

THE BOLIVIAN SALT INDUSTRY

AN ASSESSMENT

[PROSPECTS FOR SALT FLUORIDATION]



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Boliva Fact Sheet

Land Area :	1,098,581 sq km (424,164 sq mi).
Population :	7.67 million (1997 estimate)
Population Growth:	2.04 % per annum 1987-1996
Cities :	La Paz, pop 1,500,000 Sucre Cochabamba
Urbanization:	
Ethnicity:	55%----- Native Indian 30%-----Mestizos 15%-----White
Economy:	The exploitation of mineral resources ,which account for nearly all of the country's exports, and agriculture which caters mainly to the local market forms the basis of Bolivia's economy. Most of the country is underdeveloped and poverty is widespread.
Labor Force	2.3 million; agriculture majority, mining and industry 14.%,
Per Capita Income:	US \$680. per year (1992)
External debt:	US \$4.3 billion (Nov. 1996)
Exchange Rate	5.1 Bolivianos, \$B per US \$ (Feb-1998)
Fertility	4.18 live births per woman
Infant Mortality	65.7 per 1,000 live births (1997 est)
Crude Death Rate	10.2 per 1,000 inhabitants (1997 est)
Life Expectancy at Birth	60.3 years; (1991)
UNDP-HDI	0.530
DMFT	4.67 (1995)



1. Activity Summary

The PAHO consultant arrived in **La Paz** at 6:30AM on Tuesday December 16th, 1997. During the afternoon, accompanied by Ing. Antonio Mariscal, 3 of the 7 salt packers located in **El Alto** were visited. Later that afternoon, the consultant attended a meeting of participants in the upcoming national survey of fluoride in urine.

The following day Wednesday December 17th a training seminar being held by Dr Ramon Baez in connection with the up upcoming national survey of fluoride in urine, was visited. At about midday along with Daniel Alvarez Gantier the team traveled to Oruru. There 5 of the 29 salt processors were visited.

On Thursday December 18th the 400km journey to Salar Coipasa was made. There the extraction of crude salt from the salt flat deposits was observed. The team returned to La Paz that night.

On Friday December 19th the team traveled to Cochabamba. The PISABOL salt processor was visited. The return to La Paz was made later that afternoon.

2. Background

Bolivia has one of the world's largest deposits of salt. Large salt deposits are located in several salt flats the two largest being **Salar Coipasa**, area 1900 sq km and Salar Uyuni, area 9,600 sq km. These deposits were originally formed by the drying of inland seas after the last ice age. Hence the irony that Bolivia a land locked country has large deposits of what could be considered solar evaporated sea salt. The total of Bolivia's salt reserves is estimated to be over 15 billion tons.

These deposits are easily accessible and are surface mined by hundreds of individuals using mainly manual methods. These persons are organized in co-operatives. On the border of the Salar Uyuni there is a medium sized company that extracts and processes the salt.

The salt extractors at Salar Coipasa and Salar Uyuni bag the crude salt in one-quintal bags. This is then distributed by truckloads to the 48 processors and packagers. Forty-four of these processors are located within the La Paz, Cochabamba, Oruru triangle. The other four are located at Uyuni.

Total salt production amounts to 45,000 ton. All of this production is consumed nationally, as there is negligible importation or exportation of salt. Household or table salt consumption is estimated to be approximately 30,000 ton per year. The total consumption of salt may be broken down into domestic or table, ie-direct human consumption, industrial food, ie indirect human consumption and non-human industrial. **Table 1** overleaf shows the breakdown of the overall salt consumption.

**Table 1: Annual Salt Flows and Balance for the Republic of Bolivia (ton)**

IMPORTS	PRODUCTION	CONSUMPTION		EXPORTS
Imports, negligible	Salt production all from naturally occurring salt flats 45,000	Household/ Domestic/ Table (Direct Human)	29,000	Exports, negligible
		Industrial Food/ Bakery/ Cattle. (Indirect Human)	10,000	
		Industrial Non-Food (No Human Consumption)	6,000	
TOTAL IMPORTS 0	TOTAL PRODUCTION 45,000	TOTAL CONSUMPTION 45,000		TOTAL EXORTS 0
TOTAL IMPORTS + TOTAL PRODUCTION = 45,000		TOTAL CONSUMPTION + TOTAL EXPORTS = 45,000		

Bolivia has for some time now been carrying out a program of salt iodization. The laws and regulations authorizing and requiring the iodization of salt for human and animal consumption was passed in the late 1960,s. They were as follows:

Decreto Ley No. 07736, dictado de julio de 1966.

Decreto Ley No. 08338, del abril de 1968.

Decreto Supremo No.08613, del 30 diciembre de 1968.

