WORLD BANK OPERATIONS EVALUATION DEPARTMENT

Programs to eliminate micronutrient deficiencies have a significant and lasting impact on public health and disproportionately benefit poorer segments of the population. When food fortification is used to address micronutrient deficiencies, commodities with few producers are preferable as vehicles to deliver micronutrients. Dealing with an industry with few producers immensely facilitates the government's role in monitoring and enforcement.

An Analysis of Combating Iodine Deficiency: Case Studies of China, Indonesia, and Madagascar

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Abstract

Iodine deficiency is well documented as a preventable cause of mental retardation, and salt iodination is a proven cost-effective remedy. Although a minute quantity of iodine ensures a person's iodine adequacy, iodine deficiency remains a major public health problem. In a review of Bank support for activities to help eliminate iodine deficiency disorders through salt iodination, using case studies for China, Indonesia, and Madagascar, Goh finds that:

- The consumption of iodized salt is an effective means of eliminating iodine deficiency disorders.
- Raising public awareness (for example, convincing poor people that goiter is preventable and creating demand for iodized salt) is not enough—governments must also ensure easy access to iodized salt.
- The edible salt industry needs both the right incentives and effective monitoring and enforcement. Production must be monitored because the quality of iodination matters, and distribution and retail sales must be monitored because consumers cannot readily differentiate between iodized and noniodized salt.
- Incentives for maximizing compliance with salt iodination policies must be tailored to the structure of a country's salt industry.

Of the three programs examined, those in China and Madagascar had clearly positive outcomes; the one in Indonesia did not. Experience suggests that a positive outcome is more likely when the means of production is concentrated either under state control or through a limited number of large producers and when an accountability framework is in place before a project is financed.

The Chinese edible salt industry is centrally controlled, its distribution network monopolistic, its production structure province specific. Madagascar's salt industry is competitive, but six large producers supply 80 percent of national salt consumption. In Indonesia most of the salt supply comes from a multitude of small, competing salt farmers, making it difficult to develop an effective accountability framework.

In initiating and supporting programs to eliminate micronutrient deficiencies, the Bank can help most by providing critical financial resources; helping to diagnose a country's incentive structures and to ensure an effective framework is in place before financing a project; promoting intersectoral dialogue; and calling top-level political attention to the cause.

Abbreviations

GNP	Gross national product
ICCIDD	International Council for Control of Iodine Deficiency Disorders
IDD	Iodine deficiency disorders
NGO	Nongovernmental organization
OED	Operations Evaluation Department of the World Bank
UNICEF	United Nations Children's Fund
WHO	World Health Organization

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Preface

This Operations Evaluation Department (OED) study summarizes findings from a review of the World Bank's activities related to the elimination of iodine deficiency disorders (IDD), analyzes factors for effectiveness and sustainability, and draws lessons for future micronutrient activities of a similar nature. It focuses on three countries—China, Indonesia, and Madagascar—where the Bank has had substantive involvement in IDD control through salt iodination.

Iodine deficiency is well documented as a preventable cause of mental retardation, and salt iodination is a proven cost-effective remedy. Measures crucial for its success and sustainability include raising public awareness of IDD, ensuring easy access to iodized salt, promoting compliance in the salt industry, and monitoring and enforcement at all levels. Experience in the countries reviewed for this study reaffirmed findings elsewhere that consumption of iodized salt eliminates iodine deficiency disorders and prevents recurrence.

The study finds that the World Bank has an important role in initiating and supporting programs to eliminate micronutrient deficiencies. Such efforts not only have a significant and lasting impact on public health but tend to benefit poorer segments of the population disproportionately. The Bank can use its expertise in public health and in public-private sector development to help governments design effective programs that offer support to strengthen institutional capacity in surveillance and enforcement and establish an appropriate incentive-compatible mechanism in the industry.

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Summary

The World Summit for Children passed a landmark resolution in 1990 to eliminate global iodine deficiency disorders (IDD) by the year 2000. Iodine deficiency is well documented as the most common cause of preventable mental retardation. Although a minute quantity of iodine suffices to ensure a person's iodine adequacy, iodine deficiency remains a major public health problem. By 1998 about 740 million people still suffered from IDD, compared with 911 million in 1990.

The Bank's involvement in IDD control until the 1990s was indirect, limited mainly to funding surveys on goiter prevalence or salt manufacturers, giving technical advice, and supporting capsule supplementation. During the 1990s the Bank supported stand-alone projects in China (China: Iodine Deficiency Disorders Control Project 1995–2000) and Indonesia (Intensified Iodine Deficiency Disorders Project 1996–2002) for IDD control through salt iodination. In a few other countries, such as Madagascar (Food Security and Nutrition Project, Credit 2474, 1993–98), the Bank supported salt iodination as a component of larger health and nutrition projects. The objective of this OED study, which includes China, Indonesia, and Madagascar as case studies, is to recommend how IDD can be effectively controlled and provide guidance to the Bank on supporting governments to achieve this goal. The study also draws lessons for future involvement in micronutrient fortification programs and other interventions of a similar nature.

The three case study countries have contrasting industry structures and scenarios of progress. The Chinese edible salt industry is centrally controlled—the distribution network is monopolistic, while production is organized by province. In Indonesia over 70 percent of salt supply comes from small, competing salt farmers. Similar to that of Indonesia, Madagascar's salt industry is competitive, although six large producers supply as much as 80 percent of its national consumption.

China. Since the start of the National IDD Elimination Program in 1993, total goiter rates for children nationwide have declined significantly—from 20.4 percent in 1995 to 8.8 percent in 1999. The national mean coverage of iodized salt reached 93.9 percent in 1999, compared with 80 percent in 1995. The quality of salt at household level has also improved. Salt with iodine content of 20–60 parts per million increased from 30 percent in 1995 to 81 percent in 1999.

Indonesia. The progress of the ongoing program to control iodine deficiency has been slow. Problems that plagued similar efforts in the 1970s still remain, particularly poorly defined accountability and responsibility for implementation and enforcement. Although total goiter rates fell from 37.2 percent in 1980–82 to 9.8 percent in 1996–98, as much as 8.4 percent of it's the country's subdistricts (with 8.8 million inhabitants) were classified as severely endemic in 1996–98. National coverage of

iodized salt at the household level barely increased, from 78.2 percent in 1995 to about 80 percent in 1998–99. Coverage of quality iodized salt with iodine content of 30–80 parts per million increased modestly, from 50 percent in 1995 to 63.6 percent in 1999.

Madagascar. National progress in controlling iodine deficiency disorders has been encouraging. Coverage of iodized salt at the household level increased from zero in 1992 to 98.3 percent in 1999. Total goiter rates among primary school children fell from 45.1 percent to 7.1 percent during the period. Information on quality iodized salt was not systematically collected, but available data show wide variation in iodine content. In 1999 coverage of quality salt with iodine content of 30–60 parts per million ranged from 33.3 percent in Toliary province to 80 percent in Antsiranana province.

While salt iodination is technically straightforward, large-scale implementation often involves political, administrative, technical, and sociocultural changes. Once iodination of salt is effectively established as a permanent measure, it eliminates iodine deficiency and prevents recurrence. Country experiences indicate that effectiveness and sustainability of salt iodination depend on creating IDD awareness, ensuring easy access, promoting compliance in the industry, and enforcing quality control.

Create awareness of IDD. Many countries have a longstanding cultural acceptance of goiter as normal. Uninformed consumers—not only the general population, but also health workers and decisionmakers—who resist change can be an obstacle to creating awareness of the danger of IDD. Therefore, communication for behavior change must also target policymakers to ensure budgetary commitment and opinion leaders (village elders, religious heads, schoolteachers, political party workers) to persuade others to embrace the program. Informed consumers who demand iodized salt will become a self-sustaining force.

Ensure easy availability. Unless iodized salt is readily available to the population, public awareness of IDD is ineffectual. The study finds a significantly positive correlation between willingness to purchase iodized salt and knowledge of IDD. However, there is no statistically significant correlation between coverage of iodized salt and knowledge of IDD. This finding indicates that knowledge of IDD that creates demand for iodized salt is a necessary but not sufficient condition to ensure consumption of iodized salt. A reliable supply of iodized salt is equally important.

Promote compliance. Because governments in developing countries have limited resources and capacity, they must align incentives with the self-interests of the salt industry and consumers so that these players will police one another to ensure proper iodination. In many cases persuasion and direct assistance from the government are also necessary to motivate the salt industry to cooperate and to comply with iodination.

Enforce quality control. Since iodized and noniodized salt are indistinguishable without testing, the government's role in monitoring and enforcement is crucial.

Regression analysis finds that the quality of iodination—the iodine content in salt—matters. Reduction of IDD depends not only on the coverage of iodized salt but on adequacy of iodine in salt. Without enforcement, activities such as sale of noniodized salt and poor iodination quality can jeopardize progress toward eliminating IDD.

