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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
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PRODUCTION OF SALT AND IODINE

SI/GRN/75/017

GRENADA

TERMINAL REPORT

Prepared for the Government of Grenada by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization

United Nations Development Programme

PRODUCTION OF SALT AND IODINE

IS/GRN/75/017

GRENADA

Project findings and recommendations

Prepared for the Government of Grenada by the
United Nations Industrial Development Organisation,
executing agency for the United Nations Development Programme

Based on the work of C. L. Malhotra, salt expert

United Nations Industrial Development Organisation

Vienna, 1976

Explanatory notes

The monetary unit in Grenada is the East Caribbean dollar ($EC). During the period covered by this report, the value of the East Caribbean dollar in relation to the United States dollar was $US 1 = $EC 2.

The following forms have been used in tables:

Three dots (...) indicate that the data are not available or are not separately reported

A dash (-) indicates that the amount is nil or negligible

Baumé hydrometer scale. 0° is the point to which hydrometer sinks in water; 10° is the point to which it sinks in 10% solution of sodium chloride, both liquids being at 12.5°C.

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ABSTRACT

In January 1976, an expert in salt production was sent by the United Nations Industrial Development Organization (UNIDO), executing agency for the United Nations Development Programme (UNDP) project IS/GRN/74/017, "Production of Salt and Iodine", to determine the feasibility of producing salt on the island of Grenada and relieving this country of the necessity of importing its salt requirements. During his month's stay, the expert made these findings:

1. The climate and topography of Grenada are not favourable for the establishment of a modern, mechanized salt plant there;

2. The only suitable sites for small-scale production of salt by manual methods are True Blue Pond and Point Salines Pond, both in the southern coastal area. The potential productivity of these sites would be 750-900 tons per year, somewhat less than the projected requirements of Grenada in 1985;

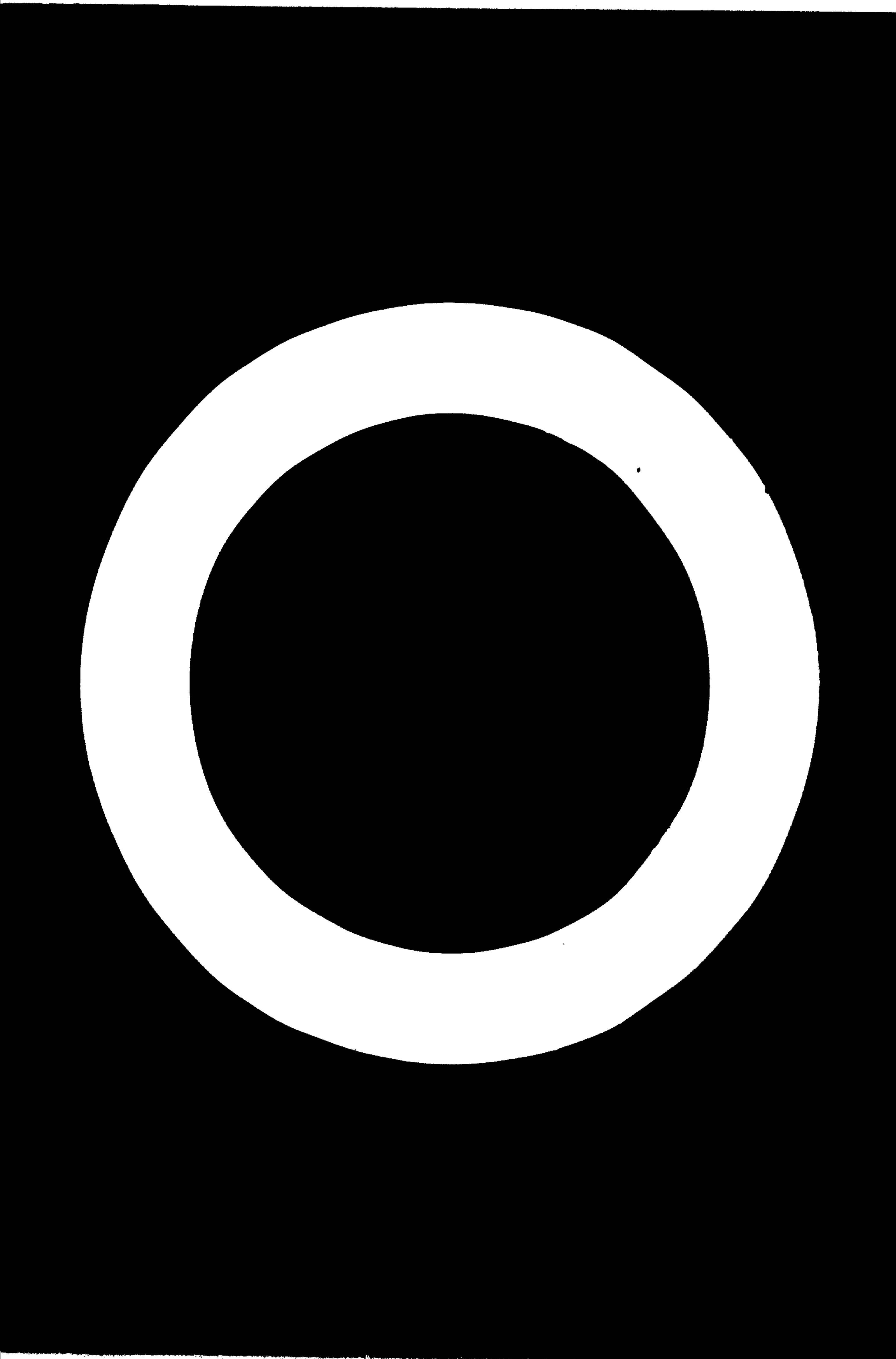
3. The quality of the salt that can be produced would not be as high as that of imported salt, and the cost of production would be relatively high;

