pump setting ready, the machine is turned on. The electrical switches of the feeder, screw conveyor and dosage pumps are all interlocked. This means that they all operate at the same time. The dosage pump immediately pumps fortification solution to the spray nozzle. A fine mist of fortified solution then sprays the salt fed to the screw from the hopper. The salt is then further mixed by the action of the screw conveying it to the discharge bag.

Ideally, samples for analysis should be taken from each bag. At the start of production for the day, the first bag's sample analysis is to be done immediately and any adjustments up or down made to the dosing pump setting. This is repeated until the iodide level in the salt is within the range required, ie 40ppm ± 10. Once this range is attained sample frequency may be reduced.

As an additional check, overall quantities of additives and salt fortified are recorded. An overall additive concentration is then calculated for all the salt fortified for the day. This value should be consistent with the required values.

Photo 2: Glostra Iodizing machine

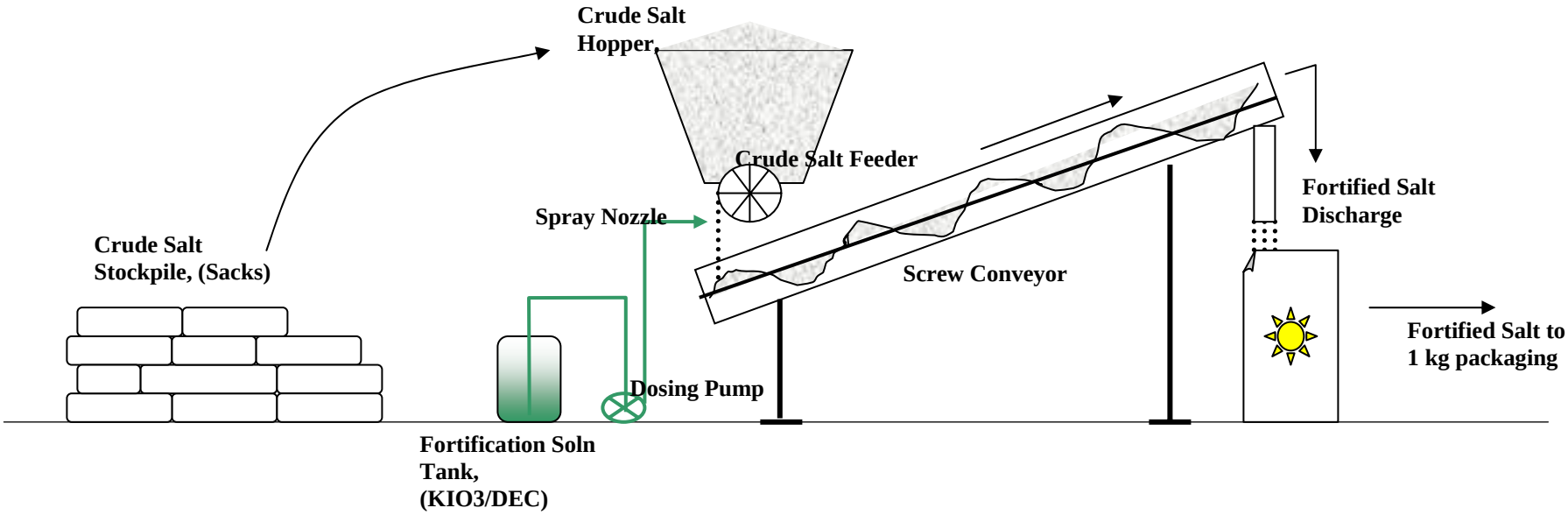


Figure 3.1: **Diagram showing salt fortification process at Lolita.**

Assuming sufficient salt availability to ensure continuous operations, the fortification process will require the following inputs.

Dedicated Labor: 2 persons, Salt Fortifier and an Assistant. Duties will be to weigh out and prepare fortification solution, keep crude salt hopper filled, operate the iodizing machine, fill, weigh and stack the filled bags of fortified salt, take fortified salt samples for analysis, make adjustments to dosing pump, maintain records of the fortification process.

Shared Labor: 2 persons. Plant Supervisor, Lab Analyst. Plant Supervisor will ensure system set up properly for fortification operation, check on the operations and quality results periodically, and check production records. Lab analyst will carry out analysis of fortified salt and advise on how to arrive at and maintain within specification product.

Time & Scheduling: 8-hour day

1-hour preparation and set-up
1-hour total breaks
5-hour total run time
1-hour shutdown, clean up, pre-preparation for next day.

Supervisor time. Routine, 1-2 hours per day, in 15min segments.

Lab Analyst time. Routine, 4 hours per day.

Expected output: At measured machine speed of 100 lbs./min, or 45.4 kg per min, an output of 10 to 13 ton per day can be expected. However this will only be possible with iodide fortification only. For double fortification the rates will have to be lowered to about 50 % of capacity. (See **Appendix V**). For iodide/DEC fortification, outputs of 5 to 6 ton per day may be attained. This translates to 50 to 60 of 100kg sacks of fortified salt, which will result in 5 to 6 thousand 1 kg packs daily.

3.2 Visit to Cité Soleil

This was an impromptu visit, made in an effort to detect whether there exists, and the extent and scale of, an informal salt distribution system in the Port au Prince area. We were quickly able to locate a depot where salt from the producing areas is received by boat, unloaded, warehoused, and redistributed to wholesalers and retailers. This is clearly a large operation moving an estimated 10,000 – 15,000 tons of salt annually. Previous reports estimated that over 50 salt depots are located in Citi Soliel with a throughput of about 50,000 ton annually.

What became clear from the visit to Cité Soleil is the fact that a good supply of salt is within close proximity to the Lolita factory. Negotiations would have to take place on the quantity, quality and price, but there is sufficient salt suitable for Lolita to commence salt fortification and to have a sustained supply available.

Present price for the highest quality salt in Citi Soliel is in the order of U$72 per ton. This is above the price of U$69 per ton paid by Lolita. This price however does not include the transport cost from Gonaïves to Port au Prince that is borne by Lolita. It could be reasonably be assumed that

through negotiations Lolita and the salt distributors at Cité Soleil could agree to a mutually acceptable price which would ensure a consistent supply of salt.