Once national coverage of iodized salt reaches over 90 percent and systematic surveillance is in place, the government can concentrate on fine tuning the program. Resources can be targeted to areas with low consumption of iodized salt. Regions where raw salt is easily available also warrant attention. Government interventions to facilitate the direct sale of iodized salt to remote villages, iodinate well water and irrigation water, or supplement iodine through capsules or injection of time-release iodine oil may be necessary to ameliorate IDD problems in such areas.

Elimination of micronutrient deficiencies has a long-term impact on public health; moreover, poorer segments of the population, who are more vulnerable to such deficiencies, tend to benefit disproportionately. While the United Nations Children's Fund (UNICEF), the International Council for Control of Iodine Deficiency Disorders, and the Micronutrient Initiative have been involved in IDD control efforts for many years, the World Bank has a comparative advantage in its complementary role. With expertise in public health and private sector development, the Bank can offer support to strengthen government institutional capacity for monitoring and enforcement and establish an incentive-compatible industry to motivate compliance with iodination. During the early stages of a program, the Bank's presence can promote intersectoral dialogue and heighten top-level political attention to enhance budgetary commitment.

It is critical to the effectiveness of an IDD control program that surveillance and enforcement mechanisms function at the outset. For sustainability during later years, adequacy of iodine in iodized salt must be ensured, and incentives must be modified as needed to increase compliance in the salt industry. Interventions in areas with low coverage of iodized salt may also be necessary.

Of the three programs examined, those in China and Madagascar had clearly positive outcomes, while the one in Indonesia did not. The experience in these three countries suggests that the outcome is most likely to be positive where an accountability framework and government ownership are in place before a project is financed. Where there is a sound accountability framework, as in China and Madagascar, technical experts outside the Bank can design comprehensive programs that include the production of iodized salt, industry regulations and standards, and enforcement. Where the accountability framework is deficient, however, as it is in Indonesia, even the best design may be inadequate. The outcome of a project is also more likely to be positive where the means of production is concentrated, either under state control or through a limited number of large producers. Indonesia's problems with salt iodination are in part a consequence of the multitude of small producers that complicates devising an effective accountability framework.

Apart from providing critical financial resources, the Bank can be most useful by diagnosing the incentive structures in a country and working with clients and partners such as UNICEF to ensure that an effective framework is in place before financing a project. During early stages of the program the Bank's presence can promote intersectoral dialogue and top-level political attention to enhance budgetary commitment to the cause. Once a project is under way, supervision should pay attention to the operation of the accountability system and other incentives. This is particularly critical for micronutrient components of larger projects.

Although this study focuses narrowly on salt iodination, its recommendations may be more broadly applied to other food fortification programs. When food fortification is chosen as the strategy to address micronutrient deficiencies, issues related to encouraging acceptance of fortified food, on the demand side, and motivating the industry involved, on the supply side, are similar to those in salt iodination. Given that asymmetric information generally exists in food fortification—that is, consumers cannot easily differentiate between fortified and nonfortified goods—commodities with few producers should be considered as vehicles to deliver micronutrients. Dealing with an industry with few producers will greatly facilitate the government's role in monitoring and enforcement.

The study concludes that:

- Iodized salt is an effective means to eliminate IDD.
- A reliable supply of iodized salt is as important as a demand for iodized salt.
- Enforcement is of paramount importance to the success and sustainability of salt iodination. Consumers cannot readily differentiate between iodized and noniodized salt, and the quality of iodination matters.
- Incentives must be tailored to the salt industry structure and given at appropriate levels (production, distribution, or retail) to maximize compliance with salt iodination.

The OED Iodine Deficiency Study

Proper nutrition is an important determinant of health, learning ability, and working capacity. Proper nutrition means consuming not only sufficient energy and protein but also adequate vitamins and minerals. While economic development and higher incomes usually ensure adequate caloric intake, they do not guarantee adequate intake of micronutrients. This is partly because most micronutrients are present only in selected types of food, and partly because people do not have a natural hunger for vitamins and minerals.

Prevention of micronutrient deficiencies enhances human development and potential economic well-being. *World Development Report 1993: Investing in Health* found that micronutrient programs were among the most cost-effective of all health interventions. A comprehensive and sustainable approach to address deficiencies of micronutrients such as iodine, iron, and Vitamin A would cost less than 0.3 percent of GNP a year; in contrast, because of these deficiencies as much as 5 percent of GNP would be lost to deaths, disability, lower education, or lost productivity.

This study examines one aspect of World Bank activity in the prevention of micronutrient deficiencies: iodine deficiency control. The goal of the study is to recommend measures for effective control of iodine deficiency disorders (IDD) and provide guidance to the Bank on supporting governments to achieve this goal. More broadly the study draws lessons for future involvement in micronutrient fortification programs and other interventions of a similar nature.

Iodine deficiency is well documented as the most easily preventable cause of mental retardation, and its elimination is a recognized priority in the field of nutrition and public health. The 1990 World Summit for Children set the goal to eliminate IDD by the year 2000. Though a minute quantity (100–150 micrograms per day) of iodine suffices to ensure a person's iodine adequacy, IDD remains a major public health problem in many countries. By 1998 about 740 million people still suffered from IDD (WHO 1999) a reduction from 911 million in 1990 (WHO 1991).

Iodine Deficiency Disorders

The human body requires iodine for the synthesis of thyroid hormones,[1] which help regulate the metabolic activities of cells. Iodine is also important for cell replication, which is especially relevant for the brain since neural cells multiply mainly in utero and during the first two years of life. Inadequate iodine impedes growth and

development and can result in numerous health problems known collectively as iodine deficiency disorders (IDD). These include cretinism,[2] goiter, mental defects, miscarriages, neonatal and thyroid deficiency, spastic weakness, stillbirths, and lesser physical and mental malfunctions. Studies have found that iodine supplementation improves the learning capacity of school children and reduces the costs of curative medicine (Bleichrodt and Born 1994; Pandav 1997).

Farm animals share with humans the risk of iodine deficiency at all stages of growth, from conception to physical performance. In iodine-deficient areas cattle and sheep have higher stillbirth rates than those in nondeficient areas, the calf mortality rate is twice as high, and production of wool, meat, and eggs is much lower. Salt for animal consumption that is iodized can improve animal reproduction, milk and meat yield, and the iodine content of food produced from those animals (Pandav 1996).[3]

Iodine is a trace element found in low concentrations in water and soil and is ingested through the fish and vegetables that grow in those media. Iodine is unevenly distributed in the soil and is often deficient in mountainous areas. Iodine deficiency can be further aggravated by environmental degradation such as deforestation and soil erosion.

Fortunately, iodine deficiency is also one of the simplest micronutrient deficiencies to address. This is done by periodically supplementing the deficient population with iodized oil capsules or other preparations or fortifying a commonly eaten food with iodine. Fortification has proven the more cost-effective and sustainable solution. In most developing countries salt iodination is usually the first large-scale experience in fortifying food nationwide. If a developing country can effectively institutionalize measures to eliminate iodine deficiency, addressing deficiencies in Vitamin A and iron may be less daunting.

Why Iodize Salt?

Several foods are possible vehicles to introduce iodine into the daily diet (salt, bread, milk, sugar, and water). In inland mountainous areas, where iodine deficiency is most severe, the population is often largely dependent on one or two staple cereals. An appropriate vehicle for iodine to reach such a population must be selected in this dietary and economic context. Salt has become the most commonly accepted for various reasons,[4] and iodized salt has been successful in eliminating iodine deficiencies for more than 80 years.

Distribution of Iodized Oil Capsules

Distribution of iodized oil capsules has been and is still considered an appropriate and necessary short-term measure to control IDD before iodized salt is widely available to a population. Even after iodized salt becomes the primary vehicle to deliver iodine, iodized oil supplements can play a complementary role in special cases. In China iodized oil capsules are still distributed to pregnant women, newly married couples, children 0–2 years old, and the entire population in areas with an

incidence of cretinism of at least 2 percent.[5] And in Madagascar iodized oil capsules are still distributed in areas with high IDD prevalence.

Risks from Iodine Supplementation

Overall, providing incremental iodine through properly iodized salt is safe, with few if any side effects. Iodine intake that is too rapid or too massive an increment may carry risks for people with have severe chronic iodine deficiency. The most serious complication for this group—usually elderly people with nodular goiters—is the development of iodine-induced hyperthyroidism; the incidence of hyperthyroidism reverts spontaneously to the background rate or below between 1 and 10 years of iodine supplementation. Other possible complications include aggravation or induction of autoimmune thyroiditis in susceptible individuals. The incidence of this adverse reaction is very low and has yet to be clearly demonstrated by large epidemiological, metabolic, or clinical surveys. Complications of iodine supplementation can be entirely avoided through adequate and sustained monitoring and control of the level of iodide in salt (Delange and Lecomte 2000).