4. Use of a desalination process to produce both fresh water and concentrated brine for salt making is not economically feasible in Grenada;

5. Domestic production of salt would effect a savings in foreign exchange of about $EC 60,000 per year and provide employment for 30 persons for six to eight weeks every year. However, the high initial and recurring investment required does not appear justified because of the high cost of production for a product of unacceptable quality;

6. Revival of the old salt industry at the two ponds along traditional lines shows no promise for the eventual establishment of a modern salt industry in Grenada;

7. The seaweed available in Grenada has so low a content of iodine that its recovery on a commercial scale would not be feasible.



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INTRODUCTION

Since Grenada imports all its salt, the Government was interested in studying the possibility of making salt by natural evaporation of sea water at a place on the southern coast where, in fact, salt had been made successfully over 30 years ago. Pursuant to the Government request for technical assistance for the study, the project document for the project "Production of Salt and Iodine" (IS/GRN/74/017) was signed by the United Nations Development Programme (UNDP) on 6 January 1975 and by the United Nations Industrial Development Organization (UNIDO) as executing agency on 10 December 1974.

Initially, the project was to have a duration of 15 days, during which an expert in salt production would investigate the feasibility of producing salt from True Blue Pond, the possibility of employing a desalination process for producing both fresh water and concentrated brine for salt making, and the possibility of producing iodine from seaweed. The expert would also make a market survey for salt and iodine, estimate the investment cost necessary to begin production and make recommendations for follow-up action. The job description is in annex I.

The time proved too short, so the project was later amended to permit the expert to spend almost the whole month of January 1976 in Grenada. The total UNDP contribution was $US 3,800.

The expert studied not only True Blue Pond but also a larger site at Point Salines. In this report he shows that the total potential production from these two places, apparently the only suitable places on the island, could approach the salt requirements forecast for 1985. However, the production costs would be high and the salt not as good in quality as imported salt. Whether the advantages of domestic production outweigh the disadvantages is questionable, and a decision will require careful consideration of the facts given here. It is certain, on the other hand, that the recovery of iodine from the seaweed available near Grenada is not feasible.