Photo 3: Salt stockpiling & distribution activities, Cité Soleil

4. Technical Discussion

4.1 Fortification Formulation.

The formulation that is normally used for iodide fortification was calculated and shown below in **Table 4.1**. This table is calculated on the basis of a measured salt throughput of 100lb/min or 45.3 kg/min

Conc. of KIO_3 soln. gm/L	Equivalent amt of I gm/L	Target 50ppm Rate of KIO_3 Soln mL/min	Target 25ppm Rate of KIO_3 Soln mL/min
10	5.935	382.2	**191.1**
20	11.869	191.1	95.5
30	17.804	127.4	63.7
40	23.738	95.5	47.8
50	29.673	76.4	38.2
60	35.607	63.7	31.8

Table 4.1 Iodine dosing formulation

This table and the other tables and graphs shown in the appendices are derived from the following:

1. The measured values of the pump calibration shown in **Appendix I**
2. A fixed throughput of salt at the machine capacity of 45.3 kg/min.
3. The calculations of the iodine and DEC mass flow rate required to give various end concentrations in salt shown in **Appendix II**.

Hence from **Table 4.1** given that the throughput of salt is 45.3 kg/min, to achieve an I concentration in the salt of 50 ppm, using a dosing solution concentration of 30gm/L KIO_3, then that solution will have to be supplied at the rate of 127.4 mL/min via the dosing pump. (See red arrows). Similarly to obtain an I concentration of 25ppm in salt, using a dosing solution of 10gm/L KIO_3, then the dosing pump will have to deliver this solution at the rate of 191.1 ml/min. (See blue arrows).

From further calculations done, shown as graphs in **Appendix III** this rate of KIO_3 solution can be readily delivered by the necessary adjustment to the setting of the dosage pump that delivers the KIO_3 solution. So for the first example stated above in the preceding paragraph, to deliver a rate of 127.4 mL/min of 30gm/L KIO_3 dosing solution to obtain a target 50ppm I in salt, a dosing pump setting of 34.8% on its blue scale would be required. (See **graph AIII-1**, **Appendix III**). Similarly for the second example, to deliver the 191.1 ml/min of 10 gm/L KIO_3 to obtain a target of 25-ppm iodine, a pump setting on the blue scale of 59.3% would be required. (See **graph AIII-1**, **Appendix III**).

The formulation for double fortification of Iodine/DEC is shown below. These were the values used in the DEC test batch made. In this case the target concentrations for iodine and DEC were 25 ppm and 0.25% respectively.

Iodide/DEC Formula

Premix formulation

Ingredient	Weight gm	% by weight
KIO_3	3.0	1.73
DEC	171.0	98.27
Total	174.0	100.0

Table 4.2 Iodine/DEC dry premix formulation

If this premix is added to 68 kg of salt the desired target of 25ppm I, and 0.25% DEC will be realized.

However for a wet addition method the premix is dissolved to form a dosing solution. The premix is then dissolved in water and sprayed on to the salt. Formulation used was: 174 gm of dry premix to be dissolved in 348gm of water. Therefore dosing solution is:

Ingredient	Weight gm	% by weight
KIO_3	3.0	0.57
DEC	171.0	32.75
Water	348.0	66.67
Total	522.0	100.0

Table 4.3 Iodine/DEC dosing solution formulation

Note however as shown in **Table 4.3** the KIO_3 solution strength is only 0.57%. Making certain solution density assumptions this translates to a solution concentration of 5.7 gm/L KIO_3. In order to deliver the required quantity of iodine per min to the spray nozzle so that the target of 25 ppm I is met, with a salt throughput of 100 lb/min or 45.3 kg/min, 318 mL/min of dosing solution would be necessary. Referring to **graph AIII-2** in **Appendix III**, this translates to a dosage pump setting of 104% This is outside of the pump range of 310 mL/min at maximum pump setting of 100%. Obviously the pump cannot deliver more than its maximum capacity, and for correct operations should be run in the range 60 % to 80%. For this set of conditions therefore the taget levels of DEC and I cannot be met. This confirms the test batch results, as satisfactory Iodine/DEC concentration levels in the salt were not obtained.

This conclusion is demonstrated further by the **graphs AIII-1**, **graph AIII-2**, and **graph AIV-1**, in **Appendices III & IV** respectively. In the case of **graph AIV-1**, the doing pump settings are shown for various DEC solution strengths. It does not matter if the flows are calculated for iodine or for DEC. These materials have to be added at fixed ratio and hence the conclusions will be the same.

Fortunately this is not a fatal situation. There are a number of options that may allow the target levels to be met. They are in decreasing order of preference:

1. Increase the concentration of the dosing solution. This is limited by the concentration of a DEC saturated solution.
2. Decrease the throughput of the machine. Temporarily a gate mechanism can be used to choke the supply of salt through the feeder. In the long run though the gate feeder speed would have to be slowed.
3. Dose the Iodine and DEC separately. ie use separate machines. Dose the DEC first in one machine and then immediately dose the iodine in the other.
4. Reduce the salt size by installing a mill and do dry addition of the DEC and iodine.

The effect of option 2 is shown by **graph AV-1** in **Appendix V**. This graph is calculated by reducing the throughput of salt from 45.3 kg/min to 20 kg/min or by 50% of the machine capacity. It may be seen from this graph that with a DEC solution concentration of about 222gm/L or about 22% a dosing pump setting of about 69% on the blue scale will deliver the required dosing solution volume to meet the target concentration of 0.25% DEC in salt. However it is important that option 1 be fully explored, as there are other consequences to implementing only a reduction in salt throughput.

These consequences are the addition of too much water to the salt for acceptable presentation and flowability and essentially a reduction in the machine production efficiency.

4.2 Salt Supply Situation.

As observed from the visit to the salt depots at Citi Soliel, there are large quantities of salt within close proximity of the Lolita factory. Further investigation will have to be done to elucidate the cost structure of crude salt and the costs of transportation and handling to see whether there is a good chance for Lolita to obtain a consistent supply of appropriate quality salt from Citi Soliel. As

usual with everything, money might be the problem. The price that Lolita pays, ex production location is U$69.00 per ton. The price at Citi Soliel for comparable quality salt is U$72.00 per ton. This does not seem to be an unbridgeable gap, especially considering the transport costs that Lolita now pays. It would appear that if negotiations took place, especially if a third party such as UNICEF brokered them, a mutually beneficial price could be agreed upon.

Photo 4: Negotiation with the** Cité Soleil **salt "Barons" may be necessary.

In the case of the pilot study where an estimated 60 bags per month will be required, there should be no problem obtaining that amount on a consistent basis from Citi Soliel and/or from Gustin Judicael of Gonaives.

5. Conclusions

There will be two issues to be dealt with so that the LF program in Haiti can move to the next stage, that of the pilot trial. These are, to modify the dosing formulation and salt throughput rate, and to ensure consistent supplies of appropriate quality salt. There is every reason to expect that if the recommendations in this report are implemented, these obstacles will be favorably overcome.