Approach of the Study

A 1999 OED review of Bank work in the health, nutrition, and population sector finds that efforts in nutrition activities have not been consistent (World Bank 1999a, p. 18).[6] The Bank's involvement in iodine deficiency control has largely been indirect, limited to funding surveys on goiter prevalence and market surveys of salt manufacturers, providing technical advice, and supporting iodine capsule supplementation. During the 1980s and 1990s Bangladesh, Benin, Burkina Faso, and Mauritania received Bank assistance for IDD control within larger projects, but the Bank's involvement in the IDD component was minimal.[7] During the 1990s the Bank financed two stand-alone projects for IDD control through salt iodination—China: Iodine Deficiency Disorders Control Project 1993–2000 and Indonesia: Intensified Iodine Deficiency Disorders Control Project 1996–2002. In Madagascar the Bank supported IDD control primarily through salt iodination within the larger Food Security and Nutrition Project, Credit 2474, 1993–98.

The present study includes China, Indonesia, and Madagascar as case studies. The study also conducted a desk review of available documents for health and nutrition projects with an iodine deficiency control component to assess whether lessons emerging from the case studies are consistent with experiences elsewhere. Information for the study is based primarily on project documents, the IDD literature, discussion with Bank staff, and field visits. Meetings and discussions were held with government officials, salt farmers, producers, wholesalers, local health officials, and laboratory technicians in China, Indonesia, and Madagascar. Simple correlation and, wherever data permitted, regression analyses were used. Variables of interest in this study include coverage rates of iodized salt, iodine content in salt, and indicators for iodine status. Common indicators for assessing iodine status of

communities are urinary iodine and the prevalence of goiter among school-age children. The median value of urinary iodine in a healthy population is 100–200 micrograms per liter.[8] A goiter is an enlarged thyroid whose size can be determined clinically by palpation or ultrasonography.[9]

Analysis of Data

The three case study countries have contrasting industry structures and progress scenarios. The Chinese edible salt industry is centrally controlled. The distribution network is monopolistic, while the production structures are organized by province. In Indonesia over 70 percent of salt supply comes from a multitude of small, competing salt farmers. Similar to that of Indonesia, Madagascar's salt industry is competitive, although six large producers supply as much as 80 percent of its national consumption.

Progress in Reducing Iodine Deficiency Disorders in China

Edible salt production in China is centrally controlled (see box 1). Salt iodination began in the 1950s with mandatory sale of iodized salt to areas of high IDD prevalence. However, enforcement was difficult. After 1990 the government began its National IDD Elimination Program to comply with the international goal of IDD reduction. World Bank support constitutes 20 percent of the total cost of the program, which was estimated at over $100 million.[10] In 1995 a Memorandum of Understanding for the Universal Salt Iodination Program was signed with the Chinese government by the Bank and United Nations partners.[11] The main objectives of the Bank loan are to support the National IDD Elimination Program by providing aid for upgrading physical plants for iodized salt production, packaging, and distribution and establishing effective quality control in the salt industry, including training of laboratory staff and improvement of laboratory facilities.[12] The Bank also helps to promote effective coordination among sectors involved and to develop an ongoing multisectoral review process. In agreement with the government, the other United Nations partners took the lead in supporting other aspects of the project in close collaboration with the Ministry of Health.[13]

Since 1995 China has seen a dramatic reduction in iodine deficiency (table 1). The national mean coverage of iodized salt (the proportion of households consuming iodized salt) reached 93.9 percent in 1999. The quality of salt at household level has also improved. Coverage of qualified iodized salt (salt with an iodine content of 20–60 parts per million) increased from 30 percent in 1995 to 81 percent in 1999. Total goiter rates for children nationwide have declined from 20.4 percent in 1995 to 8.8 percent in 1999. The reduction in total goiter rates during earlier years was a result of both distribution of iodine oil capsules and increased consumption of iodized salt. Since capsule supplementation was discontinued in 1998, improved iodine status is likely be a result of iodized salt.

Box 1. The Salt Industry in China

China produces two types of salt, industrial salt and edible salt. Industrial salt has an open market, while edible salt is centrally controlled. The China National Salt Industry Corporation[a] issues production, distribution, and transportation licenses and controls the annual production quota for edible iodized salt in each province. Retail packaging and wholesale counterparts—the monopolistic provincial salt companies—enjoy larger profit margins than salt-producing units, most of which are state owned and have very little retained earnings for investment or maintenance of their facilities.

Provincial organizational structures vary widely in the salt industry. Salt producers in Gansu and Liaoning, for example, are owned by county-level governments, whereas Jiangsu has a vertically integrated salt industry owned and run by a conglomerate. In Hunan and Hubei the prefecture governments own some of the production units, and their respective provincial salt companies own and run the rest. Salt factories that are owned and run by their provincial salt companies generally have better access to financial resources, technology, and management. For example, Guangxi Salt Company cross-subsidizes its salt producers between 20 and 30 million yuan (about $3 million) a year from profits in retail packaging and distribution.

Provincial salt companies have strong incentives to eliminate unauthorized salt dealers to safeguard their profits. They promote goodwill and cooperation among local police to facilitate monitoring and devote significant resources to uprooting illegal salt operations. In Wuxi and many other cities salt inspectors patrol each day to sample salt in retail stores, restaurants, hotels, and households. The crackdown has been successful, with salt dealers apprehended after only two months of underground operation.

Unauthorized salt accounted for about 10 percent of the Chinese salt market in 1998, but more than half of that salt was iodized. Costs of iodination are low, and factories iodize their salt before smuggling it out to reduce detection. Local health officials make regular, unannounced inspections at production plants, wholesale distributors, and retail shops. Some laboratories of provincial health bureaus are very sophisticated in analyzing the iodine content of salt.[b]

The most common source of noniodized salt is raw salt—residents in salt-producing regions or on salt hills do not buy salt. Another, less common source is industrial salt sold illegally as edible salt. Retail sales of iodized salt in Suzhou fell when noniodized industrial salt from neighboring Shanghai was sold fraudulently as edible iodized salt. Interprovincial smuggling is another source of noniodized salt. Retail prices for iodized salt are uniform within a province but not between provinces, and this differential encourages smuggling. A complete list of retail prices is not available, but the few available prices from the China National Salt Industry Corporation show that retail prices in Shandong Province are 85 feng compared to 120 feng in neighboring Jiangsu. It would be useful for the China National Salt Industry Corporation to examine retail prices among neighboring provinces to eliminate any arbitrage opportunity.

a. Provincial salt companies and the China National Salt Industry Corporation are electronically linked with data exchanged periodically. Officials from the provincial companies and the headquarters convene about 12 times a year. Most meetings are discussions at working level; only a couple involve high-level policy-oriented dialogue.
b. An example is the Hubei Provincial Anti-epidemic and Sanitation Station. Its researchers have received a patent for a user-friendly test kit to analyze urinary iodine content and a national award for a semiquantitative test kit to analyze the iodine content in salt. Such test kits have simplified village-level fieldwork in the province (Liu and others 1999).
Source: Interviews with China National Salt Industry Corporation authorities and their provincial counterparts.

Coverage of iodized salt at the household level in 26 provinces, autonomous regions, and municipalities (with the exception of Fujian, Qinghai, Xinjiang, and Xizang [Tibet]) reached over 85 percent in 1999. Eighteen of the provinces showed

Table 1. Main Indicators of Iodine Status in China, 1995, 1997, and 1999

Indicators	1995	1997	1999
Iodized salt			
National mean coverage (percentage)	80.2	90.2	93.9
Percentage of qualified iodized salt samples			
With iodine level ≥ 20 parts per million	39.9	81.1	88.9
With iodine level 20–60 parts per million	29.7	69.0	80.6
Iodine level in parts per million for median households	16.2	37.0	42.3
Iodine content in urinary excretion among school children age 8–10			
Average levels in micrograms per liter	164.8	330.2	306.0
Percentage with iodine content < 50 micrograms per liter	13.3	3.5	3.3
Number of provinces with a median level of iodine < 100 micrograms per liter	5	1	1
Total goiter rates among school children age 8–10			
Percentage tested by palpation	20.4	10.9	8.8
Percentage tested with B-ultrasound	—	9.6	8.0
Percentage with grade 2 goiter	2.1	0.5	0.3

— not available.
Note: A healthy population's median value of urinary iodine is 100–200 micrograms per liter.
Source: National IDD Surveys of 1995, 1997, and 1999, analyzed and prepared by the Chinese Research Center for Disease Control (China, Ministry of Health 1999, table 27).

over 95 percent coverage. Iodine deficiency status, as measured by proportions of school children 8–10 years old with enlarged thyroids or low levels of urinary iodine, was found to be highly correlated with coverage of iodized salt in the vicinity. Evidence in China echoes findings elsewhere that iodine deficiency disappears when iodized salt reaches the population.