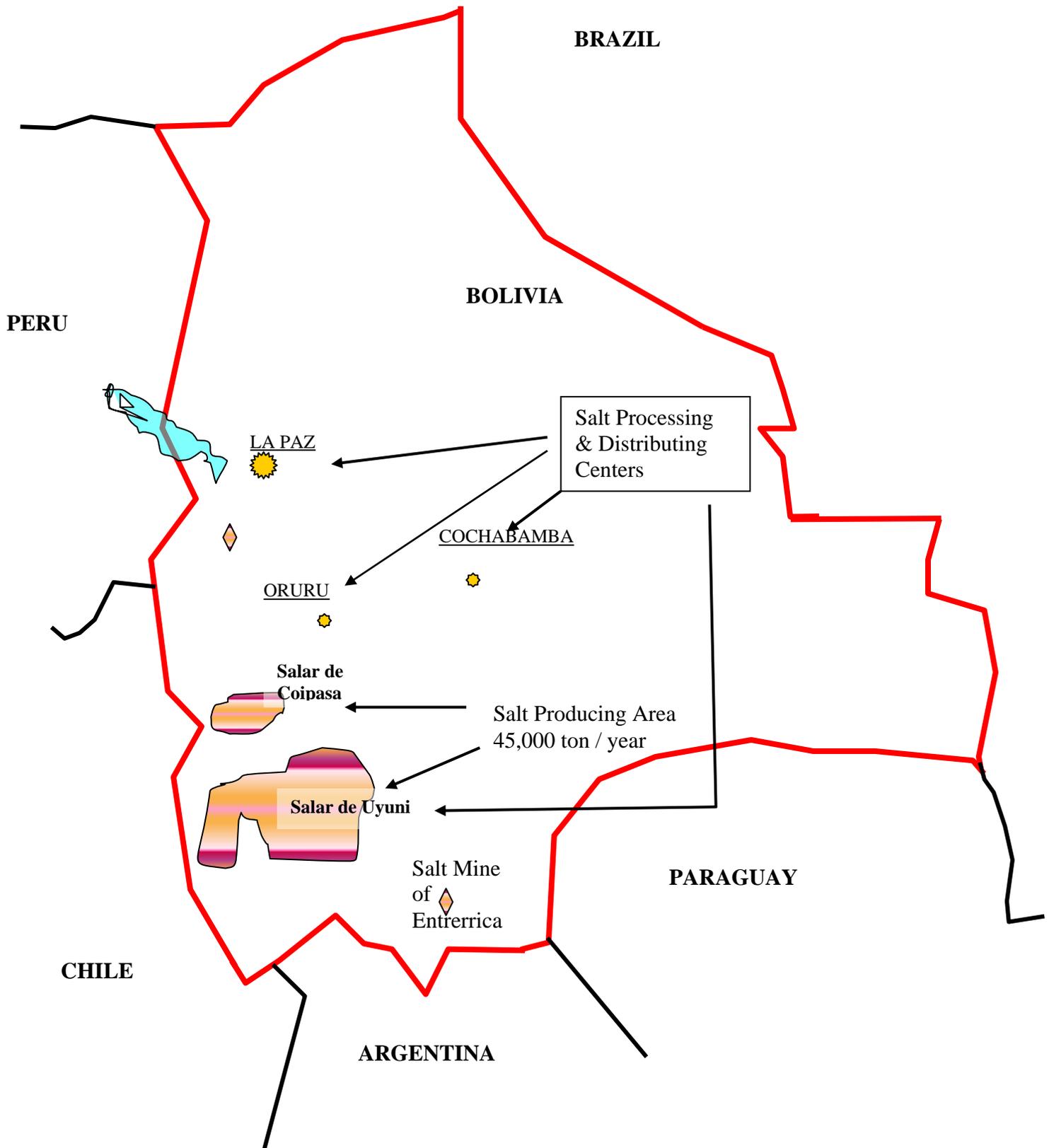
It was not until the 1980's however that sufficient institutional support was afforded the program and the establishment of the **Programa Nacional de Lucha contra el Bocio, (PRONALCOBO)**. **PRONALCOBO**, which was founded in 1984, is responsible for the consolidation and co-ordination of the technical assistance and monitoring aspects of production and distribution of iodized salt. The **PRONALCOBO** seal is on the rear panel of all iodized and fluoridated salt packs conforming to its standards. See **Figure 3**.

The overall program of salt iodization may be regarded as a success, In 1985 production of iodised salt was estimated to be 2000 ton per annum or 10% of salt for human consumption. In 1994 it was estimated that 25,000 ton or 95% of salt for human consumption was iodized. Incidence of goiter in school children has reduced from 64 % in 1981 to 4.6 % in 1994.

A key factor to this success has been the bulk purchasing, distribution and financing of the iodation chemicals by the Government of Bolivia.



Figure 1: Diagram Showing Salt Flows for the Republic of Bolivia





3. Visit to Salt Producers in the La Paz Area:

Three enterprises were visited in El Alto just outside of La Paz. These were the **Empresa Aguila Real**, **Empresa Illimani** and the **Empresa Perla Andina**. These enterprises are typical of the 13 salt processors / packagers in the La Paz area.