I. THE DEFUNCT SALT INDUSTRY OF GRENADA

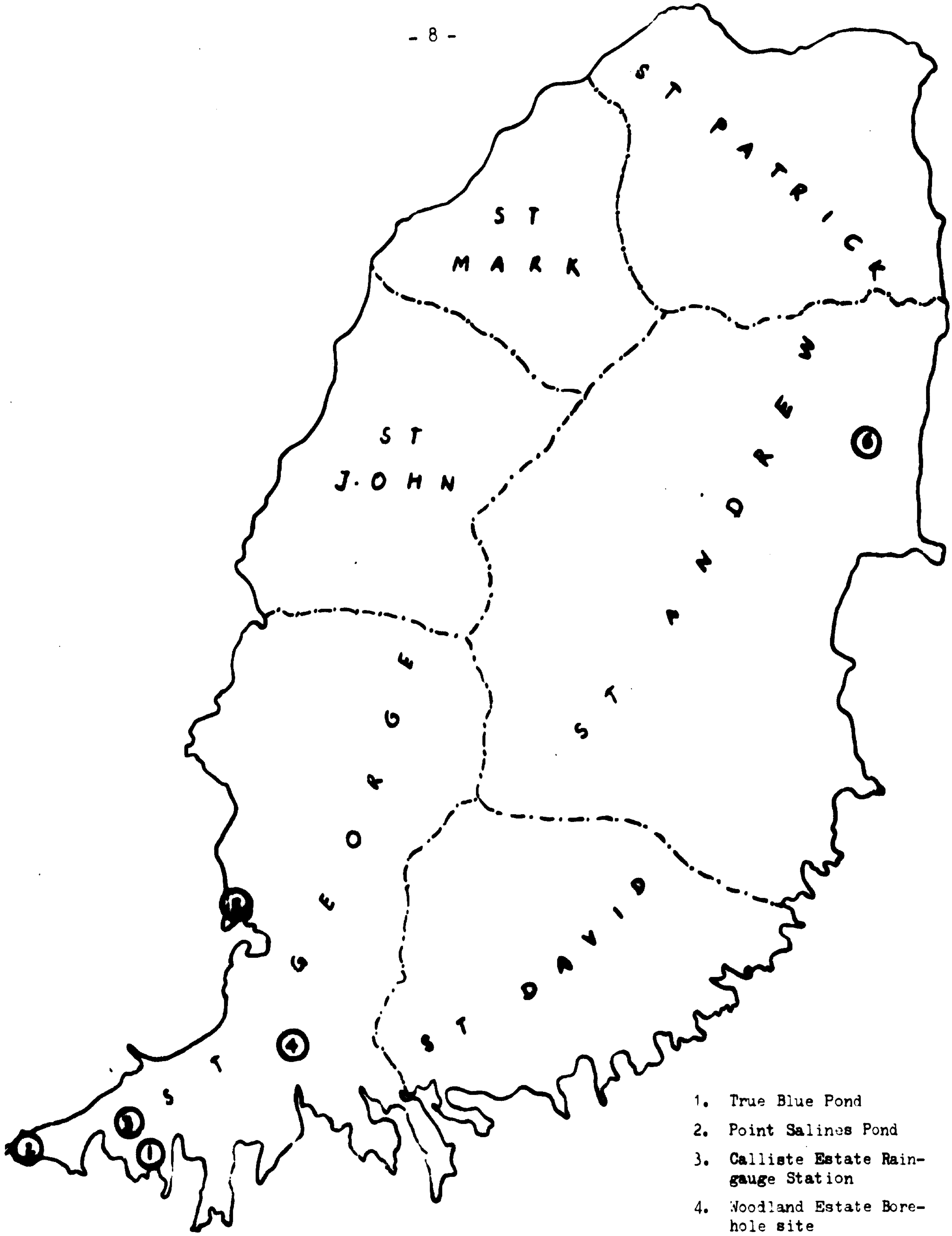
Salt was manufactured in Grenada prior to 1940 in two localities, Point Salines Pond and True Blue Pond (see figure I). These two places are seven and five miles, respectively, south of St. George's, the capital, and are connected by a motor road. The ponds are close to the sea. Salt manufacture was abandoned and the land used for other purposes, possibly because salt imported from Bermuda, St. Kitts and elsewhere was found to be cheaper. However, the expert was told that the salt formerly manufactured at these places in Grenada was shipped to Trinidad and other nearby islands in small boats.

From the ruins at the two sites, it is clear that sea water was impounded in reservoirs by means of a pump. It was allowed to fill two other ponds and remain in these ponds for a few days. Finally, it was transferred into a pond with a bottom made of wooden planks. The salt that deposited on the surface of these planks was periodically collected, heaped on the sides of the pond and then removed to the stores and sold. The working season extended over three months - February to April - and the salt crop was often washed away by showers, even in these dry months. According to the accounts given by those who worked at the ponds, the total production of salt from both the places might have been of the order of 100 tons in lean seasons and 200 tons in exceptionally dry and long spells, so that it may be assumed that the production from both places in a normal year was 100-150 tons.

On the average about 16 persons were employed at these places during the manufacturing season, the number varying with the amount of salt to be collected.

It is reported that salt is even now deposited as thin crust during the dry season at Point Salines Pond and the adjoining area. In the past, such deposits were collected by the inhabitants for use in their kitchens.

Both ponds are now silted up by local drainage, and the wooden and concrete installations are completely ruined and cannot be recovered or reused.



1. True Blue Pond
2. Point Salines Pond
3. Calliste Estate Rain-gauge Station
4. Woodland Estate Bore-hole site
5. St. George's, Capital of Grenada
6. Pearls Airport

Figure I. Map of Grenada

II. STUDY OF CLIMATIC AND OTHER FACTORS IN THE SOUTHERN COASTAL AREA

General

Geography

The Caribbean island of Grenada has an area of about 120 m^2 and consists mostly of mountains rising up to more than 2,000 ft above sea level. The drainage of the land is mostly to the east and west, the coastal lands in the south being less steep.

Geology

The island appears to have been formed by volcanic activity. The rocks are basalts, epidiorites and tufa. The weathering of these rocks has resulted in the formation of plastic clays that are a deep bluish black in colour. These clays intercalated by light-coloured sandy clays form the flats near the coast.

Hydrology

Situated only 12° north of the equator, Grenada of course has the typical tropical climate. The rainy season is seven to eight months long, with the rainfall in the mountains amounting to more than 100 in. a year. The coastal areas in the south of the island receive 50-60 in. of rain, the bulk of which takes place during the period June to December.

Climatology

No data are available for the places where salt manufacture took place in the past. Some date are available for Pearls Airport but the climatic conditions are quite different. Steps should be taken to install simple instruments (maximum and minimum thermometer, wet- and dry-bulb thermometer, rain gauge, evapometer, wind gauge) at the agricultural farm at True Blue Pond, so that the resident officer there can record basic meteorological data. A three-year record, at least for the five dry months of the year (January to May), should suffice for drawing correct conclusions about the local climate at the pond.