Progress in Reducing Iodine Deficiency Disorders in Indonesia

In Indonesia salt iodination began under Dutch rule in 1927 but ceased in 1945, when the salt monopoly was disbanded. Efforts to combat iodine deficiency began again in 1976 with UNICEF support, but progress was limited for three reasons. First, information on the iodine status of the population was not widely available. Second, responsibility and accountability for enforcement were unclear within the government. Third, there was no mechanism for coordination among involved ministries and the private sector (see box 2). The Indonesian government resumed a nationwide IDD control program in the mid-1990s with the assistance of the Bank, UNICEF, and other agencies. The goal of the Bank-financed project is to reduce the prevalence of IDD through monitoring the iodine status of the population, increasing the supply and consumption of iodized salt, and improving intersectoral coordination. Progress has been slower than expected because of unresolved problems of poor accountability and

weak enforcement. Moreover, the 1997–99 financial crisis in the region caused economic and political turmoil in Indonesia that still affects much of the country.

National coverage of iodized salt (> 5 parts per million) at household level increased from 78.2 percent in 1995 to 81.5 percent in 1999, while coverage of qualified iodized salt (30–80 parts per million) rose from 50 percent in 1996 to 63.6 percent in 1999 (table 2). Total goiter rates fell from 37.2 percent in 1980–82 to 9.8 percent in 1996–98 (table 3). It is important to note that the three rounds of surveys on goiter prevalence are not perfectly compatible, and the information is at best a rough comparison. During 1996–98 about 8.4 percent of Indonesian subdistricts (with 8.8 million inhabitants) were still classified as severely endemic (table 4). A test of school children in 1999 found that 23 percent had urinary iodine levels of less than 100 micrograms per liter.[14] It is unclear whether reduced goiter prevalence is primarily a result of supplementation with iodized oil capsules or improved coverage of qualified iodized salt.[15]

Box 2. The Salt Industry in Indonesia

The state-owned PT Garam produces 20 percent of all Indonesia's salt, and more than 25,000 small salt farmers produce the rest. Until 1996 a 25 percent tariff was levied on imported salt for human consumption; the tariff will be reduced to 10 percent by 2003. There was also a floor price for small producers until 1992. A large national stock resulted, amounting to 1 million tons by the time the price support was eliminated.

Salt production is concentrated in Java island, South Sulawesi, Madura, and Nusa Tenggara Timor. Small salt farmers produce their salt from solar evaporation of seawater during the dry season between July and December. Production technology is basic, and salt yields are low. Returns to salt production are much lower than those in other agricultural activities and lower than the wages of the unskilled. Small farmers usually sell to traders (middlemen) who then resell the salt to processors for iodination and packaging.

Salt processing is also concentrated in Java, with limited capacity in other provinces. Of about 300 enterprises, 11 account for half of the total capacity. Many larger enterprises also purchase their raw salt overseas when local salt is of poor quality as a result of long rainy seasons. Compliance with iodination is problematic among smaller enterprises, as they lack financial and technical resources.

Monitoring of iodine levels in salt is done by the Ministry of Trade and Industry and the Ministry of Health. Information sharing between the two ministries is infrequent. Processors change their packaging and brand names frequently to evade iodination. There has been little enforcement at the local level, and very little ministry direction. Legislation is in place to cancel processors' licenses after three warnings, but effective enforcement is absent. Because of the low profitability of salt production, salt farmers sell raw noniodized salt, albeit illegally, in the market. Direct sale is a more attractive alternative because the middleman margin is eliminated and payment is immediate. Direct assistance to ameliorate the liquidity and profitability problems of the salt farmers and effective enforcement will be necessary to keep noniodized salt from reaching the market.

Table 2. Coverage of Iodized Salt in Indonesia, 1995–99

Indicators	1995	1996	1997	1998	1999
Percentage of households consuming iodized salt (> 5 parts per million)	78.2	83.5	85.1	80.3	81.5
Percentage of households consuming qualified iodized salt (30–80 parts per million)	49.8	58.1	62.1	65.2	63.6

Source: National Household Surveys (SUSENAS) 1995–99, analyzed in Indonesia, Statistics Bureau (1998, 1999).

Table 3. Indicators of Iodine Status in Indonesia, 1998

Indicators	1980–82	1990	1996–98
Total goiter rates (by palpation) among school children age 6–12 (percentage)	37.2	27.7	9.8
Urinary iodine content among pregnant women			
Average of provinces' median levels in micrograms per liter[a]	—	—	161.32
Percentage of provinces with first quartile of urinary iodine content < 50 micrograms per liter	—	—	21
Percentage of provinces with first quartile of urinary iodine content < 100 micrograms per liter	—	—	33
Percentage of provinces with median urinary iodine content < 100 micrograms per liter	—	—	21

— not available.
a. The median value of urinary iodine in a healthy population is 100–200 micrograms per liter. National median or average levels of urinary iodine levels were not calculated. The average of provinces' median was calculated by averaging all provinces' median levels of urinary iodine. This estimate, albeit crude, attempts to provide an overall picture of the situation.
Note: Only the 1996–98 survey is nationally representative. The sampling framework for surveys in 1980–82 and 1990 might produce an upward bias in the national estimates. The three surveys are not perfectly compatible, and information provided is at best a rough comparison.
Source: Indonesia, Ministry of Health 1998a.

Table 4. Proportion of Subdistricts Categorized by Prevalence of Goiter in Indonesia, 1996–98

Degree of severity based on total goiter rates (by palpation) among school children age 7–12 in 1999	Number of subdistricts	Percentage
Severe (> 30 percent total goiter rates)	334	8.4
Moderate (20–30 percent total goiter rates)	278	7.0
Mild (5–19 percent total goiter rates)	1,167	29.9
Non endemic (< 5 percent total goiter rates)	2,184	54.7
Total subdistricts	3,963	100.0

Note: The total number of school children surveyed was 1.2 million.
Source: Indonesia, Ministry of Health 1998a.

Progress in Reducing Iodine Deficiency Disorders in Madagascar

The Malagasy diet consists mainly of rice, with little iodine-rich seafood eaten by any but the inhabitants of coastal areas. The population in the highlands gets little benefit from iodine in the soil, which is depleted by frequent flooding; their condition is exacerbated by high consumption of goitrogenous cassava, particularly among the poorest communities. A 1992 survey on goiter prevalence showed that 25 percent of

the population lived in areas with total goiter rates above 30 percent. Seven sentinel sites have since been established to monitor goiter prevalence.[16] The Bank's Food Security and Community Nutrition Project (1993–98) financed $1 million of Madagascar's $1.62 million national program of IDD control. UNICEF and the Nutrition Services of the Ministry of Health designed and implemented the program.

Indicators collected at sentinel sites show national progress in controlling IDD between 1992 and 1999 (table 5). Coverage of iodized salt (>5 parts per million) at the household level increased from zero in 1992 to 98.3 percent in 1999 (see box 3). Levels of urinary iodine in children have also risen: the proportion of children with less than 50 micrograms per liter of urinary iodine fell from 70.7 percent to zero. Total goiter rates among primary school children declined from 45.1 percent to 7.1 percent during this period.

Table 5. National Progress in Control of Iodine Deficiency Disorder in Madagascar, 1992–99

Indicators	1992	1995	1996	1997	1998	1999
Coverage of iodized salt (percentage) at household level	0.0	0.0	83.1	92.0	96.6	98.3
Level of urinary iodine in school children 6–12 years old						
Average (micrograms per liter)	41.5	74.1	170.3	160.0	— [a]	— [a]
Median (micrograms per liter)	—	70.2	161.2	148.3	156.8	— [b]
Percentage with < 20 micrograms per liter	16.0	5.0	0.9	0.7	0.0	— [b]
Percentage with < 50 micrograms per liter	70.7	25.8	3.8	0.7	0.0	— [b]
Percentage with >100 micrograms per liter	0.0	23.8	78.8	85.7	91.2	— [b]
Total goiter rates by palpation (percentage) of school children 6–12 years old	45.1	22.4	16.0	15.1	8.7	7.1

— not available.
a. Averages are not calculated after 1998. Instead, only the medians are reported to better reflect the distribution.
b. Data on urinary iodine content for 1999 were sent to the Division of Nutrition Services in Antananarivo in early 2000, and analysis was not yet available as of April 2000.
Note: Nationwide salt iodination began in 1995, and iodized salt reached the market by December 1995. A healthy population's median value of urinary iodine is 100–200 micrograms per liter.
Source: Madagascar, Ministry of Health 1998, 2000a; Lantum 1998.

Achieving and Sustaining Salt Iodination

While salt iodination is technically straightforward, its large-scale implementation often involves political, administrative, technical, and sociocultural changes. IDD awareness that creates demand for iodized salt, together with enforcement and compliance in the entire salt sector are essential for successful and sustainable salt iodination. Once is established, prevents recurrence and virtually eliminates iodine deficiency.