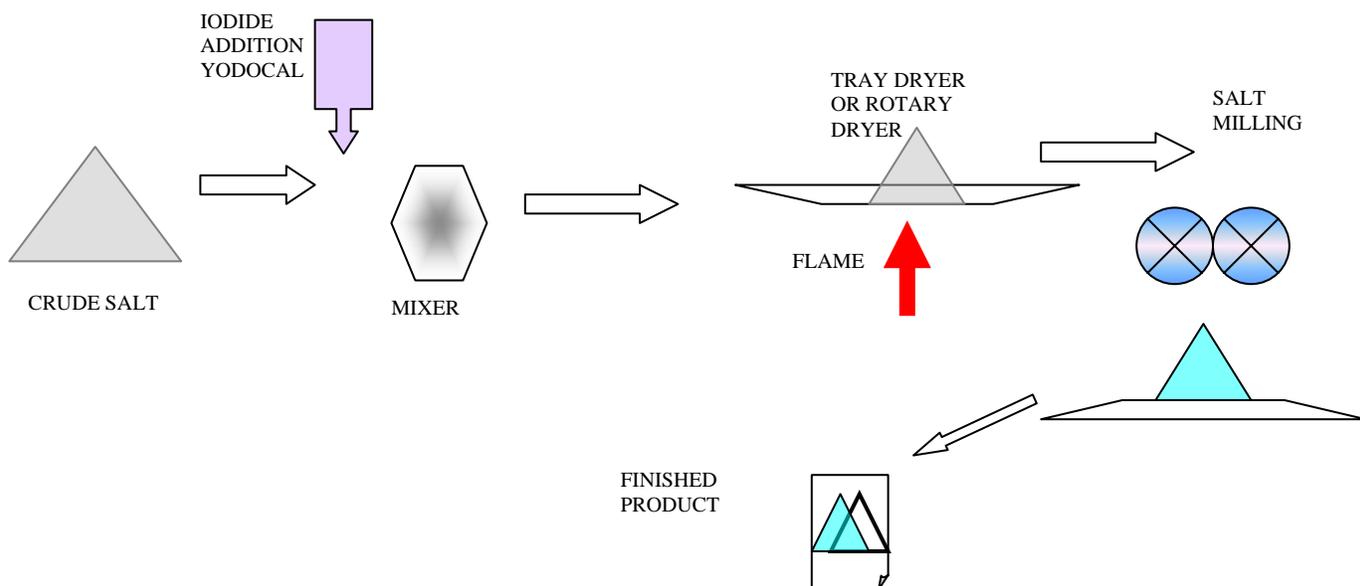
The facilities are housed behind walled compound in the normal residential area of the town. They are quite small, usually the equivalent of two unfinished rooms in the proprietor's house. In the case of **Empresa Aguila Real** the entire "plant" including a 100 ton crude salt stockpile was housed within an area of approximately 40 sq. meters.

The process used is essentially the same in all enterprises, and may be described as a **Mill Dry and Package** process, see Figure 2 below. There may be slight differences in the type of one or the other pieces of equipment, but the process is highly artisan and manual.

In the case of **Empresa Aguila Real**, the crude salt was emptied manually in a batch mixer where potassium iodate was added. The iodate used was Yodocal, a 9 to one mixture of calcium carbonate and potassium iodate. This is then mixed for between 20 minutes to half an hour and the contents emptied on a tray dryer. This interesting piece of equipment is simply a sheet of 1/8 in thick steel with legs and upturned edges, so the salt does not spill off the edges, and a propane torch under the sheet. The salt is dried by the heat of the torch as it is shifted to different positions under the sheet.

The salt after drying has gone from about 2.5% moisture to anywhere between 0.5 to 1% moisture.

Figure 2: Diagrammatic representation of the Mill ,Dry and Package Salt Process typically done in Bolivia.





The salt is then conveyed manually to a hammer mill where particle size reduction takes place. After milling the salt is placed on a packing table where it is manually packed in plastic bags and sealed by a propane heated heat sealer. Packaging is done in 500gm, 1kg and 3kg packs. See **Figure 3** below. The plant production is 1.5 ton per day. That is 3000-500gm packs per 8 - 10 hr day. Production capacity is about 1000 ton per year.

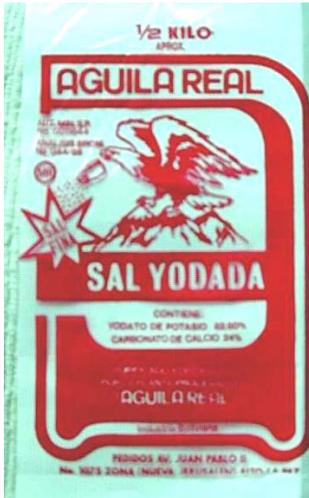
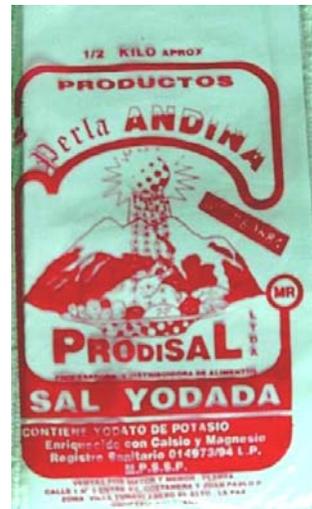


Figure 3: AGUILA REAL Brand Salt (1/2 kilo pack) showing the PRONALCOBO logo on the Package Rear Panel

In the case of **Empresa Perla Andina**, and **Empresa Illimani**, the process is the same except that a rotary dryer is used for salt drying. Also at the end of the dryer is a sieved section that separates the fine-ingrade salt from the coarser particles. The coarse particles are recycled through the mill. For those processors that adopt this step, a more consistent salt particle size, and hence better looking salt is obtained.

The **Empresa Perla Andina** produces on average 2 ton per day. Plant capacity is 1500 ton per year. Packaging is in 500gm, 1kg and 3 kg packs. See **Figure 4** below.

Figure 4: The ILLIMANI & Perla ANDINA Salt Brands (1/2 Kilo Sizes)





4. Visit to Salt Producers in the Oruru Area:

Oruru is the main center of salt processing. Twenty-seven of the countries 48 producers are in the Oruru area. Two of the producers here have started fluoridating salt. These were visited as well as 3 other producers, at total of five.

INDUSTRIA MOLINERA ORIENTE

This is a medium level processor and distributor of salt. This processor has already started to produce fluoridated salt. The processing plant has a capacity of 3 ton per day or 1000 ton pr year. Production typically for an eight-hour day is 1 ton.

The production process is similar to that shown in **Figure 2**, except a rotary dryer is used. This dryer is directly fired by a propane flame and is of asbestos-cement construction. It is 15 ft long by 2 ft diameter. It has two roller supports near either end and is driven by a ring gear in the middle.