Table 1. Record of rainfall at the Calliste estate, 1970-1973

Month	1970		1971		1972		1973	
	N	R	N	R	N	R	N	R
January	10	1.77	9	1.57	10	2.37	6	1.61
February	9	1.24	6	1.48	6	1.41	8	1.88
March	10	1.25	3	0.46	5	1.39	3	0.40
April	4	0.56	5	0.38	11	1.98	4	0.62
May	8	1.78	11	2.79	8	0.91	7	1.61
June	17	5.40	7	1.61	10	1.94	12	2.82
July	14	8.14	16	4.37	22	4.68	9	2.27
August	16	9.20	16	6.38	13	3.82	19	5.41
September	7	4.93	14	13.10	10	3.89	14	9.09
October	13	4.37	14	6.22	...	...	22	10.22
November	11	3.38	8	3.85	12	3.23	...	...
December	10	6.16	11	3.02	14	2.58	...	...
Total	129	48.18	120	45.23	121 a/	28.70 a/	104 b/	35.93 b/

Source: Grenadian Ministry of Agriculture.

Note: N = number of days with measurable rainfall

R = total rainfall in inches

a/ For 11 months.

b/ For 10 months.

Rainfall. In the meantime, for the purposes of the present study, the pattern of rainfall in this area was evaluated and analysed from data for the Calliste estate, where, until three years ago, daily rainfall measurements were recorded. Since the estate is adjacent to the two ponds, these data have helped to give some insight into the actual number of days without rain in the dry period (February through April). The data, which are presented in tables 1 and 2, may be summarized as follows:

(a) The dry season extends from February through April, sometimes into May;

Table 2. Intensity of rainfall during the period January-May at the Calliste estate, 1968-1973

Year	January			February			March			April			May		
	D	M	T	D	M	T	D	M	T	D	M	T	D	M	T
1968	1	0.35	1.10	22	1.15	5.49	25	2.64	9.84	2	0.94	1.78	7	0.38	1.38
1969	28	1.81	4.77	11	0.22	0.45	15	0.23	0.67	30	0.24	0.33	8	0.28	0.91
1970	30	0.45	1.77	13	0.44	1.24	22	0.22	1.25	23	0.26	0.56	19	0.63	1.78
1971	18	0.43	1.57	23	0.53	1.48	19	0.27	0.46	24	0.21	0.38	20	2.07	2.79
1972	6	0.99	2.37	24	0.49	1.41	30	0.69	1.89	29	0.69	1.98	12	0.43	0.91
1973	23	0.25	1.61	20	0.98	1.88	11	0.19	0.40	14	0.24	0.62	10	1.16	1.61

Source: Grenadian Ministry of Agriculture.

Note: D = date of greatest rainfall in a 24-hour period

M = amount of rain on that day in inches

R = total rainfall for the month in inches

(b) Out of the 40-60 in. of rain falling annually in the southern coastal areas, the rainfall during the dry season varies from 3 to 6 in.;

(c) Light rain occurs at irregular intervals even during the dry season. Any continuous dry spell of rainless days usually lasts 7, but may be as long as 14, days;

(d) Rain in the dry season usually falls as light showers. Although, these showers may not seriously impede manufacturing operations, they do increase the humidity and retard evaporation;

(e) Short, heavy showers will occasionally occur. These would adversely hamper manufacturing operations. The brine concentration cycle would have to be of the shallow-charge type, and such showers would dilute the brine and may even damage the installation, bringing the crystallisation process to a halt for a number of days following the shower, even though no more rain falls.

Relative humidity. No data are available except at Pearls Airport, where it averages 75%. The less rainy southern coastal areas must have a lower average than that.

Maximum and minimum temperatures. Data are not available; there is no instrument for obtaining them.

Wind speed. At Pearls Airport, the wind speed is reported to be 4-5 knots; it is probably the same in the south. The winds blow mainly from the east.

Evaporation. No data are available for any part of Grenada, which is unfortunate, since the production capacity of a solar salt plant depends on the rate of evaporation.

Owing to the lack of adequate data, the above conclusions can only be tentative ones. The required climatic data should be collected by actual measurements with suitable instruments. Such instruments are neither costly nor difficult to use, and the information made available can also be used for other purposes.

Nature of soil

The beaches near True Blue Pond and Point Salines Pond are sandy; however, about 50 to 75 ft from the water the soil becomes bluish black, plastic and firm. Such soil is quite suitable for making hard beds for ponds. At Point Salines, however, the pond is so silted that large amounts of dredging would be needed to regain the original bed. Further soil testing may become necessary if it is decided to install a plant there.

Tides

The height of the tide is reported to be only 18 in. so that the tide is therefore no hazard.

Sea water density

The density of the sea water was measured at a number of places in the various bays in the south and was found to be 3° Baumé. Regular daily measurements would be required at a later stage of planning, but they would present no difficulty as only a Baumé hydrometer is required to make them.