Awareness of Iodine Deficiency Disorders

In many countries goiter is accepted as normal. Uninformed consumers who resist change hinder the elimination of IDD. Because health workers and decisionmakers may also lack awareness of iodine deficiency disorders, communication planning must target not only consumers but also policymakers to ensure budgetary

Box 3. Salt Iodination in Madagascar

In Madagascar local production of salt is sufficient for nationwide consumption. La Compagnie Salinière de Madagascar (Madagascar Salt Company) in Antsiranana Province, partially owned by the government, produces over 40 percent of total local salt. Some 35 percent is supplied by four medium-size enterprises in Toliary Province, and multiple small producers in Toliary provide the remainder.

The national IDD control program has held training and educational workshops for salt producers, provided potassium iodate solution free of charge until 2000, and leases iodizing equipment to all producers. While each large and medium-size producer receives individual iodizing units, small producers are grouped into teams by location to share seven units. Classic free-rider problems occur when the communal iodizing equipment breaks down.

Compliance of large and medium-size enterprises with iodination has contributed to the high coverage of iodized salt in Madagascar. Coordination and dissemination have been facilitated by the consolidation of all data collection and analysis, iodine laboratories, epidemiological surveillance, and impact monitoring under the Nutrition Services Division of the Ministry of Health. The Ministry of Health and Ministry of Commerce participate in monitoring and enforcement.

La Compagnie Salinière and some of the medium-size enterprises (for example, Ifaty) export salt to the African continent. They are competitors in international and local markets. Although la Compagnie Salinière is the only producer with an in-house laboratory to monitor the iodizing process, medium-size enterprises have incentives to produce quality iodized salt to protect their market share. Large and medium-size enterprises voluntarily comply, but their small number also facilitates government monitoring. In contrast, most of the numerous small producers in Toliary, scattered in the vast southwest coastal area, do not produce salt regularly. Their salt is often wet, dirty, and noniodized. They sell at a much lower price to distributors and have no incentives to use or repair their communal iodizing equipment.[a] The prevalence of inadequately iodized salt threatens national efforts to eliminate IDD—much of Toliary's poorly iodized salt is sold in goiter-endemic highland regions.

a. A national maintenance workshop is in charge of repairing iodizing equipment but is not usually responsive.
Source: Discussions and interviews with government officials and those involved in the salt industry, Madagascar.

commitment and opinion leaders (village elders, religious heads, schoolteachers, political party workers) who can persuade others to embrace an IDD program. Informed consumers who demand iodized salt will become a self-sustaining force.

High-level political commitment in China initiated the iodination program and sustained its momentum. Health officials and the salt industry have intensively promoted public awareness of IDD through many channels, from advertisements on public buses to editorials in newspapers. In Madagascar the Ministry of Commerce and Ministry of Health publicize their "check-and-seize" operations to confiscate noniodized salt, as well as conducting standard information campaigns.[17]

In China awareness of IDD among provincial governors has led to prompt action. When Guangxi Province changed its governor, commitment to IDD control in remote villages lapsed. Direct sale of iodized salt to remote villages stopped, and indicators of iodine deficiency deteriorated. However, after the new governor was informed, efforts resumed, and the situation reversed. Smuggling of (noniodized)

salt was rampant in bordering counties in Shandong, Henan, and Hebei Provinces. These areas are designated economic development zones, and local governments tend to adopt a laissez-faire attitude. But publicity by salt officials in television and newspapers has motivated local governments to act to deter smuggling.

In contrast, mobilization of local government to support IDD control in Indonesia has been limited, and the interest of leaders is generally lukewarm. Accountability and responsibility for enforcement are unclear among central ministries and provincial and local government. One approach to address recalcitrant and unabated incidence of IDD is to seek commitment directly from district heads (*bupatis*) with appropriate information, education, and communication strategies targeting this group. Another is to involve mosques, schools, and communal nongovernmental organizations (NGOs) in monitoring salt, using low-cost field test kits to increase awareness and community participation.

Access to Iodized Salt

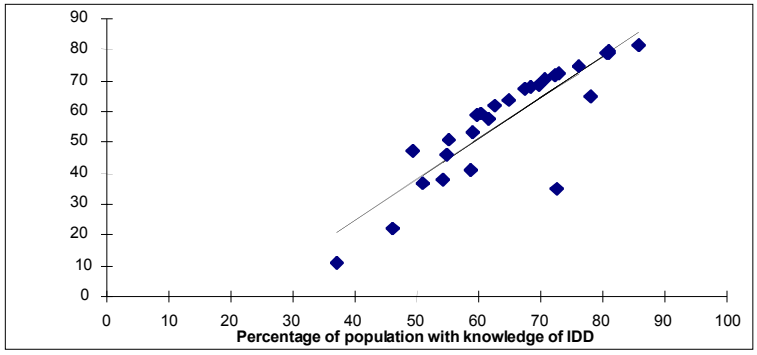
Despite its importance, public awareness will be futile if adequately iodized salt is not readily available. About 40 percent of rural households in Indonesia have cited the nonavailability of iodized salt in grocery shops as their reasons for consuming noniodized salt, while only 14 percent have cited price as a factor (Indonesia Statistics Bureau 1999). In Indonesia the correlation between IDD knowledge and willingness to purchase iodized salt (figure 1) is significantly positive at 0.87 (standard error of 0.09). However, the public is not necessarily more aware of IDD in provinces with high coverage of iodized salt. In provinces with coverage of over 80 percent, the proportion of population with knowledge of IDD ranges from 49 to 81 percent (figure 2).[18]

Similarly, there is no statistically significantly correlation between public awareness of IDD and iodized salt coverage in China (figure 3). The average scores on knowledge of IDD range between 72 and 92 for provinces with high coverage (over 85 percent) and between 71 and 94 for provinces with low coverage (less than 85 percent). Such findings indicate that knowledge of IDD that creates demand for iodized salt is a necessary but not sufficient condition to ensure consumption of iodized salt. A reliable supply of iodized salt is equally critical. The importance of access to and availability of iodized salt is illustrated by the Lhasa example. In 1998 the Chinese government established a salt factory near Lhasa, Xizang Province (Tibet) to address the problem of delivering salt from coastal producers to the inland province. Iodine status in the greater Lhasa area improved significantly (National Household Survey 1999).

Compliance with Iodination

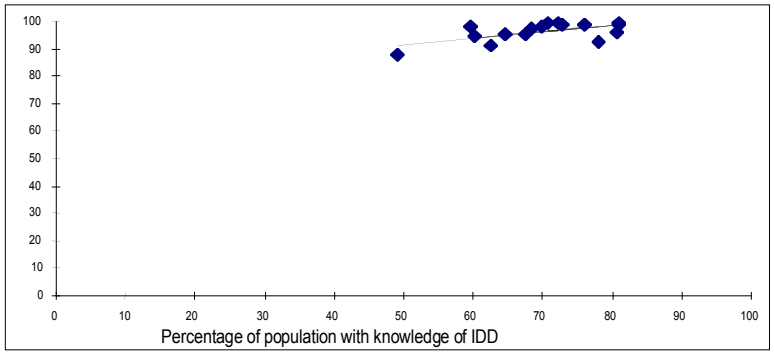
To ensure effective iodination and distribution of iodized salt within the limits of public resources and capacity in developing countries, governments must align incentives with the self-interests of the salt industry and consumers at the appropriate levels—production, distribution, or retail sales—so that they will willingly police one another. In many cases government persuasion and direct assistance may be necessary to motivate the salt industry to cooperate and comply with iodination.

Figure 1. Correlation between Knowledge of IDD and Willingness to Purchase Iodized Salt in Indonesia, 1999



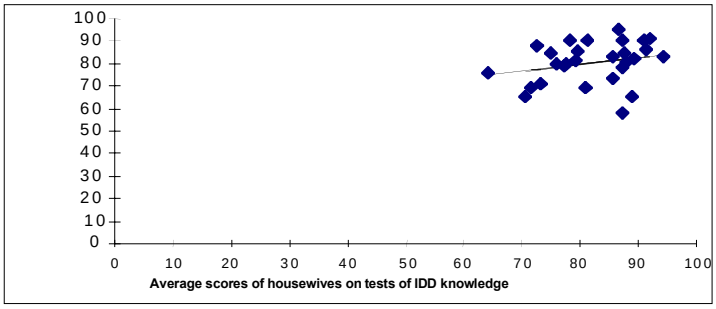
Note: The y axis represents percentage of population who say they use iodized salt.
Source: Indonesia Statistics Bureau 1999.

Figure 2. Correlation between Knowledge of IDD and Coverage of Iodized Salt in Indonesia, 1999



Note: The y axis represents percentage of population covered by iodized salt. Data covers provinces with coverage > 80 percent in Indonesia. Correlation coefficient = 0.15 (standard error = 0.14).
Source: Indonesia Statistics Bureau 1999.