The addition of fluoride and iodide is done after drying at **Industria Molinera Oriente**. The dry method is used, with sodium fluoride and potassium iodate are the chemicals used. Measured quantities of these chemicals are added along with 50kg salt in a cube shaped batch rotary mixer. The amounts are 2.9 gm sodium fluoride, and 8 gm potassium iodate. These amounts are added to give a target value of 250 ppm Fluoride and 90 ppm Iodide in salt.

Mixing takes place for 15 minutes for each batch. Following on the addition of fluoride and iodide, the salt is transferred from the batch mixer to packing tables where women use scoops to pack the salt into printed polyethylene sacks. Fluoridated salt is produced under the **SonriSal** brand, and is packaged in 1 kg sizes. See **Figure 5** below.



Figure 5: Industria Molinera Oriente SonriSal Brand of Fluoridated and Iodized Salt.

The operations of **Industria Molinera Oriente** are well organized and efficient. Fluoride storage and handling is being done is a correct fashion.



COPISAL

COPISAL was the most modern and organized of the producers in Oruru. It is also the largest, having a capacity of 20 ton per day or 6,000 ton per year. Production, which is normally on an 8hr basis, is 8 ton per day.

Again the process is similar to that represented in **Figure 2**, page 8, except a direct fired rotary dryer is used. **COPISAL** is installing a larger capacity "double barreled" rotary dryer. This is simply two dryers coupled together and driven by a single gearbox and motor. Two burners provide heat, one in each barrel, to the dryer.

After drying the salt is transferred to a batch rotary mixer where potassium fluoride and potassium iodate are added. Mixing takes place and the salt is then transferred to the packing table, where it is packed manually, then sealed using a gas sealer. Ninety percent of **COPISAL's** salt is packed in 1 kg packs. Packaging is done in 5 kg, 3 kg, 1 kg and 500 gm sizes.



Figure 6: COPISAL Brand of Iodized Salt.

MOLINA SANTIAGO, EMPRESA GERLI & EMPRESA SAL ANDINA

These three enterprises are typical of the majority of less developed salt processing establishments.

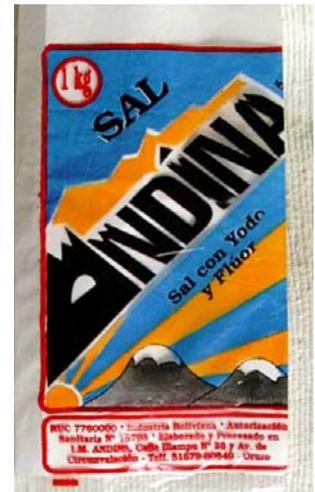
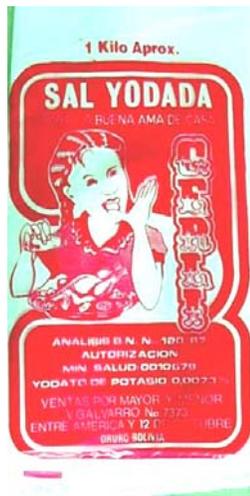
The process is the same as described earlier and shown in **Figure 2** on page 8. The crude salt is milled and at the same time iodine in the form of yodocal is added. The salt is then transferred to a rotary kiln dryer which is directly fired. In the case of **MOLINA SANTIAGO** it is a double barreled dryer. This type of dryer is favored by many of the Bolivian producers because for the same capacity drying the equipment is shorter than a conventional, single barreled dryer. It therefore saves space. Hence its use in the very cramped quarters of most of Bolivia's salt producing facilities.



After drying, packaging and sealing is done. At these three plants this is a manual operation. Sealing is done by holding the package directly over the flame of a propane burner, something that requires a high level of skill.

In the case of **Molina Santiago**, the plant's production is 12 ton per day. The package sizes are 1 kg and 500 kg. For **Empresa Gerli**, 2 processing lines are squeezed into what are most of the downstairs quarters of a family dwelling. Twenty ton per day are produced by this enterprise. Packaging sizes are 5 kg, 1kg, and 500gm. In both cases over 90% production is in the 1 kg size.

Figure 7: The SANTIAGO, GERLI & SAL ANDINA Brands of Iodized Salt (1 Kilo Sizes)



The operations described above are far from ideal in many aspects. For the addition of fluoride, the main problem apart from a relatively low level of management expertise, which will be encountered is the lack of space for proper storage and handling of the fluoride chemicals.

5. Visit to Salt Producer PISABOL in the Cochabamba Area:

PISABOL or **Planta Industrializadora de Sal y Alimentos Bolivianos** is one of 5 salt processors in the Chocabamba area, the eastern-most corner of the La Paz, Oruru, Cochabamba triangle. It is owned and operated by the young entrepreneur Gonzalo Molina. He has been very active through **ABISAL, Asociacion Boliviana de La Industria Salinera** in attempts to have salt fluoridation started in Bolivia. PISABOL manufactures fluoridated salt.