Assuming an average sea-water density of 3° Baumé and taking into account the probable losses due to rain, handling etc., the productivity of a salt-making plant at True Blue Pond during the dry season of 80 days would be about 25 tons per acre.

III. SALT REQUIREMENTS OF GRENADA

Grenada had a population of 105,000 in 1973. Assuming an annual growth rate of 2-2.5%, and a *per capita* consumption of 5 kg of salt (in accordance with nutritional standards), the estimated population in Grenada and the requirements of salt for the next decade have been computed and are given in table 3.

Table 3. Estimated salt requirements of Grenada, 1975-1985

Year	Population (thousands)	Salt requirement (tons)
1975	111	555
1976	114	570
1977	117	585
1978	121	605
1979	124	620
1980	130	650
1981	138	685
1982	144	720
1983	150	750
1984	153	765
1985	157	785

As population increases, the requirements of salt for water softening, food processing etc. will also increase, and provision should be made for them. Therefore, the total requirement may be placed at 1,000 tons per year by 1985.

Imports of salt into Grenada

Table 4 gives the annual amounts and values of salt imported from 1969 to 1973, broken down by origin. A careful study of this information discloses that:

(a) Salt is imported at the rate of about 4.5 kg *per capita*;

(b) The salt imported from Venezuela is the lowest in price;

(c) The cost of importing salt ranges from 3 to 5 cents per pound.

Table 4. Imports of salt into Grenada, 1969–1973

Origin	1969		1970		1971		1972		1973	
	Amount (lb)	Value ($EC)	Amount (lb)	Value ($EC)	Amount (lb)	Value ($EC)	Amount (lb)	Value ($EC)	Amount (lb)	Value ($EC)
Canada	38,600	1,885	44,238	2,644	44,320	2,917	1,680	252	25,948	2,161
China	-	-	-	-	-	-	72	30	-	-
Germany, Federal Republic of	60,000	2,237	56,000	2,022	-	-	94,500	9,544	1,000	342
Jamaica	-	-	5,376	384	-	-	1,125	330	-	-
St. Kitts	173,882	4,408	30,685	1,002	-	-	-	-	-	-
Trinidad and Tobago	-	-	-	-	112	11	2,200	143	-	-
United Kingdom	966,717	40,933	1,116,802	44,034	1,293,139	55,992	767,538	38,205	685,216	42,897
United States	150	66	1,008	52	160	38	-	-	55,492	2,042
Venezuela	-	-	-	-	-	-	215,040	8,759	360,000	13,[illegible]7

<u>Source</u>: Grenadian Ministry of Finance, Statistical Section.

Wholesale and retail prices of salt

Salt is imported in bags. It is then packed into smaller paper packages for retail sale. The market prices are as follows:

Wholesale price: $EC 14-15 per bag of 100 lb

Retail price of refined salt: 18-20 cents per pound

Retail price of coarse salt: 8 cents per pound

Quality of imported salt

Two main varieties of salt are imported: (a) fine refined salt; (b) unrefined salt, also called coarse salt. The Grenadian consumer is accustomed to using a white, fine-quality refined salt.

IV. POSSIBILITIES AND LIMITATIONS OF SALT MANUFACTURE IN GRENADA

The success of any salt-making enterprise in Grenada requires (a) consumer acceptability of the product and (b) a price competitive with that of imported salt. Both these requirements can be met by planning production on a large scale using modern mechanized methods.

By 1985 Grenada will need 1,000 tons of salt per year (see chapter III). The productivity at an ideal site in the southern coastal area, as calculated in the chapter II, would probably not exceed 25 tons per acre per year. A minimum land area of 40 acres is therefore needed. The land should be flat, have impervious soil and be near the sea. An intensive search for a single parcel of such land was made, but none was found. In fact, the only suitable sites seen on the search were the two plots at True Blue Pond (10 acres) and Point Salines Pond (20 acres) themselves. Together, the ponds would not be counted on to yield more than 750 tons per year. Even the most optimistic estimate, 900 tons per year, is somewhat short of the 1985 requirement.

Large-scale production is therefore not possible and the ponds would have to be worked by manual methods; the installation of machinery and equipment would not be justified. Though the cost of production of salt would be high in these conditions, it could prove competitive with the cost of imported salt, which has to include charges for ocean freight, loading, unloading, storage, transport etc.

However, the quality of the domestically manufactured salt would not be able to compete with that of imported refined salt, which is purified, dried, sieved etc. The locally manufactured salt would at best be pan-washed, naturally dried, then crushed and sieved. Without special precautions, its colour would not be white. It is doubtful that the product would be acceptable to the consumer even if it were cheaper than imported salt.

Manufacture of salt by desalination of sea water

On the nearby island of Carriacou, drinking water is in short supply. The possibility of producing sweet water there by the desalination of sea water in solar stills and using the effluent for the manufacture of salt was examined.