Once the supply situation is settled and the machine modifications are made there should be no problem in fortifying salt on a consistent and efficient basis at the Lolita plant. Lolita personnel posses the basic elements of organizational ability, interest and technical know how. What will also be required is the analytical capabilities in order to fine-tune the process. The installation of the lab and equipment should therefore proceed *post haste*.

The management of Lolita should therefore restart the fortification and packaging of salt as soon as possible, and use this time to sort out the logistical and operational problems that is an inevitable

part of any new undertaking. Practice now will reduce the amount of mistakes in the long run, and bring operations to an efficient and optimum cost level in as short amount of time as possible.

Since the price of crude salt in Haiti is still quite high, Lolita has to ensure high levels of efficiency to ensure break-even or a modest profit on the operation. Operational efficiency will improve with practice and increased throughput, and hence Lolita's cost of production will trend downwards. In addition the main cost of production at this time, the cost of crude salt, will trend down significantly over the next 3 to 5 years. The pressure for this will be the improvements made in efficiency of crude salt operations, and the inevitable and unavoidable importation of cheap crude salt from elsewhere in the Caribbean.

The financial viability of producing and distributing fortified salt is obviously of great concern to Lolita. By carrying out this program they are taking on a fair amount of risk. There is additional cost in building inventories, namely in packaging, crude salt raw material, fortified salt intermediate and fortified salt finished product. There will be extra costs of supervision and analytical costs. The producer must be concerned if these costs will be recovered and how long it will take. Although they are providing much social good by taking on the program to fortify salt, it is at much risk to their operations. All the support materially and politically which can be provided to them to minimize their risk will be necessary.

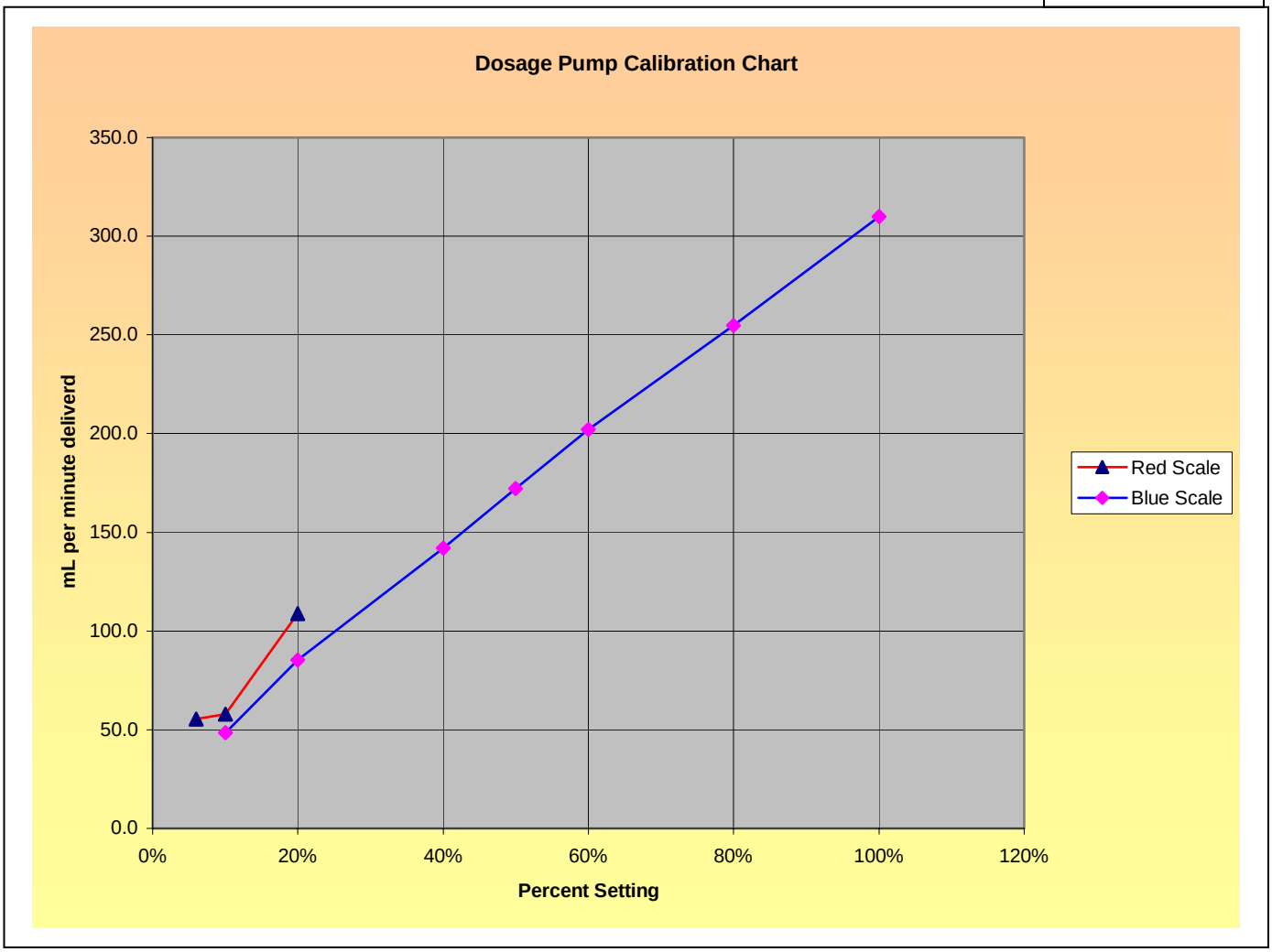
6. Recommendations

1. Develop an optimum formulation for the Iodide/DEC fortification to be within the machine pump capability.
2. That the analytical laboratory and equipment be installed as soon as possible.
3. Investigate the best method to reduce the salt throughput through the machine.
4. That UNICEF carry out the salt availability survey as soon as possible.
5. That Lolita with whatever supplies they are able to obtain from Cité Soleil and Gonaives restart the iodine fortification and packaging of salt now. Apart from allowing the producer to begin the learning curve sooner rather than later, it will provide public visibility for the "*Flamingo*" salt brand and product.