Figure 3. Correlation between Knowledge of IDD and Coverage of Iodized Salt in China, 1999



Note: The y axis represents percentage of population covered by iodized salt (20–60 parts per million).
Covers all provinces, autonomous regions, and municipalities except Xizang (Tibet) (coverage = 28 percent; score = 54), Hainan (coverage = 38 percent; score = 65), and Qinghai (coverage = 55 percent; score = 45). Correlation coefficient = 0.31 (standard error = 0.22).
Source: China, Ministry of Health 1999.

In China effective formal enforcement and the monopolistic structure of the salt industry create additional incentives for wholesale distributors to police and uproot unauthorized salt. In provinces such as Fujian, Guangdong, and Liaoning, where many local residents produce sea salt of variable quality, the China National Salt Industry Corporation facilitates the sale of raw salt to larger salt plants and refinement centers for iodination. Such support to small licensed producers is an attempt to reduce noniodized salt in the market.[19]

In Madagascar authorities may need to consider shifting their focus from noncompliant small salt producers to distributors. Small salt producers are numerous, elusive, and uncontrollable, whereas distributors are few and more manageable. Since all salt producers sell through the wholesale channel, authorities can provide disincentives (confiscation or fines) to discourage wholesale distributors from purchasing noniodized salt. Distributors' demand for iodized salt may be effective in motivating salt producers to iodize.

In Indonesia noniodized salt comes from salt farmers who sell raw noniodized salt to grocers or consumers[20] and from salt processing plants that do not comply with the iodination requirement.[21] Enforcement at the retail level is crucial since 30 percent of the population buys salt from the wet market and 60 percent from grocery stores.[22] The government could impose disincentives on grocery stores to deter them from selling noniodized salt. Similarly, salt farmers must be discouraged from peddling their raw noniodized salt in the market.

The Indonesian government may need to provide assistance as well as penalties. First, the Ministry of Industry may need to extend technical and financial assistance to processing plants to facilitate their compliance with iodination. Second, problems of liquidity constraint faced by salt farmers must be addressed. Raw salt is sold, usually on credit, through intermediaries to processing plants. Hence, cash-constrained salt farmers with a tight profit margin prefer to peddle their raw salt, albeit illegally, in the market. If authorities can intervene to improve farmers' terms of trade with SNI-certified salt processing plants through moral suasion or subsidies in iodide for processing plants, salt farmers may have greater incentives to sell to them.

Grouping Indonesian salt farmers into cooperatives may help strengthen their bargaining position; moreover, microcredit can be extended through the cooperatives to ease salt farmers' liquidity constraint before salt harvest. Conditions for microcredit can stipulate that salt can serve as collateral and provide incentives for members to monitor one another on repayment. However, a careful study must be undertaken before proceeding with a microcredit program, as potential benefits can be nullified by weak enforcement.

Enforcement

Besides aligning incentives to promote compliance, governments need to monitor the salt industry closely. Many countries have legislation on mandatory salt iodination,

but enforcement is more critical than the legislation on paper. Because consumers cannot easily distinguish between noniodized and iodized salt, the government must strictly enforce appropriate iodination of salt sold to the public. Successful programs maintain frequent testing of iodine content at production sites and periodic testing at intermediate points in the distribution network, retail outlets, and households, as well as effective enforcement.[23]

In China the salt industry has a comprehensive internal surveillance system at all manufacturing stages, while health officials make regular visits to producers, distributors, retailers, and households to examine salt samples. The provincial governments of Hunan and Tianjin reimburse their health bureaus for carrying out tests on salt samples. In other provinces testing of salt samples is either financed solely by the salt industry or shared between the industry and the health sector.

In Indonesia the Bank has financed monitoring activities at the production, market, and household levels, but there have been no follow-up corrective actions.[24] Much data have been collected since 1996, but because of inconsistent sampling, very little analysis has been done. Available data in provinces of Java and Bali islands indicate that coverage of iodized salt did not improve much between 1997 and 1998 (figure 4). Except in a few *kabupatens* (districts), proportions of salt with adequate iodine have fallen while those with no iodine have risen. In all but one kabupaten of East Java (with consistent data), the proportions of noniodized salt sold at market level rose between 1998 and 2000 (table 6).[25]

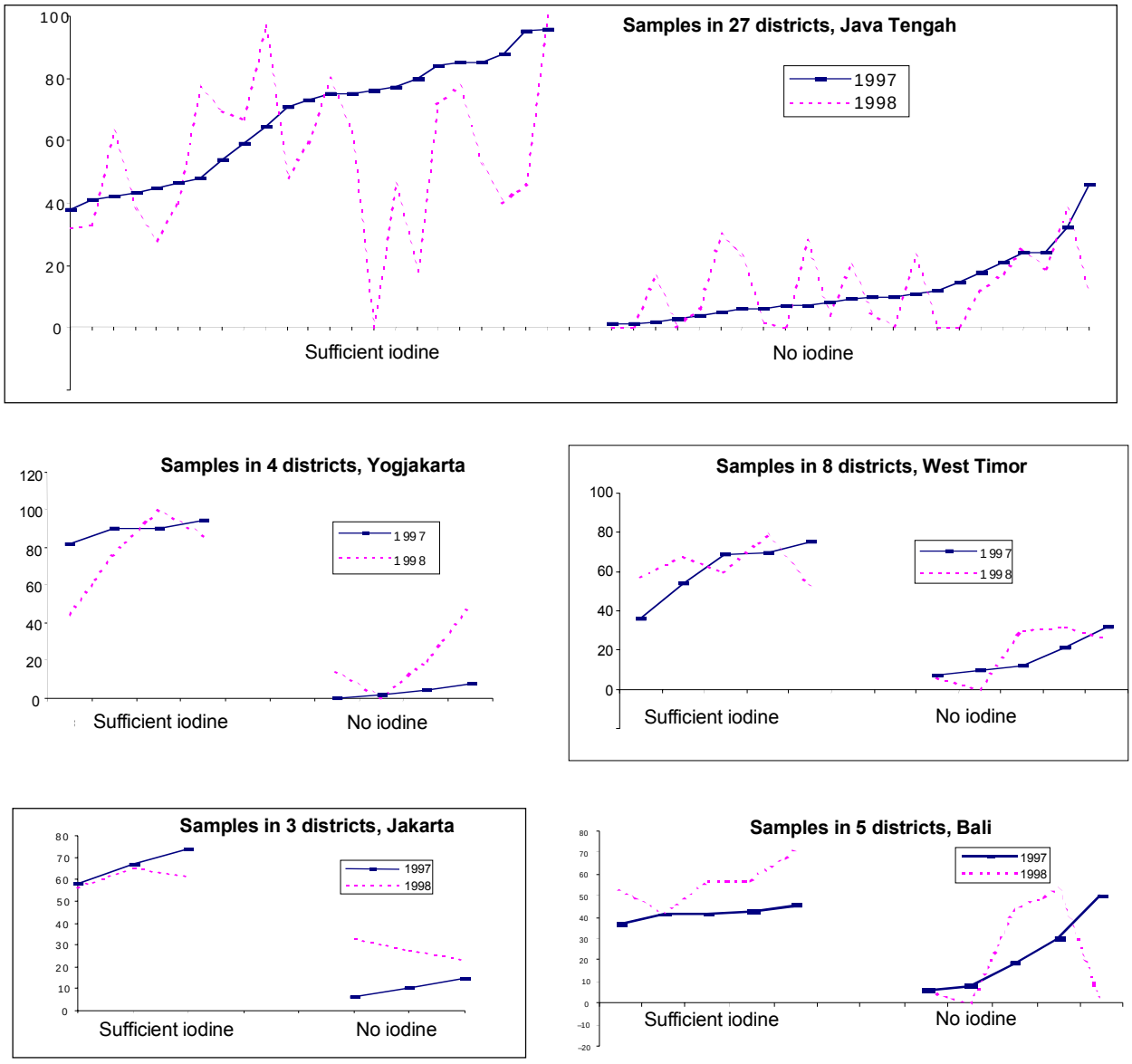
Table 6. Percentage of Noniodized Salt Sold in the Market in Five Districts in East Java, Indonesia, 1998–2000

District	1998	1999	2000
Magetan	7.6	11.5	20.1
Mokokerto	5.5	2.2	0.6
Madiun	10.6	11.6	6.3
Kediri	3.5	4.9	5.0
Pacitan	0.9	2.2	7.0

Source: Pemeriksaan Obat dan Makanan 1998–2000.

Monitoring systems must also include rapid analysis and dissemination of data to inform authorities of necessary corrective actions. In China data and analysis on monitoring activities and progress are undertaken by the Technical Center of International Cooperation Program on IDD of the Ministry of Health. In Madagascar the Division of Nutrition Services of the Ministry of Health has sole responsibility for overseeing iodine laboratories and monitoring iodine status. In contrast, dissemination of information is slow in Indonesia. Several agencies are charged with monitoring at various levels, and all information is sent to another agency to be processed. Inconsistency and incompatibility of data further complicate analysis and dissemination.