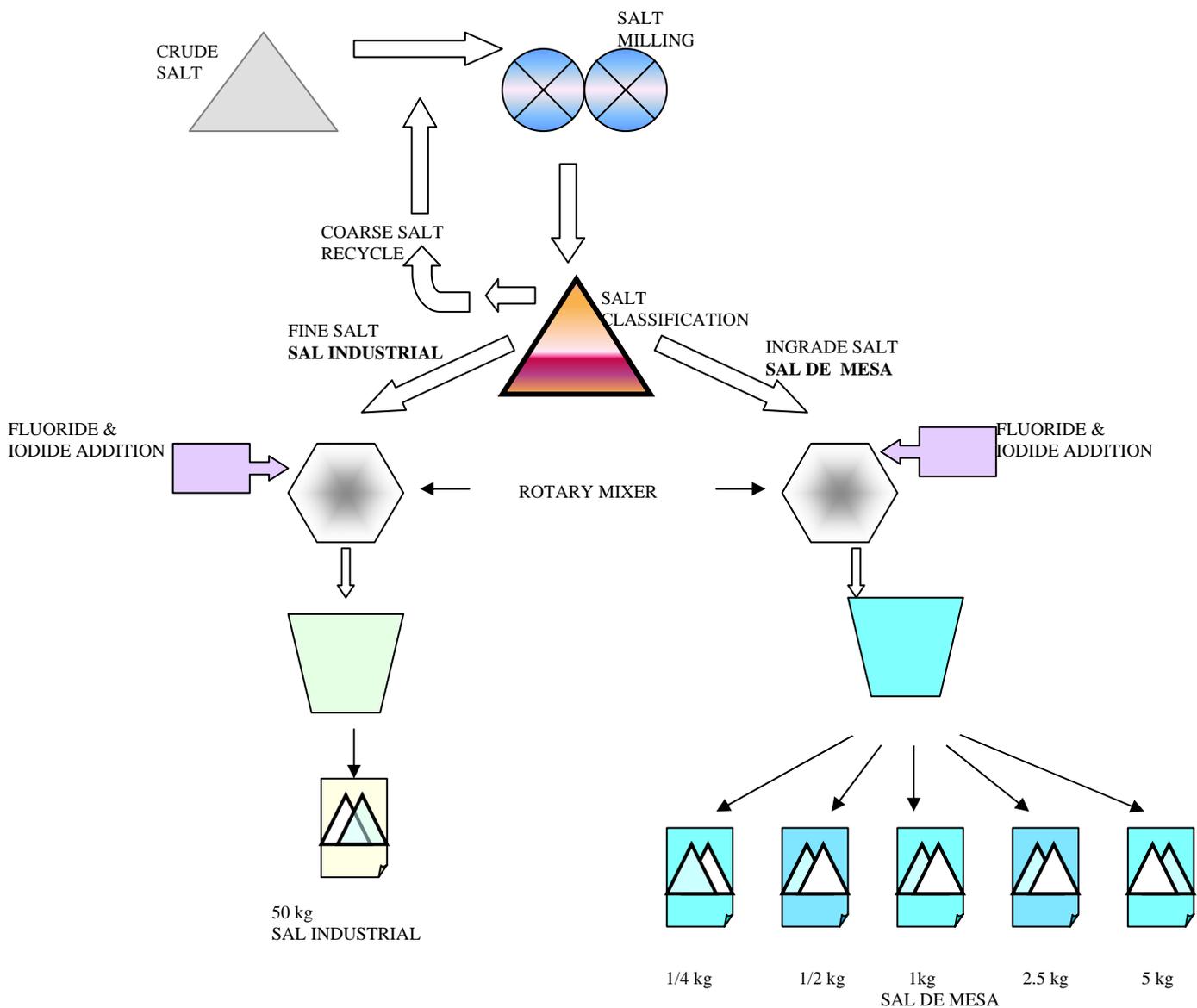
The present plant has a capacity of 6 ton per day or 1800 ton per year. Although it the most organized and efficient at present in Bolivia a new one of double the capacity is



being constructed at a different site. The process is the typical **Mill, Dry and Package**, see **Figure 8** overleaf.

Crude salt which is transported from **salar coipasa** on trucks carrying 300 or 500 quintals (13.5 or 22.5 ton), at a time, is stored in a covered warehouse. Production begins with the milling of the salt in a hammer mill, then the drying in a directly fired rotary dryer. The dried salt is then classified into various particle sizes as follows. Retained on 18 mesh is recycled and re-milled. Some of this salt fills a small-specialized demand by restaurants for the pickling of beef.

Figure 8: Diagrammatic representation of the Mill ,Dry and Package salt process used by PISABOL in Cochabamba.





The salt size that passes 18 mesh but is retained by 30 mesh is ingrade product for table and household salt. This is called **sal mesa**. Salt finer than 30 mesh to 80 mesh is called **sal industrial** and is used in the baking industry.

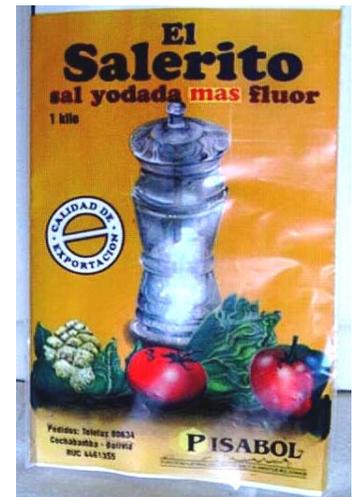
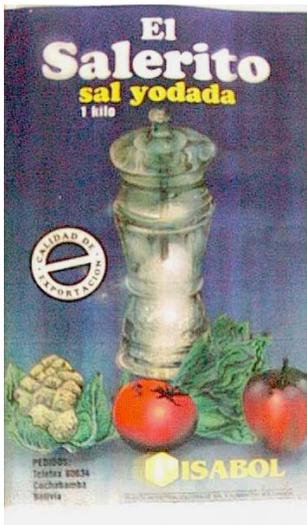
For the sal mesa this is dosed with fluoride and iodide and is transferred to the **ITOMOE** brand rotary mixer. This mixer holds a ton of salt per batch. A premix of 40 kg salt, 120 gm potassium iodate and 650 sodium fluoride is made up previously and also added. These quantities give the targeted values of 250 ppm Fluoride and 70 ppm Iodide.