Appendixes

Appendix I

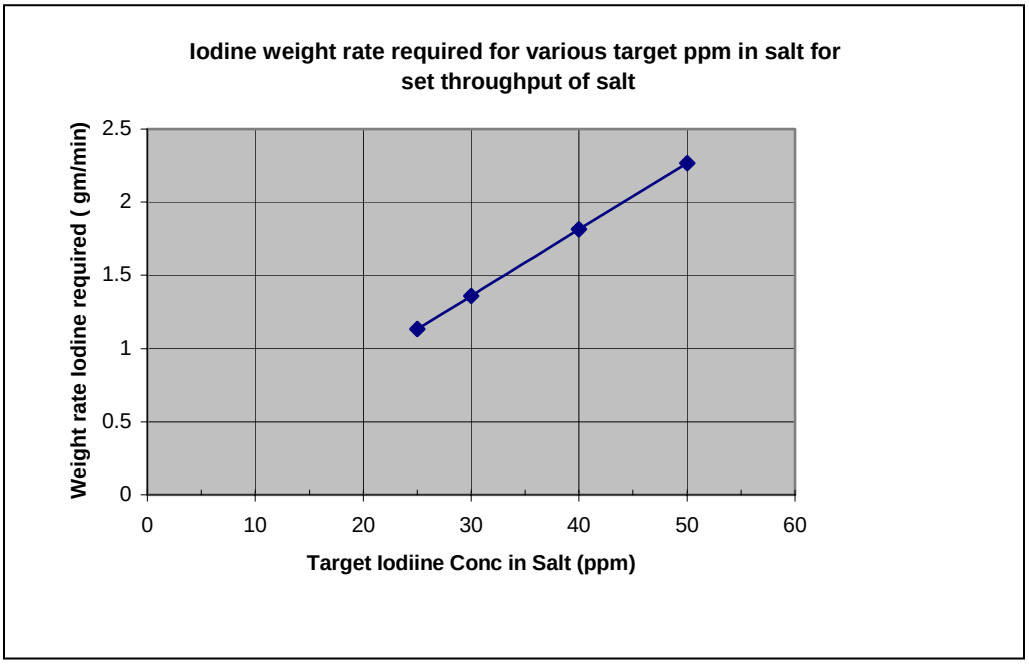
Graph AI-1



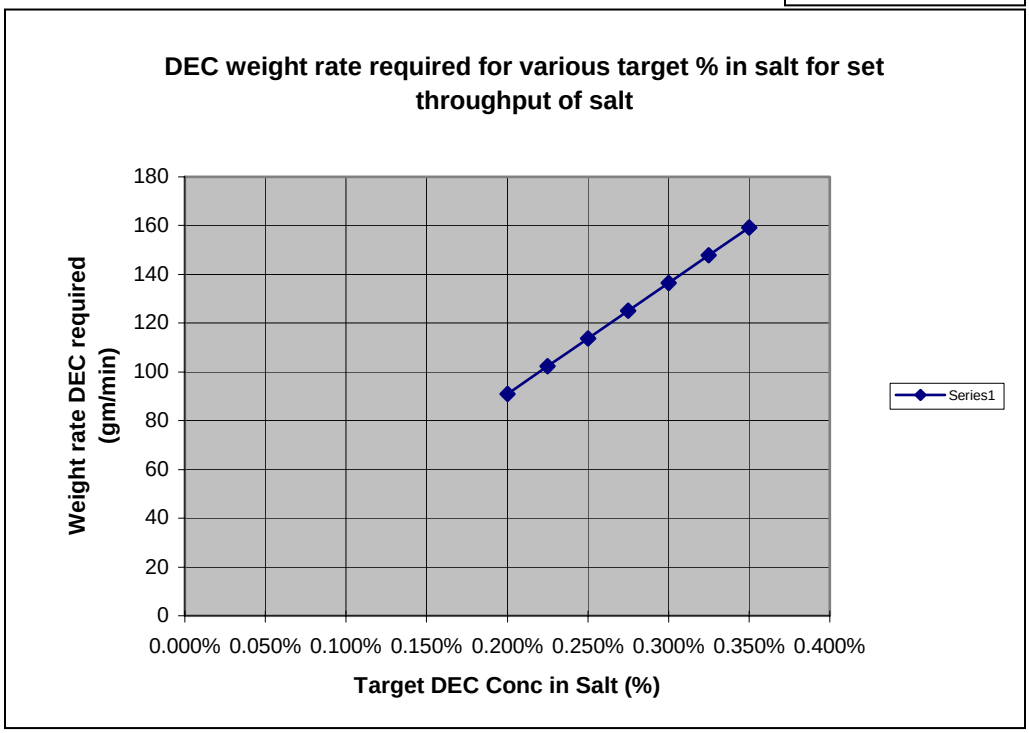
Dosing Pump Setting		Time to completly fill 310 ml bottle		Volume delivered in ml	
Red	Blue	m sec	sec	per sec	per min
%	%				
6		5m 36	336	0.92	55.36
10		4m 22	322	0.96	57.76
20		2m 51	171	1.81	108.77
	10	6m 24	384	0.81	48.44
	20	3m 38	218	1.42	85.32
	40	2m 11	131	2.37	141.98
	50	1m 48	108	2.87	172.22
	60	1m 32	92	3.37	202.17
	80	1m 13	73	4.25	254.79
	100	1m 0	60	5.17	310.00