Figure 4. Percentage of Salt Samples Containing No Iodine or Sufficient Iodine in Various Regions of Indonesia, January–March 1997 and January–March 1998



Note: The y axis represents percentage of salt samples.
Source: Data for 1997 are from salt samples taken at household level; data for 1998 are from salt samples taken at market-retail level.

Quality Control

Quality control is important in salt iodination. Monitoring iodine content not only ensures adequacy of iodine intake but prevents hyperthyroidism that can be triggered by excessive iodine intake after prolonged deficiency. The following regression analysis highlights the importance of quality control in reducing IDD.

Regressions on China's 31 provinces, autonomous regions, and municipalities in 1995, 1997, and 1999 were estimated to analyze impacts of iodized salt coverage and salt quality on total goiter rates. Robust standard errors were calculated in the regressions to reflect correlated cluster effects of states between years. Total goiter rates consisted of goiter of grades 1 and 2. The median value of iodine content (in parts per million) in the samples measures salt quality. Two indicators for iodized salt coverage are used: percentage of salt within the qualified range of 20–60 parts per million and percentage of salt with at least 5 parts per million iodine. The latter indicator is used in most countries to quantify coverage. A percentage increase in coverage reduces total goiter rates by 18–20 percent, but when the quality proxy (iodine content in salt) is included in the regression, the effect of coverage of iodized salt on total goiter rates falls (table 7). Thus, the iodine content—not merely the presence of iodine—in salt significantly affects reduction of IDD.

Weak quality control in iodination programs in Madagascar risks reversing progress made so far.[26] Control of iodine content in salt has been poor. The coverage of iodized salt is almost universal, but iodine content in salt varies widely. Barely half of salt samples fall within the qualified interval of 30–60 parts per million iodine (table 8). For example, the minimal iodine content in samples in Antananarivo is only 7.4 parts per million, whereas the maximum reaches 209 parts per million. As the only plant with internal quality-control units in Madagascar, la Compagnie Salinière de Madagascar has supplied its home province of Antsiranana with salt of more consistent quality. Its salt samples were well confined within the interval of 27–48 parts per million of iodine.

Intervention in Problematic Areas

When national coverage of iodized salt reaches over 90 percent, monitoring and enforcement are generally effective. Remaining problems often lie in pockets of poverty in remote areas where access is difficult and the population is uninformed.

Non-Salt-Producing Remote Areas

Through direct sale iodized salt can still reach the population as long as raw salt is not readily available. In China several provinces—Guangxi, Hebei, and Shandong—have been effective in convincing inhabitants in mountainous areas to purchase iodized salt directly delivered to their villages. However, in provinces where local authorities were not committed, wholesalers were unable to collect payment for their shipment, and delivery ceased. In Indonesia, too, many remote villages have little access to iodized salt. Intervention of subdistrict heads on direct sale of iodized salt through local NGOs such as the Persatuan Kesejahteraan Keluarga (Women's Welfare Organization) or Nahdlatul Ulama (Organization of Religious Leaders) will be necessary to counter this deficiency.

Table 7. Impacts of Iodized Salt Coverage and Quality of Salt on Total Goiter Rates in China, 1995–99

Independent variables	Regression used: total goiter rate$_{it}$ = $\__0$ + $\__1$ (coverage of iodized salt)$_{it}$ + $\__{it}$	Regression used: Total goiter rate$_{it}$ = $\__0$ + $\__1$ (coverage of iodized salt)$_{it}$ + $\__2$ (quality of iodized salt)$_{it}$ + $\__{it}$
Coverage (percentage) of iodized salt with 20–60 parts per million iodate	–0.199	–0.098
	[0.038]	[0.048]
Quality of salt samples measured by the median parts per million of iodate.	—	–0.251
		[0.106]
Total number of observations	82	82
Total number of provinces	31	31
R^2	0.2408	0.2856
Coverage (percentage)of iodized salt with ≥ 5 parts per million iodate	–0.178	–0.110
	[0.069]	[0.069]
Quality of salt samples measured by the median parts per million of iodate	—	–0.194
		[0.119]
Total number of observations	60	60
Total number of provinces	31	31
R^2	0.2000	0.2357

— not available.
Note: The regression used is total goiter rate$_{it}$ = $\__0$ + $\__1$ (coverage of iodized salt)$_{it}$ + $\__2$ (quality of iodized salt)$_{it}$ + $\__{it}$
Robust standard errors are below the reported coefficients estimates in square brackets. The data is reproduced in the annex. Standard errors are robust, reflecting the correlation corrected for states between years. The quality of iodized salt is defined as the median parts per million of iodate in salt samples for that province. Because the coverage of iodized salt with ≥ 5 parts per million iodine was not reported in 1995, in the second panel of the regressions only 1997 and 1999 are used.
Source: China, Ministry of Health 1999.

Table 8. Quality Indicators of Iodized Salt in Various Provinces of Madagascar, 1998

Indicators	Antananarivo	Toliary	Fianarantsoa	Toamasina	Antsiranana	Mahajanga
Percentage of salt samples[a] tested (+) of iodine, by field test kits	94.8	85.2	93.5	96.5	98.6	99.7
Percentage of salt samples[b] with 30–60 parts per million iodine, by titration at laboratory	58.9	33.3	55.9	35.0	80.0	—
Number of salt samples with						
Minimum level of iodine (parts per million)	7.4	1.9	11.1	18.7	27.4	20.63
Maximum level of iodine (parts per million)	209.9	35.4	55.5	66.5	48.1	69.83
Mean iodine level (parts per million)	46.9	21.3	30.3	29.5	35.8	26.54

— not available.
a. Salt samples are collected monthly from school children in sentinel sites by District Nutrition Services Division.
b. Salt samples are collected by officials at the Ministry of Health laboratories several times a year. Laboratories in the provinces of Antsiranana and Mahajanga were recently (1999) established, and there has been no data yet from the laboratory of Mahajanga.
c. Though there is no data for the entire province of Mahajanga, information in this column is obtained from salt samples at marketplace in Bealanana in Mahajanga.
Source: Madagascar, Ministry of Health 1998.

Salt-Producing Regions

In regions where raw salt is readily available, the direct sale approach often breaks down. In China inhabitants with easy access to salt hills, dehydrated salt lakes (as in Xinjiang), or sea salt (as in Jiangsu) refuse to pay for salt. However, officials have found that inhabitants of salt mountains in Xinjiang purchase refined salt in the market but consider refined salt a superior product and use it solely to pickle vegetable and meat. In Indonesia noniodized salt is readily available at household level in salt-producing provinces, ranging from 23 percent of households in East Java to 48 percent in South Sulawesi in 1999.[27] At market level half the salt sold in salt-producing provinces bears no trademark or company name on the packaging.[28] In such cases enforcement must be strengthened.

In areas where the population is unreceptive to the benefits of iodized salt, authorities must identify reasons for not consuming iodized salt and formulate alternative remedies accordingly. Do people use noniodized salt out of habit and tradition? Is the price of iodized salt a deterrent when raw salt is easily available? Are people unaware of IDD? In some cases increasing public awareness may be sufficient to address the problems, but in others iodizing well water or water for irrigation may be a more effective way to deliver iodine to the population. Alternatively, distribution of oil capsules or injection of time-release iodine oil every few years to a nomadic population in remote areas may be the solution.

Conclusion

Of the three programs examined in this study, those in China and Madagascar had clearly positive outcomes. That in Indonesia did not. While the Bank's role in these programs was comparatively small, all three offer lessons for the Bank's involvement with micronutrient activities.

Experience in these three countries suggests that the outcome is most likely to be positive where an accountability framework and government ownership are in place. While in China and Madagascar this means a centralized approach, a decentralized approach might be equally effective if there is strong government ownership of the goals of micronutrient interventions.

Where there is a sound accountability framework, as in China and Madagascar, technical experts outside the Bank can design comprehensive programs that include the production of iodized salt, industry regulations and standards, and enforcement. As the Bank has limited in-house expertise in the technical aspects of iodination, partnerships of this sort are critical to program success. Where the accountability framework is deficient, however, as it is in Indonesia, even the best design may be unable to overcome this limitation.

The outcome of a project is also more likely to be positive where the means of production are concentrated, either under state control or through a limited number of large producers. Indonesia's problems with salt iodination are in part a consequence of the large number of small producers, which complicates the government's ability to devise an effective accountability framework.

Apart from providing critical financial resources, the Bank can be most useful by diagnosing the incentive structures in a country and working with clients and partners such as UNICEF to ensure that an effective framework is in place before financing a project. During early stages of the program, the Bank's presence can promote intersectoral dialogue and heighten top-level political attention to enhance budgetary commitment to the cause. Once a project is under way, supervision should pay attention to the operation of the accountability system and other incentives. This is particularly critical for micronutrient components of larger projects.