The mixer, which uses a 20-hp motor and operates at 40 HP takes approximately 15 minutes per batch.

The dosed salt is then conveyed to a storage hopper above a volumetric packaging machine. The packaging machine may be adjusted for a variety of package sizes, namely 250 gm, 500 gm, and 1 kg. 5 kg and 2.5 kg packs sizes are done manually. Salt packs are sealed on a continuous heat-sealing machine. **PISABOL** is very aggressive in the marketing of salt. The company has targeted the higher economic levels of the society with attractively designed packaging. See **Figure 9**. In this way he is able to make more of a margin which may be re-invested for better product quality and higher efficiency.

The **sal industrial** is also dosed with fluoride and iodide in the same way and packed in 50 kg sacks only. It is marketed to the baking trade.

Figure 9: Gallery of El Salerito Brand Salts Made by PISABOL Iodized & Fluoridated at left.



PISABOL is a well-managed and efficient operation. The leadership of that enterprise is very forward looking and seems bent on continuing to be in the fore in maintaining modern standards of efficiency and quality. All aspects of the additive operation were observed to be carried out to the highest standards.



6. Visit to Salar Coipasa

Salar Coipasa is the second largest of five salt flats systems in Bolivia. Formed many hundreds of thousands of years ago, it is 1900 sq km in area. The estimated reserves of salt are 2 billion tons. The salt is easily obtained by simply cutting out solid blocks of salt from the surface. The salt block dimensions are usually 30 ins X 24 ins X 6 ins. When the salt block is taken out it is replaced naturally by saturated brine solution which evaporates slowly to replace the surface of solid salt within a few months.

The salt quality is surprisingly good. Insoluble impurities are very low, less than 0.5%. In some parts of the **salar** there are high insoluble impurities which show up as layers or stripes in the blocks of salt. These areas can be isolated and salt not mined from them. However depending on how the salt is handled insoluble impurities are added during handling and transportation from the site to the salt processor. Chemical impurities are at an average level consisting mainly of Calcium and magnesium sulfates. Moisture is lower than solar evaporated sea salt, about 1%, cf 3-4% for solar salt. In some areas of the **salar** the salt has a pink coloration, due to the presence of halophytic algae or bacteria.

The main problem of the extraction of salt from the **salars coipasa** and **uyuni** is their isolation. These areas are far from good roads so transportation and living conditions are extremely difficult. The main cost of salt is therefore the cost of transportation. Individual workers in the **salars** band together to form co-operatives that share labor and marketing for the salt extraction. The average earning for a co-operative member is B\$100 or U\$19-U\$20 per day. A truckload of salt consisting of 300 one-quintal bags, or 13.5 tons is sold for U\$100, that is U\$7.4 per ton. Transportation and distribution mark-ups are added along the way so that a ton of salt in Oruru or Cochabamba is purchased by the processor for U\$21.24 and U\$44.44 respectively.

Figure 10: Member of Cooperativa de Coipasa, beside salt blocks he reaped



Figure 11: Close up of salt block reaped.