The prerequisites for the successful working of solar stills are (a) high rates of evaporation, (b) extremely high temperatures, (c) availability of flat land, (d) a water requirement of about 50,000 gallons a day and (e) inexpensive power. The cost of solar stills in 1968 was reported to be at the rate of $US 2 per ft^2 of the lined surface. The cost of production of potable water from stills having 3,000 to 5,000 ft^2 lined surface was reported to be about $US 8-12 per thousand gallons. The costs now would be more than double that, certainly too high to be considered seriously in Grenada, where the costs would be even higher.

Moreover, the effluent from the stills has a salinity of only 5° Baumé, which is not enough higher than the 3°-3.5° Baumé of the sea water to provide a significant economic advantage in using it.

V. PROPOSED LAYOUT OF A SMALL SALT PLANT (MANUALLY OPERATED) AT TRUE BLUE POND

If, after taking account of all the factors mentioned above, the Government decides to revive the salt industry at True Blue Pond and Point Salines Pond, the ponds may be laid out so as to conform generally to the pattern in figure II, which is a schematic sketch of a solar salt plant at True Blue Pond.

Sea water is pumped into and stored in a reservoir area of about 4 acres at the upper part of the pond. The reservoir is built on the natural ground by constructing embankments of natural earth and has four compartments with sluices. It is large enough to hold one week's requirements. After a week or so, the sea water becomes concentrated by evaporation to a salinity of 8°–10° Baumé, after which it may be transferred by gravity to the compartmented condensers situated immediately below the reservoir, which have an area of about 5 acres. Here the brine is concentrated further by evaporation, and when the salinity becomes 23° Baumé the brine goes to the pre-crystallizers (0.20 acre) where it attains a salinity of 24.5°–25° Baumé. At this stage, the brine is fed into the crystallizers to a depth of about 4 cm. These crystallizers are made of wooden planks. There may be about 20 of them, each about 15 cm deep, over an area of about 0.5 acre. Alternatively, polythene sheets may be used to line the crystallizers. As it is not proposed to upgrade the quality of salt by expensive purification methods, and as the local labour is not trained to harvest salt from the naturally puddled and compacted beds manually, it is proposed to achieve the objectives of white colour and good quality by having the crystallizers on clean artificial floors and crystallizing salt in them within the range 25°–29° Baumé. Thus if brine of 25° Baumé is put in, it will immediately start depositing salt, and as soon as the brine dries to a depth of 13 mm, more should be added and the process repeated until sufficient salt has been formed for collection.

Ordinarily, it may be necessary to collect the salt once a week, twice a week in the hotter spells. The salt so collected should be stored and drained on a clean floor, covered with a polythene sheet to avoid dust contamination. After two or three days, the salt should be spread out and dried in the sun. Thereafter, it may be crushed in a small rolling mill, sieved and packed in bags or in small retail packages as required. The stacked packets should be kept covered with polythene sheets until sent to the market for sale.