Appendix II

Graph AII-1



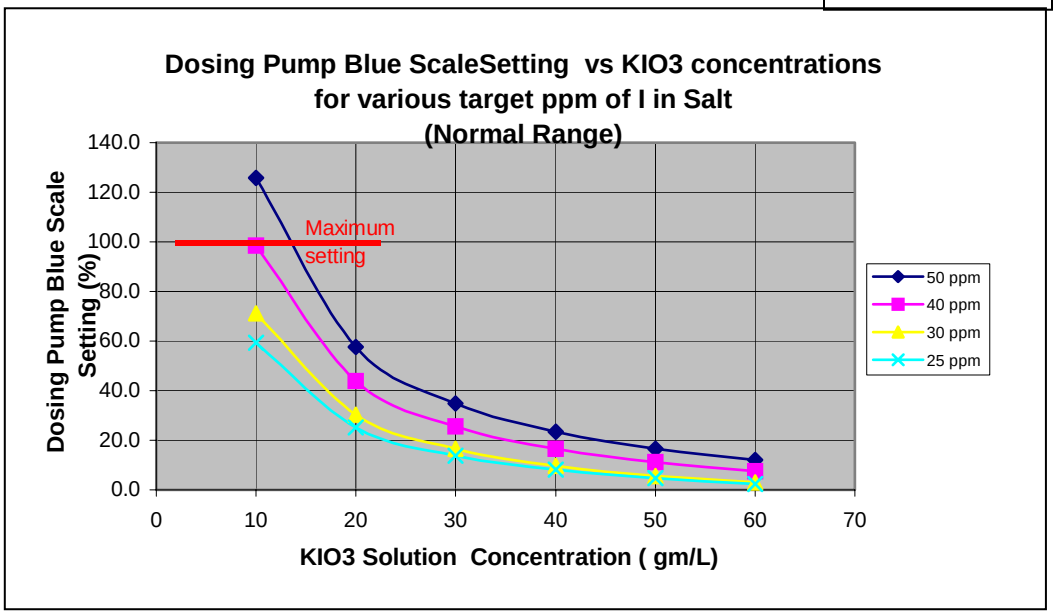
Graph AII-2



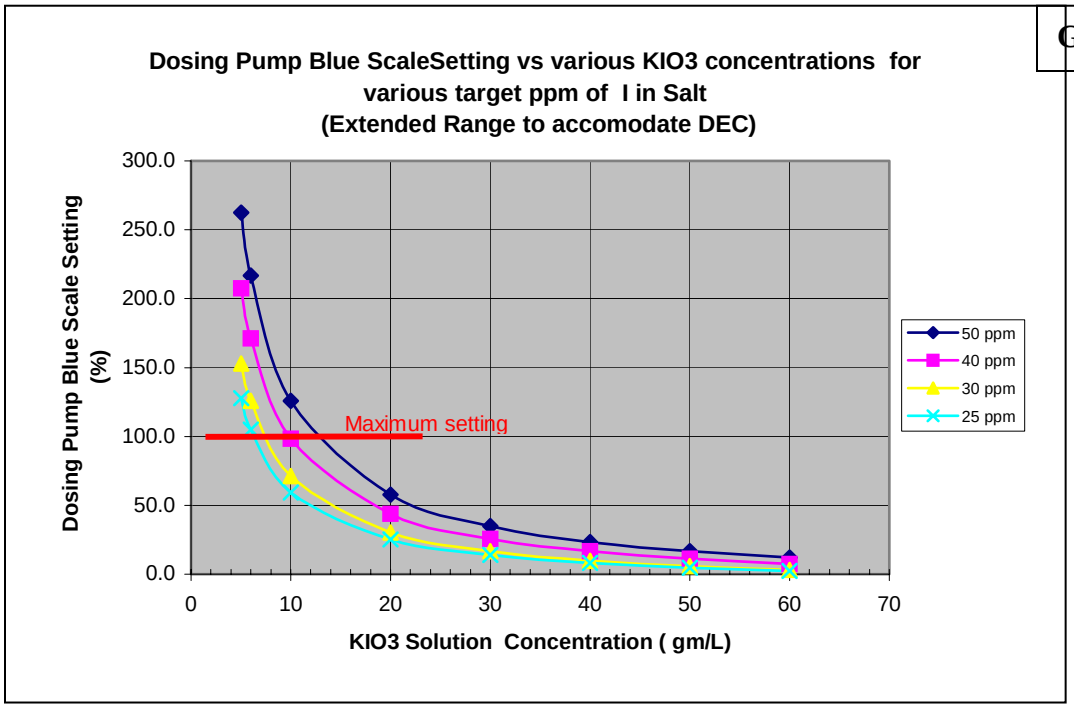
% DEC	gm DEC/min
0.200%	90.90121
0.225%	102.2895
0.250%	113.6835
0.275%	125.0832
0.300%	136.4886
0.325%	147.8997
0.350%	159.3166

Appendix III

GraphAIII-1



Graph AIII-2

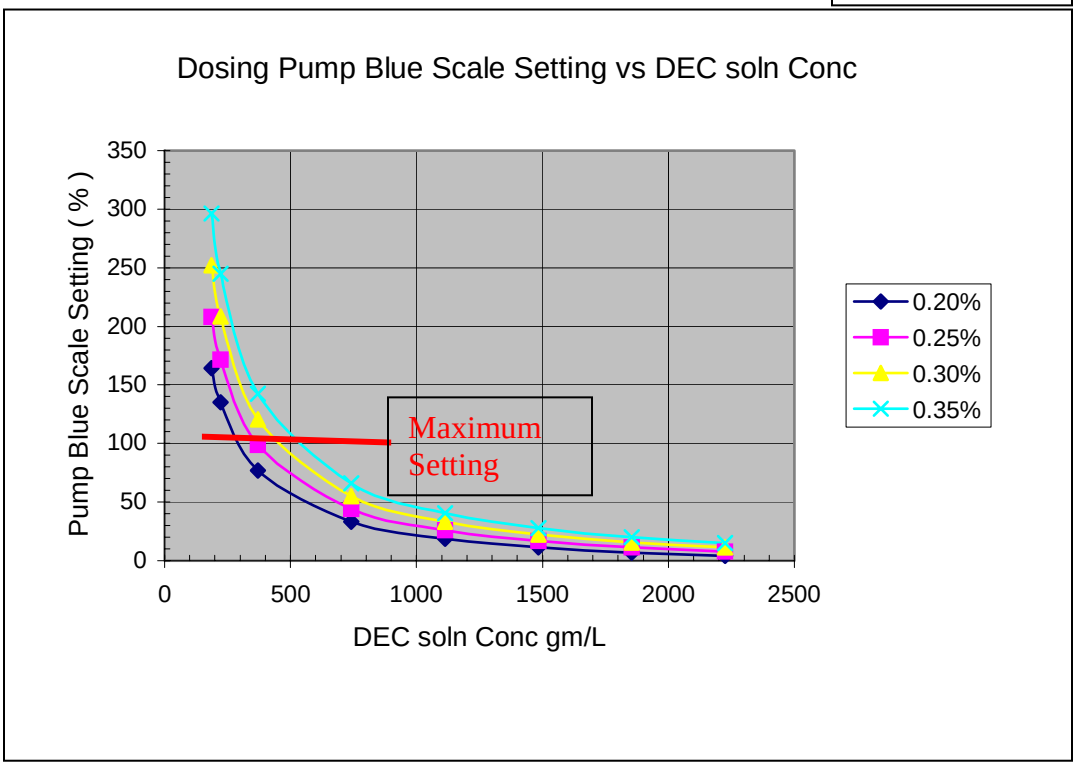


		ppm I			
gm/L KIO_3	gm I /min	50	40	30	25
5	2.967	262.3	207.7	153.1	127.6
6	3.561	216.8	171.3	125.8	104.8
10	5.935	125.8	98.5	71.2	59.3
20	11.869	57.5	43.9	30.2	25.2
30	17.804	34.8	25.7	16.6	13.8
40	23.738	23.4	16.6	9.8	8.1
50	29.673	16.6	11.1	5.7	4.7
60	35.607	12.0	7.5	2.9	2.4

gm/L KIO_3 soln vs % dosing pump blue scale setting for various ppm I in salt at fixed salt throughput of 45.3 kg/min