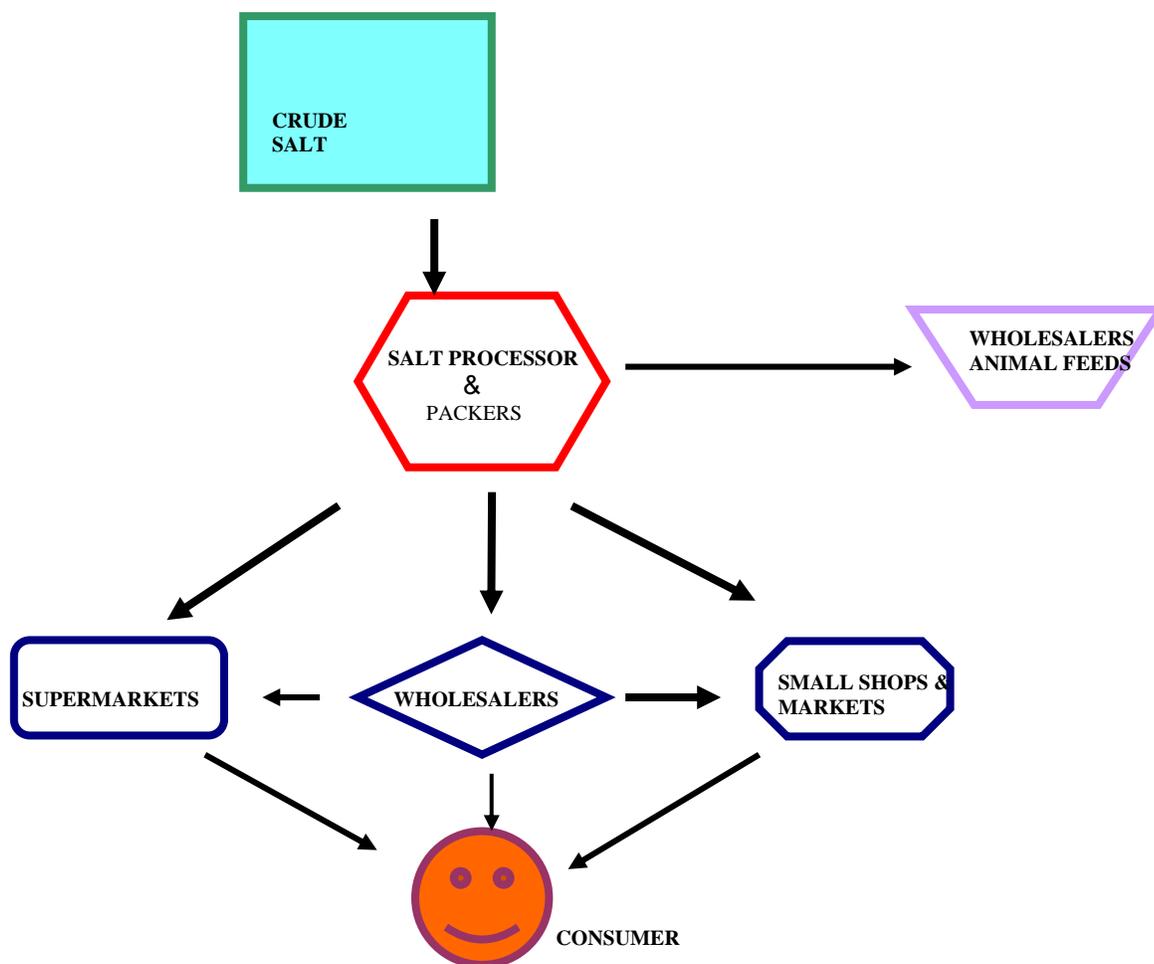


7. Salt Marketing and Distribution

The **Figure 12** shown below outlines the distribution channels and marketing arrangements for salt. More study is needed to accurately quantify the various streams.

The majority of salt sales are done through the open-air markets in each town and village. The low price of Bolivian salt has high impact on its marketing and distribution. For instance there are less brands per processor than in other countries. Expenditure on packaging is less and hence packaging quality is lower than in other countries. Also the distribution of brands is limited in the main to the immediate vicinity of the processors. For example the processors of La Paz and El Alto distribute mainly in the surrounding highland region. The Oruru and Cochabamba processors distribute mainly in the eastern sections of the country

Figure 12: Salt Distribution Channels, Republic of Bolivia.





8. Analysis of the Bolivian Situation

The Bolivian Salt Industry may be characterized as mainly artisan. The processing and packaging plants suffer from undercapitalization and inefficient methods. The following lists the main characteristics of this industry.

1. Operations have a high manual content.

This is so for all areas of the operation. In the production of crude salt manual labor is used for the extraction, bagging, loading and unloading of the salt. Only in the transportation of salt is machinery in the form of trucks utilized consistently. In most of the packaging plants although machinery is employed, all transfer points, and storage activities are manual.

2. The industry is in a state of "immature stability".

This characterization may seem quite paradoxical, but it is an accurate one. The industry although seemingly fragmented with 47 processors is not really so for the overall country demographics and production size. Apart from one, there is no clearly defined outstanding individual or group of producers. Nor is there likely to be much change in the near future given the particular cost structure of the Bolivian salt industry. Of the six Kellogg grant countries Bolivia has the lowest price of crude salt at source and the lowest price of packaged salt to the consumer. There doesn't seem to be much hope to squeeze the required capital out of the national market in order to reinvest and upgrade the industry. Short of serious export growth, which again seems unlikely given the present state of the regions salt production, self-generation of reinvestment or investment capital is unlikely. Hence the stability at the present state.

3. The wholesale price of packaged salt is in the range of US\$ 0.12/kg to US\$ 0.08/kg.

If the final price to the consumer is 50% higher this would put the final range of packaged salt to the consumer at between US\$ 0.18/kg to US\$ 0.12/kg. This is the lowest price of salt within the region and certainly of the six Kellogg grant countries. It is even far below that of the most efficient producer in Venezuela.

4. The operational facilities of the typical producer are extremely cramped for space.

This of course is as a result of his overall lack of capital and his necessity to "make do" with scarce resources in a low margin industry. However this will further militate against plant upgrading and the safe handling and storage of fluoride chemicals.

5. There exists some brands with acceptable international standard quality.

However a significant quantity of packaged salt, approximately 50%, is below what may be considered normal international standards.

The main shortcoming of salt quality in Bolivia are: inconsistent particle size, caking or hardening of salt during storage, substandard packaging quality, high degree of sealing defects and poor weight control. Package weights are normally far below the declaration, with some processors simply labeling the weight as **approx**. Insufficient



evidence is available from the monitoring authorities to make a judgement on additive control.

6. **There is no capacity among the producers to carry out any quantitative analysis on raw material or finished products.** There is an absence of analytical facilities at the producer level. PISABOL will have laboratory facilities at their new plant location.
7. **The program of iodization from all indications has been successful with 95% compliance by processors.** Three processors have taken the initiative to commence fluoridation.

9. Recommendations

It is unrealistic to expect that rapid upgrading of the majority of salt processing facilities in Bolivia will take place. This is obviously what is needed to enable these facilities to start a program of salt fluoridation to move the production of fluoridated salt from 4% of salt at present to 95%. Rather what should be envisioned is a gradual approach, facilitating the existing fluoridated salt producers and encouraging those who are enthusiastic to fluoridate. It would be logical to concentrate on Oruru where 75% of salt production takes place, and to try to convert at least 80% of the producers there by centralizing and sharing common requirements. e.g. laboratory and storage and handling of the fluoride chemicals. The widespread fluoridation of salt in Bolivia will probably take more time than in other countries. It is recommended that the following strategies be pursued.