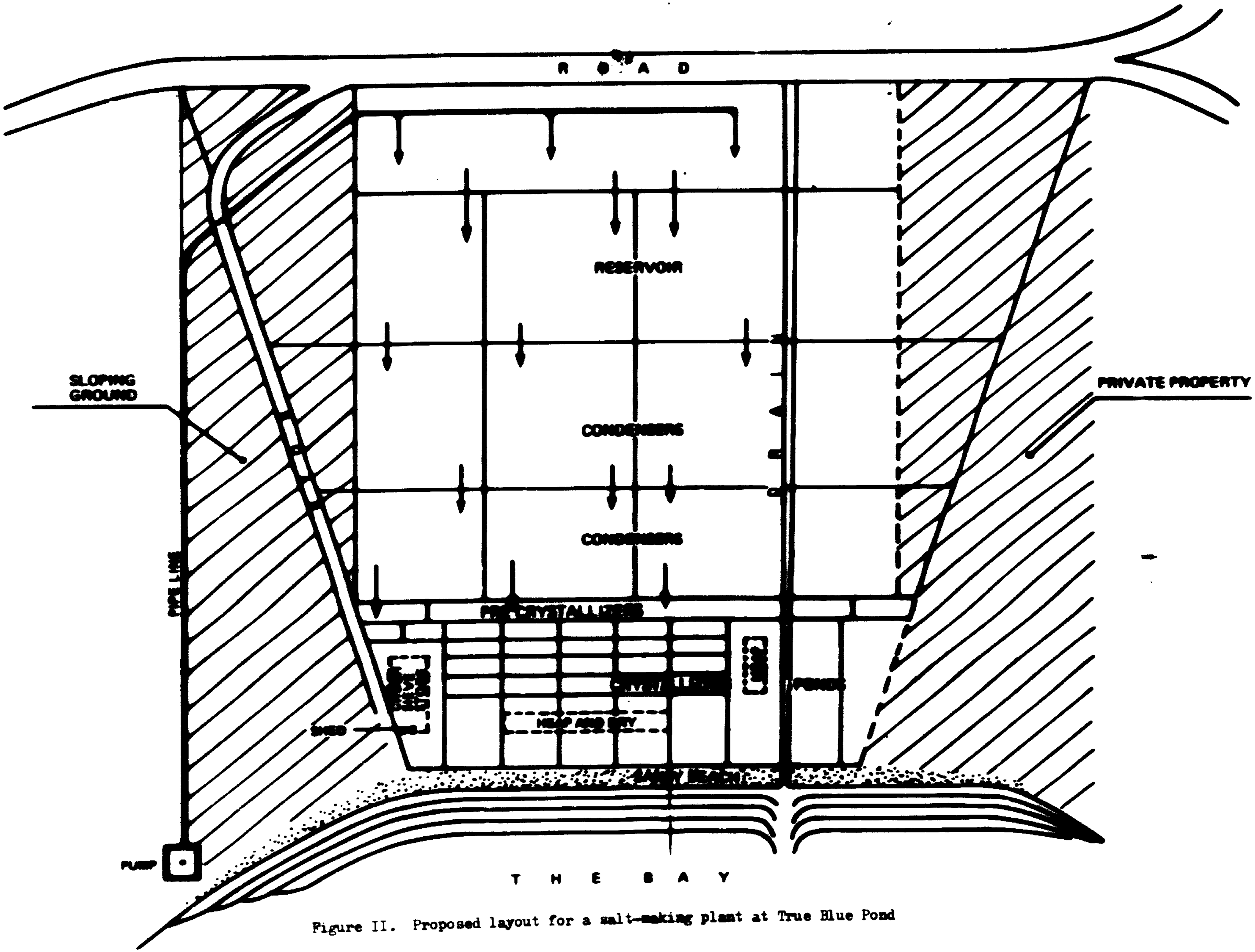


Figure II. Proposed layout for a salt-making plant at True Blue Pond

In order to accelerate evaporation in the crystallizing ponds, a dye called Solivap Green may be added. The cycle should be continually repeated throughout the dry season, taking care to flush and clean the crystallizers after every four cycles to ensure better quality of the product.

All the operations of collecting, heaping, drying, transporting, storing etc. are carried out with the help of manual labour and hand tools. Capital investments include the construction of the ponds, a pump, a crushing roll, cement or wooden drying platforms and a shed for storage.

VI. INVESTMENT AND PRODUCTION COSTS OF SALT PRODUCTION IN GRENADA

The following approximate financial analysis may be found helpful in making decisions. The rates and estimates made here are based on the information obtained from officials in the Public Works Department, the Land Survey and the Agriculture Department and from local engineering supply firms. They are meant solely to give an approximate idea of costs for an assumed production capacity of 300 tons per year.

Investment costs
(Thousands of $EC)

Non-recurring	
1. Cost of 10 acres of land (The cost is nil since the land belongs to the Government. For commercial enterprises, the cost of land should be taken into account, of course. The value of land is estimated to be $EC 0.30 per ft^2)	-
2. Site clearance and earth moving in the construction of reservoir and condensers, levelling of crystallizer beds, digging of canals and sluices etc.	6
3. Making wood- or polythene-lined crystallizing beds	36
4. Wooden shed	7.5
5. Plant and machinery (pump with spares, roller mill, pipelines, tools and implements)	20
6. Miscellaneous	0.5
Total	70
Recurring	
7. Bags, oils, greases etc.	4
8. Electricity, water etc.	0.5
9. Labour: supervisor, engine driver, 3 workers for 3 months	4.5
15 workers for 40 days	3
10. Miscellaneous maintenance and office expenses	1
Total	13

Production costs

Depreciation at 5% on items 2, 3, 4 and 6 above	2.5
Depreciation at 10% on item 5 above	2
Interest on capital at 10%	7
Total	11.5
Operating costs (items 7 to 10 above)	13
Total	24

On the basis of the estimates above, the unit production cost would be $EC 82/ton (in 100-lb bags). Adding transport charges to the market at $EC 8/ton and administrative expenses at 20%, the total cost may be expected to be $EC 108/ton.

Conclusions

The selling price of the domestically produced salt in the markets of Grenada will be comparable to the price of salt imported from Venezuela, which is sold in the markets of Grenada for $EC 14-15 per 100-lb bag. Imported coarse salt sells for $EC 8 per 100-lb bag.

The cost of production as worked out above is very high, mainly because of the small size of the plant and the other limiting factors mentioned in chapter IV. And, in view of the rising costs of labour, power and materials, it is likely to increase in the years to come.

The amount of available land at Point Salines is about 20 acres (8 hectares). The potential production is 500-600 tons per working season. However, the land is privately owned and would have to be purchased. Therefore, cost would be higher there, and consequently the cost of production of salt at this plant would be higher than at True Blue Pond.

The advantages and disadvantages of reviving the salt industry in Grenada may be summarized as follows:

Advantages

The foreign exchange (about $EC 60,000) now expended for the import of salt would be saved.

Employment opportunities (30 jobs for six to eight weeks) would be created.