Appendix IV

Graph AIV-1

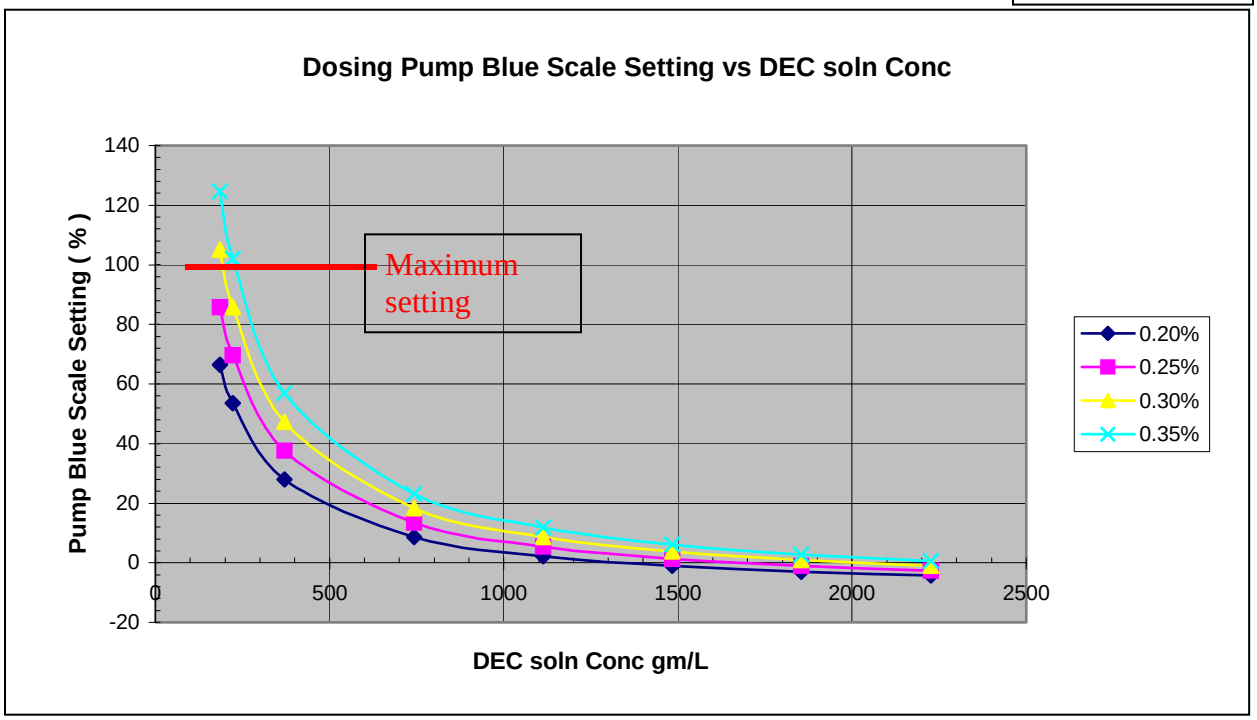


gm/L KIO3	gm/L DEC	0.2% DEC %pump rqd	0.25%DEC %pump rqd	0.3% DEC %pump rqd	0.35%DEC %pump rqd
5	185.459941	164.3355	208.2076	252.1237	296.0839
6	222.551929	135.1605	171.7206	208.3174	244.9509
10	370.919881	76.81059	98.74665	120.7047	142.6848
20	741.839763	33.04815	44.01618	54.99521	65.98526
30	1112.75964	18.46067	25.77269	33.09205	40.41875
40	1483.67953	11.16693	16.65095	22.14046	27.63549
50	1854.59941	6.79069	11.1779	15.56951	19.96553
60	2225.51929	3.873194	7.529204	11.18888	14.85223

gm/L DEC solution vs. % dosing pump blue scale setting for various % DEC in salt at fixed salt throughput of 45.3 kg/min

Appendix V

Graph AV-1



gm/L KIO3	gm/L DEC	0.2 %pump DEC rqd	0.25 %pump DEC rqd	0.3 %pump DEC rqd	0.35 %pump DEC rqd
5	185.459941	66.46865	85.81275	105.1762	124.5592
6	222.551929	53.60483	69.72491	85.86115	102.0136
10	370.919881	27.87718	37.54923	47.23098	56.92244
20	741.839763	8.581449	13.41747	18.25835	23.10408
30	1112.75964	2.149537	5.373553	8.600802	11.83129
40	1483.67953	-1.06642	1.351593	3.77203	6.194896
50	1854.59941	-2.99599	-1.06158	0.874767	2.81306
60	2225.51929	-4.28237	-2.67037	-1.05674	0.558502

gm/L DEC solution vs. % dosing pump blue scale setting for various % DEC in salt at fixed salt throughput of 20 kg/min

Part II. Investigation in the Gonaïves Area of Haiti of the Potential for the Development of the Production of Washed Crude Salt, Suitable for Fortification with Iodide and DEC.

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1. Background

During the week of April 24th, 2001, this consultant was in Haiti advising on the operational aspects of salt fortification for iodide and DEC. The opportunity was then taken to broaden the terms of reference to include investigating the sources of crude salt production and to advise on ways to ensure sustainability of production and supply of washed crude salt, which would be suitable for fortification. It was deemed that it was important to better understand this aspect of crude salt production, as lack of supply of suitable quality salt was now preventing the fortification and distribution of iodized salt. If this continued it would also stall plans for the double fortification of salt with iodide/DEC for a proposed pilot trial towards the elimination of LF.

It was then decided to visit the Gonaïves area and to meet as many of the producers as possible and visit their production facilities. The objective was to understand what were the opportunities and obstacles to ensuring consistent supplies of appropriate quality crude salt to be fortified.

2. Activities

Travel to Gonaïves occurred on Friday, April 27th, 2001. On arrival a meeting took place with Gustin Judicaël the president of the salt cooperative in the Gonaïves area, *Cooperative des Producteurs de Sel Iode des Gonaïves*, or COPSIG. The following morning the facilities of Judicaël were visited. Nearby, other producers who utilize the traditional salt-making method, were visited and discussions held.