1. That the Government of Bolivia ensure the continuation of bulk buying and distribution of Fluoride chemical to ensure the lowest possible cost of this input to the salt processor.
2. That PISABOL, COPISAL and Molienda de Oriente be encouraged in all ways possible so that their addition program is successful and may be expanded.
3. That the other producers whom have shown an interest in fluoridation be given any available assistance to implement fluoridation.
4. That Oruru being the main salt production center, be focused on to see if sharing of facilities may be accomplished in that area.
5. That PAHO develop a "Travelling Seminar " to expose the Bolivian Producers to appropriate developments in salt process technology.
6. That a detailed study of the salt distribution and marketing system be made.
7. That PAHO explore the possibility of obtaining funding for improvement of salt production methods and for setting up of analytical facilities for fluoride analysis.



APPENDICES





APPENDIX 1

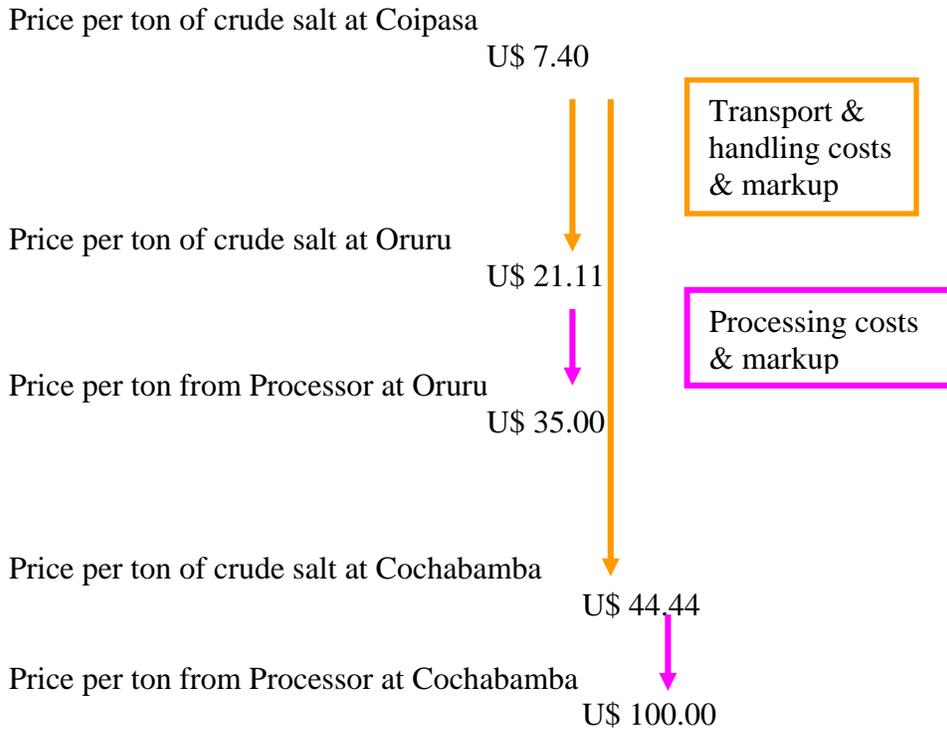
LIST OF BOLIVIAN SALT PROCESSORS

NAME OF PROCESSOR	BRAND PACKAGED	LOCATION
1. Empresa Aguila Real	Sal Aguila Real	La Paz
2. Empresa Astra	Sal Astra	La Paz
3. Empresa Illampu		La Paz
4. Empresa Illimani	Sal Illimani	La Paz
5. Empresa Vicuna	Sal Vicuna	La Paz
6. Cooperativa Jacaya		La Paz
7. Empresa Leon	Sal Leon	La Paz
8. Empresa Nuevo Amanecer		La Paz
9. Empresa Perla Andina	Sal Perla Andina	La Paz
10. Empresa Princesa Real	Sal Princesa Real	La Paz
11. Cooperativa Tarquiamaya		La Paz
12. Empresa Pacajena	Sal Pacajena	La Paz
13. Empresa Amadito	Sal Amadito	Oruru
14. Empresa Copacobana	Sal Copacobana	Oruru
15. Empresa Coipasa	Sal Condor de Oro	Oruru
16. Empresa Condor de Oro	Sal Crucena	Oruru
17. Empresa Crucena	Sal El Rey Inca	Oruru
18. Empresa El Rey Inca		Oruru
19. Empresa Gerli	Sal Girli	Oruru
20. Empresa Guadalupe		Oruru
21. Empresa Insalvo	Sal Margarita	Oruru
22. Empresa Lainal		Oruru
23. Empresa Los Arenales		Oruru
24. Cooperativa Litoral	Sal Orocondo	Oruru
25. Empresa Magarita	Sal Paulita	Oruru
26. Empresa Ocoisal		Oruru
27. Empresa Oriente		Oruru
28. Empresa Orocondo		Oruru
29. Empresa Paulita		Oruru
30. Empresa San Augustin		Oruru
31. Empresa Santiago	Sal Santiago	Oruru
32. Empresa Universo		Oruru
33. Empresa Yodisal		Oruru
34. Empresa Inca		Cochabamba
35. Empresa Maqui		Cochabamba
36. Empresa Nectar		Cochabamba
37. Empresa Joaquin		Cochabamba
38. Empresa PISABOL	El Salerito	Cochabamba
39. Empresa Hadita		Potosi-Uyuni
40. Empresa Nevada		Potosi-Uyuni
41. Empresa Oro Blanco		Potosi-Uyuni
42. Cooperativa Rosario		Potosi-Uyuni



APPENDIX 2

COST STRUCTURE OF BOLIVIAN SALT, FROM CRUDE SALT TO CONSUMER





APPENDIX 3 MAP OF BOLIVIA





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