Disadvantages

The quality of the locally manufactured salt would not be as good as that of the refined and fine imported salt.

The cost of production would be high and would increase.

The return on the investment would not be as high as that from investments in certain other gainful activities that would provide the same advantages as listed above.

VII. RECOVERY OF IODINE FROM THE SEAWEED FOUND NEAR GRENADA

The Atlantic Ocean is known to contain plants of the genus Laminaria which contain economically recoverable iodine. The Government therefore requested that a study be made of the possibility of recovering iodine from the weeds that are found in the outer tidal waters and are washed ashore at the southern coast of the island.

Some seaweeds that had washed ashore at True Blue Pond and Point Salines Pond were collected. However, they did not contain any stalks, which have a higher concentration of iodine than the leaves. Also, a water sample from Black Bay, which is adjacent to Point Salines Pond was collected for determinination of iodine content.

Since facilities for the identification and chemical analysis of weeds were not available in Grenada, the samples were taken to the laboratories of the University of Trinidad.

It was found that no plants of the genus Lamineria were present in the samples, and that the iodine content of the weeds was too low for recovery of iodine on a commercial scale. A copy of the analysis is annexed to this report.

VIII. RECOMMENDATIONS

Should it be decided to begin making salt again at True Blue Pond and Point Salines Pond, the following recommendations should be considered:

1. A set of meteorological instruments should be installed at the True Blue Pond agriculture farm and measurements taken for at least two years, during which the density of the sea water should also be measured daily from January to May.

2. The 10-acre area available immediately at the True Blue Pond should be developed first as a small salt works. A large-scale contour map of the area will be needed.

3. An experimental bore-hole to tap high-density sub-soil brine should be drilled in this area, in consultation with a geologist or the government Water Commission.

4. A qualified chemist (national of Grenada) should be given a fellowship to be trained in salt manufacturing methods in a nearby salt works, for example in Venezuela.

Annex I

JOB DESCRIPTION

POST TITLE: Expert in the production of salt and iodine

DUTY STATION: Grenada

DURATION: 2 months

DATE REQUIRED: As soon as possible

DUTIES: The expert if expected to make a pre-feasibility study on the production of salt and iodine and will undertake the following duties:

1. To investigate the feasibility of producing salt from the True Blue Pond by natural evaporation and the possibility of employing desalination process for the production of fresh water and concentrated brine; it will also include:

   (a) Organization, management, staff and labour requirements;

   (b) Financial plan and source of financing;

   (c) Financial statements including projected balance sheets and statements of sources and applications of funds showing net cash flows; profitability and break-even analysis;

   (d) Benefit/cost analysis, internal rate of return, foreign exchange earnings or savings and contribution to government revenues;

   (e) Country benefits including value added to national economy.

2. To investigate the possibility of producing iodine from seaweed;

3. To make a survey of the markets for salt and iodine including their export potentials;

4. To propose the processes, capacities and locations of the respective plants and to make estimates of investment;

5. To make recommendations for follow-up actions.

LANGUAGE: English

QUALIFICATIONS: Chemical engineer with extensive experience in salt and iodine production, and in feasibility studies.

BACKGROUND INFORMATION:

Grenada is importing about 600 tons of salt per year (1,262,866 lb of coarse salt and 2,989 lb of fine salt in 1972). The Government requests UNIDO assistance in undertaking a study on the production of salt from the True Blue Pond by natural evaporation, and also on the possibility of employing desalination process which can also produce fresh water for local uses.

There is abundant seaweed growing in three areas within easy reach of the salt pond. The Government expects that the possibility of producing iodine from this seaweed also be studied in this project.

Annex II

COPY OF CHEMICAL ANALYSIS OF SEAWEED

CARDI
UNIVERSITY OF THE WEST INDIES
ST. AUGUSTINE
TRINIDAD, W. I.

CARIBBEAN
AGRICULTURAL
RESEARCH AND
DEVELOPMENT
INSTITUTE

CABLES "STOMATA" PORT OF SPAIN
TEL: 662-5511

10 March, 1976.

OUR REFERENCE: CAL: 1/17/1-2

The Chief Agricultural Officer
Ministry of Agriculture
St. George's,
GRENADA.

Dear Sir,

On the 23 January, 1976, Mr. C. L. Malhotra of the Food and Agriculture Organization of the United Nations left some samples of seaweeds for chemical analysis. The results are now available and are shown below:

ppm	Seaweed sample		
	1	2	3
Iodine	150	10	150
Potassium	1.08	2.95	1.30
Calcium	0.885	1.46	4.13
Magnesium	3.43	1.08	1.32
Nitrogen	1.20	1.16	1.07
Phosphorus	0.075	0.160	0.150

Yours sincerely,

Dr. St. Clair Forde
Head, Central Analytical
Laboratory

cc. Mr. C. L. Malhotra
83/1, Jawahar Nagar
Mandi Town, Himachal
Pradesh
India

cc. Dr. P. Barnard
Biological Science

C-272

77.07.04