Next, the area immediately adjacent to Gonaïves, Raboteau was toured. This site is a large salt producing area having close to 900 ponds or *basins.* There are approximately 150 producers at this site controlling various numbers of ponds. Again production is all by the traditional method. It is estimated that the total salt production from the area of Raboteau is about 12,000 ton per annum.

Photo 1: Area around Raboteau showing basin using traditional salt making method

The area next to the ponds that is being reserved for COPSIG to construct a proper Salina was examined.

We returned to Port au Prince on Saturday night. On Sunday April 29th, 2001 a meeting was held with the responsible UNICEF officer, at which the findings and recommendations contained in this report were discussed.

3. Discussion

It is clear that the traditional salt making system is at its limit with regards to output, quality level and efficiency. Expectations from this system for increased output and improved quality will not be realized. The emphasis therefore has to be on supporting the efforts of those who have started to adopt efficient methods and are improving their production efficiency and quality.

One such producer that is making every effort to improve quality and become efficient is Gustin Judicaël, who also happens to be the president of COPSIG. He has been a salt producer for over 9 years. He started out making salt the traditional way. Since the start of technical assistance by UNICEF, and through the visit of salt production experts, Mr Judicaël, has been very active in efforts to improve his facilities. He is thirsty for knowledge and information. He has continuously reinvested in his facilities and continues to improve and implement new ideas and suggestions.

Photo 2: View of the crystalizer ponds at Judicaël's facility near Gonaïves. (Note the organized layout and symmetry of construction)

The Judicaël facility presently consists of 4 large concentrator ponds with a 5th under construction. There are 6 crystalizer ponds of regular size and shape with more planned for construction as soon as concentrator volume warrants it. In addition there are 3 brine storage ponds.

The operations are that of a continuous salt-making operation. Seawater is directed via a channel into the plant and is pumped into the first concentrator pond. Originally the pumping of seawater was done using a gasoline powered pump. The operating cost using gasoline proved too high. This has since been substituted by a diesel-powered pump and has resumed full scale water pumping and production. This is one example of Mr Judicaël's striving for improvement and increased efficiency.

His pond area currently totals 9 *carrreaux* ie, 116,100 sq meters or 11.6 hectare. Depending on a number of factors this already installed area could produce up to 8,000 ton of salt per year. In addition the surrounding space available would allow expansion to twice the size. This gives Judicaël the potential to eventually produce 16,000 to 20,000 ton of high quality salt per year.

Mr Judicaël has developed a crude washing system and washes salt after harvesting. The salt quality is therefore good in appearance and white and clean with good crystal structure. The procedure however is inefficient and would not be able to handle large loads, which would be the case at peak production.

Unfortunately due to time constraints, only the Gonaïves area was visited. However there are other major salt production areas such as Anse-Rouge, Coridon, Grand Saline and Baie de Henne. It will be necessary for UNICEF and the Ministry of Health to identify producers in those areas, who like Mr. Judicaël are modernizing and improving efficiency and quality. They will need to be supported, encouraged and motivated to further improve as much as possible.

It is also important to put Haiti's salt production in a regional context. Countries of the Caribbean basin produce a total of about 6.75 million ton of crude salt per annum. (See **Appendix II**). At least 30% of this salt is available for export or is being exported at FOB prices of U$12-14 per ton. Depending on the shipment quantity some proportion of this salt could easily be landed in Haiti for under U$30 per ton. That is less than half the current price of Haitian crude for salt of purity on average 98% NaCl, compared with the best Haitian crude of about 85% NaCl. Presently, the price of the best quality Haitian crude salt ranges between U$69 to U$72 per ton.

Within 100 miles of Haiti, sizable quantities of top quality salt are immediately available from the Dominican Republic, the Bahamas and Cuba for under U$40 per ton. Clearly it will not be long before someone figures out that the importation of salt into Haiti could be a very profitable business. With the best will in the world it will be impossible for Haiti to be isolated from these competitive pressures for much longer.

The salvation of the local Haitian salt industry will therefore mean the development of this industry so that local salt will be able to compete with salt from elsewhere in the region. Because the economics of salt production and distribution means that anywhere from 25% to 60% of the salt price is transport cost, Haitian producers will always have a competitive advantage. They now need to hone that advantage by reducing other production costs, the way other producers have done.

4. Conclusions and Recommendations

In order to start the sustainable production of iodized salt in Haiti it is necessary to commence with what exists and is available now and build upon that. It will be important to support those producers who have demonstrated ability to improve, to enable then to accelerate their development even faster. This will result in the production of better quality salt, more efficiently and at lower cost. This will ultimately lead to lower prices of crude salt and improve the ability of the salt industry to withstand the inevitable competition from abroad.

In the case of Judicaël, he has the installed capacity now to produce 6,000 tons per annum, as a very conservative estimate. If a washing plant were built at his plant site it could probably attract another 2,000 tons from salt producers nearby and from COPSIG. This would mean the availability of about 8,000 ton per year or about 20% of the estimated 40,0000 ton per year consumed as direct household salt. So 20 % coverage within the first year of a USI program could be realistically achieved.

It would therefore be necessary to design and build a washing plant at the Judicaël facilities for about 10,000 ton per year in anticipation of increased production. This approach could be replicated at Anse-Rouge or Coridon in order to cover the country. (See **Appendix I**). This could be easily achieved, with some modifications for local variations, by simply replicating the washing plant design in those areas. This would guarantee the availability of good quality salt suitable for fortification with iodide, fluoride and DEC.

There are also opportunities for cross-sectoral linkages. In the case of the Judicaël facilities there is no electricity available and might not be for some time. However this should be viewed as an opportunity. Firstly there is well-established wind pump technology that can be implemented quite economically to enable him to pump water using wind power. This would result in significant operating costs saving, as one of the main costs in operating a solar salt works is that of pumping water. This area from observations and from discussion with persons in Haiti, is well suited for wind power.

Secondly, for the running of machinery for the washing plant, solar power technology could be utilized as the power source of choice from the design stage. Again, savings could be made in future operating costs. A project like this with its multi sectoral linkages has the potential of being a model of sustainable development. It could therefore serve additionally to inspire other economic projects with linkages into the environment and alternative energy.

The next stage would then be the development of fortification plants closer to or at the site of the washing plants. Again this will result in the improved availability of high quality salt and increased competition and price stability for the consumer.

The Gantt chart overleaf shows what could be realistic timeline if the necessary decision-making and resources are in place to start the program outlined.

Figure 1: Gantt chart for washed salt supply strategy

	Task/ Event	2001		2002				2003	
		3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	
1.	Restart salt fortification at Lolita Plant								
2	Carry out salt availability survey								
3	Design 10 ton / day wash plant								
4	Carry out salt production improvements								
5	Construct wash plant								
6	Train salt producers/ coop								
7	Commission Wash plant								
8	Construct 2nd wash plant								

20 % national coverage with iodised salt

The following recommendations are presented:

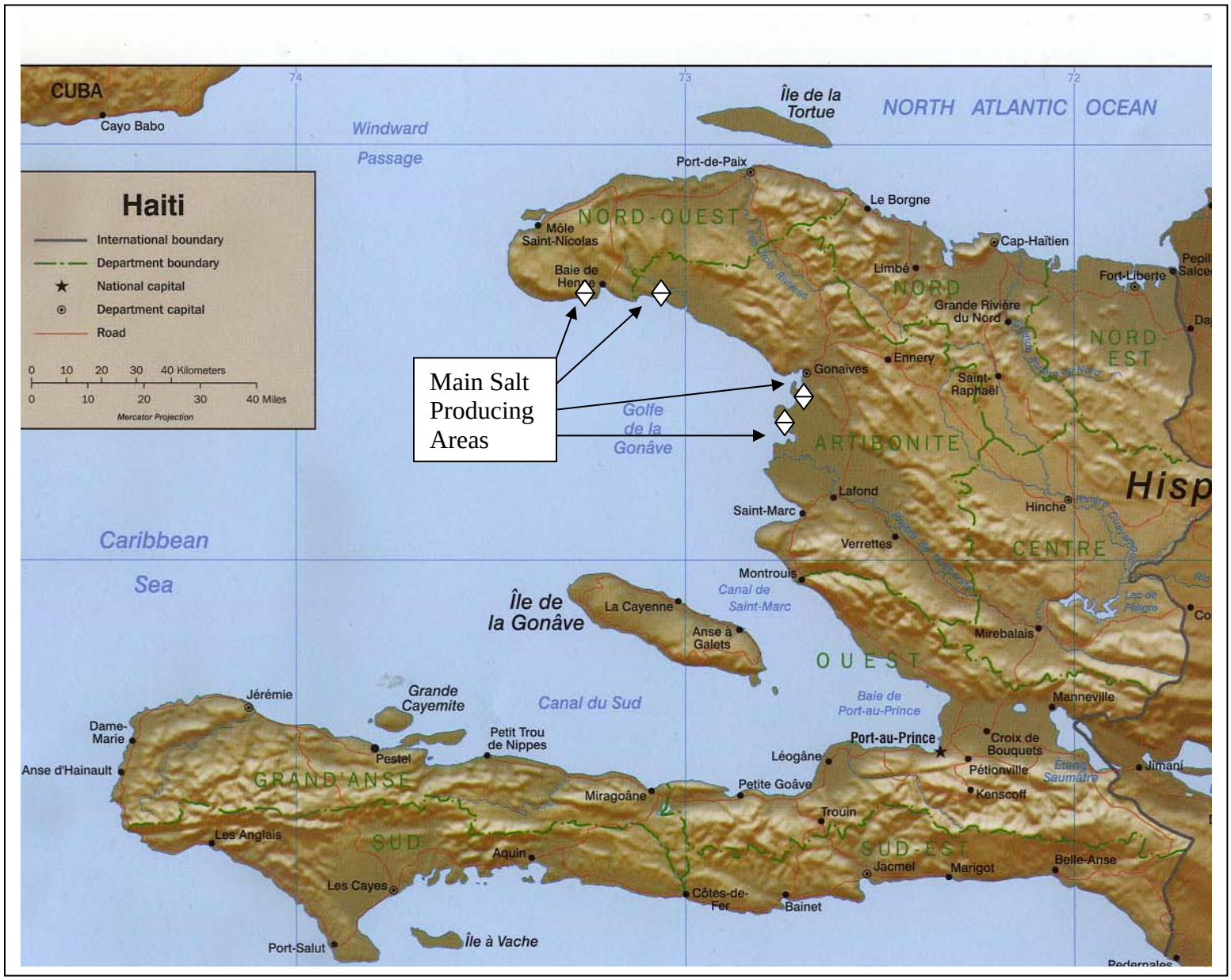
1. Restart fortification with KIO3 immediately at the Lolita plant.
2. Negotiate with salt distributors in Cité Soleil for increased and consistent suppliers of appropriate quality crude salt for fortification.
3. Design 10,000 ton/year washing plant for Gonaïves.
4. Incorporate wind power and solar power technology in washing plant design and in present salt works operations.
5. Continue program of technical advice and assistance to crude salt producers, concentrating on those who demonstrate the greatest will to become efficient and improve quality.
6. Build and commission salt washing plant.

Therefore, the overall strategy to restart a sustainable program of salt fortification in Haiti may be summarized as follows:
"*Restart fortification immediately at the Lolita plant with what ever salt supplies are available. Negotiate with the various salt producers and middlemen for consistent supplies of appropriate quality salt. Use this time to iron out operational kinks and to have the "Flamingo" iodized salt brand become visible to the consumer. At the same time start arrangements to design and build a 10,000-ton per year washing plant at the Judicaël facility in Gonaïves, whilst identifying other progressive salt producers and supplying technical assistance to improve their salt works efficiency and salt output quantity and quality. The target would be that within a year about 20% of the household salt needs are being fortified. The next stage would be the installation of other washing plants in the Grand Anse or Coridon areas. The final stage would be the setting-up of iodization facilities at or near the washing plants. By building on what is available and repeating the process in order to arrive at sustainability, near universal coverage could be attained by 2005.*"

Appendixes

Appendix I:

Map of Haiti showing main crude salt production areas



Appendix II:

Salt Production and Prices in the Caribbean Region

Country	Crude Salt Production ton/annum	Price FOB U$/ton
Bahamas	1,000,000	12-16
Bonnaire	1,500,000	12-16
Columbia	1,250,000	16-18
Cuba	150,000	20-30
Dominican Republic	75,000	35-45
Mexica (Caribbean)	2,000,000	12-16
Venezuela	750,000	10-14
Total	6,725,000	

Glossary

CDC	Centers for Disease Control
COPSIG	Cooperative des Producteurs de Sel Iode des Gonaïves
DEC	Diethylcarbamazine Citrate
I	Iodine
KIO_3	Potassium Iodate
LF	Lymphatic Filariasis
PAHO	Pan American Health Organization
UNICEF	United Nations International Children's Education Fund