Although this study focuses narrowly on salt iodination, recommendations from IDD experiences may be more broadly applied to other food fortification programs. When food fortification is chosen as the strategy to address micronutrient deficiencies, issues related to encouraging acceptance of fortified food on the demand side and motivating the industry involved on the supply side are similar to those in salt iodination. Because information is generally asymmetric in food fortification (that is, consumers cannot easily differentiate between fortified and nonfortified goods), commodities with few producers should preferably be considered as vehicles

to deliver micronutrients. Dealing with an industry with few producers will facilitate the government's role in monitoring and enforcement immensely.

The main conclusions of this analysis of combating iodine deficiency in three countries with Bank assistance can be summarized as follows:

- *Iodized salt is an effective means to eliminate IDD.* The case studies reaffirm findings elsewhere that consumption of iodized salt eliminates iodine deficiency disorders and prevents recurrence.
- *Factors that effect a reliable supply of iodized salt are as important as those that create the demand for iodized salt.* Public awareness of IDD that creates continuous demand for iodized salt is an important force to sustain elimination of iodine deficiency. However, without a reliable supply of iodized salt that is easily available to the population, demand will be ineffectual.
- *Enforcement is of paramount importance to the success and sustainability of salt iodination*. Where market failure has made it impossible for informed consumers to distinguish readily between iodized and noniodized salt, government intervention is necessary for monitoring and enforcement. Enforcement is important because the quality of iodination matters—excessive intake of iodine may trigger hyperthyroidism in those with chronic iodine deficiency, and inadequately iodized salt is inefficient in ameliorating the iodine status of the population.
- *Incentives must be tailored to the salt industry structure to maximize compliance with salt iodination*. The nature of the intervention must be tailored to the structure of the salt industry so that proper incentives are given at appropriate levels (production, distribution, and retail) to maximize compliance with salt iodination. Persuasion and direct assistance may be necessary to motivate the industry to cooperate and to comply.

Recommendations

At the outset of any food fortification program to address micronutrient deficiencies:

- *Surveillance and enforcement mechanism must be functioning.* The Bank must ensure that accountability for program effectiveness is properly assigned, relevant local personnel are properly trained and equipped with laboratory facilities for testing and assessments, a system is established for monitoring the implementation and maintenance in laboratories (for example, salt titration), and enforcement is effective at all levels from production to distribution of fortified commodities. Monitoring systems must also include rapid analysis and dissemination of data to inform authorities of corrective actions. In this light, responsibilities pertaining to micronutrient deficiencies control (laboratories, data collection and analysis, monitoring) can be consolidated under one division of a ministry (for example, the ministry of health) to maximize effectiveness in monitoring efforts and minimize bureaucratic friction among ministries.

During later years:

- *The quality of fortified food must be ensured.* When coverage of fortified food reaches the majority of the population (for example, over 85 percent), authorities can concentrate on quality-ameliorating measures. Improving fortifying techniques and limiting losses during storage and transportation will prevent large variance in the concentration of micronutrient in fortified commodities.
- *Incentives may need to be modified to increase the compliance rate in the industry.* Besides strengthening enforcement, incentives (or disincentives) must be tuned according to industry structures and distribution networks to effect total compliance with fortification. Incentives directed at the demand and profit interests of the industry can be adjusted to ensure a reasonable level of self-policing.
- *Interventions in areas with continued deficiencies may be necessary.* Resources need to be targeted at remote areas where consumption of fortified food remains low. This can be done through direct subsidized sale of fortified food through village heads or local NGOs or through other vehicles to deliver the micronutrient. Supplementation through use of capsules or injection may also be considered as intermediate and longer-term measures.

References

Bleichrodt, N., and M. P. Born. 1994. "A Meta-analysis of Research of Iodine and Its Relationship to Cognitive Development." In J. Standbury, ed. *The Damaged Brain of Iodine Deficiency*. New York: Cognizant Communications.

China, Ministry of Health. 1999. "1999 Monitoring Report of China IDD." Preventive Disease Research Center. Paper prepared for the Fuzhou Iodine Deficiency Disorders Conference, December 17–18, Fuzhou, China.

Delange, F., and P. Lecomte. 2000. "Iodine Supplementation: Benefits Outweigh Risks." *Drug Safety* 22 (2): 89–95.

Hetzel, Basil S. 1988. "The Prevention and Control of Iodine Deficiency Disorders." Nutrition Policy Discussion Paper 3. United Nations Administrative Committee on Coordination—Subcommittee on Nutrition, Rome.

———. 1989. *The Story of Iodine Deficiency: An International Challenge in Nutrition.* New York: Oxford University Press.

Hetzel, B. S., and C. S. Pandav, eds. 1996. *S.O.S for a Billion: The Conquest of Iodine Deficiency Disorders.* New Delhi: Oxford University Press.

ICCIDD (International Council for Control of Iodine Deficiency Disorders). 2000. "The ICCIDD Report 1999." Paper presented at the 27th Session of the Subcommittee on Nutrition, April 10–14, Washington, D.C.

Indonesia, Ministry of Cooperatives. 1999. "Laporan Kegiatan Tim Pembentukan Kelompok Usaha Petani Garam." Direktorat Jenderal Bina Koperasi, Jakarta.

Indonesia, Ministry of Health. 1998a. "Survei Nasional Pemetaan Gangguan Akibat Kekurangan Yodium." Pusal Penilitian dan Pengembangan Gizi and Direktorat Bina Gizi Masyarakat, Jakarta.

———. 1998b. "Survei Nasional Pemetaan Gangguan Akibat Kekurangan Yodium." Pusat Penilitian dan Pengembangan Gizi, and Direktorat Bina Gizi Masyarakat. Jakarta.

Indonesia Statistics Bureau. 1998. "Konsumsi Garam Beryodium di Rumah Tangga." Badan Pusat Statistik and Direktorat Bina Gizi Masyarakat, Jakarta.

———. 1999. "Konsumsi Garam Beryodium di Rumah Tangga." Badan Pusat Statistik and Direktorat Bina Gizi Masyarakat, Jakarta.

Institut Teknology Bandung. 1999a. "Executive Summary of Survey on National Iodized Salt Monitoring in Indonesia." Pusat Penelitian Antar Universitas-Mikroelektronika, Bandung, Indonesia.

———. 1999b. "Laporan Round IV: Bimbingan Teknis Sistem Pemantauan Dan Rangkuman Hasil Pemantauan." Pusat Penelitian Antar Universitas-Mikroelektronika, Bandung, Indonesia.

Khorasani, S. S. M. A. 1999. "Salt Iodination in Bangladesh—Problems and a Suggestion." *Bulletin of the World Health Organization* 77 (2).

Lantum, Daniel. 1992. "Plan D'Action 1993–1999: La Lutte contre les Troubles dûs à la Carence en Iode à Madagascar." Government of Madagascar and UNICEF, Antananarivo, Madagascar.

———. 1998. "Report of Evaluation of Five Years Progress 1992–1998: National Programme for the Control of Iodine Deficiency Disorders in Madagascar." Ministry of Health, Madagascar, and OMNI/USAID, Antananarivo, Madagascar.

Latief, Dini. 1999. "Program Intensifikasi Penanggulangan Gangguan Akibat Kekurangan Yodium di Indonesia." Ministry of Health, Jakarta, Indonesia.

Liu, Liejun, Yuqin Yan, and Zhaohui Zheng. 1999. "Cold Digestion of Urine by ADA and Time-Recorded Determination of Iodine by its Catalytic Effect on the As-Ce Reaction." *Chinese Journal of Endemiology* 18 (1): 62–3.

Madagascar, Ministry of Health. 1998. "Rapport d'Activités Année 1998 du Projet des Troubles dûs à la Carence en Iode." Antananarivo.

———. 1999a. "Rapport d'Activités Année 1999 du Service de la Nutrition." Antananarivo.

———. 1999b. "Rapport Trienal 1997–1999 du Service de la Nutrition." Antananarivo.

———. 2000a. "Programme de Lutte Contre les Troubles dûs à la Carence en Iode." Antananarivo.

———. 2000b. "Rapport d'Activités 1999 du Service de la Nutrition." Antananarivo.

Mannar, M. G. Venkatesh, and John Dunn. 1994. *Salt Iodization for the Elimination of Iodine Deficiency*. Geneva: World Health Organization.

Pandav, C. S. 1996. "The Economic Benefits of the Elimination of IDD." In Hetzel, B. S. and C. S. Pandav, eds. *S.O.S. for a Billion: The Conquest of Iodine Deficiency Disorders.* New Delhi: Oxford University Press.

———. 1997. *Iodine Deficiency Disorders in Livestock: Ecology and Economics.* New Delhi: Oxford University Press.

Pemeriksaan Obat dan Makanan, Indonesia. 1999–2000. "Laporan Pelaksanaan Pemautauan Garam Beryodium di Propinsi Jawa Timur." Various issues of quarterly reports, Subabaya, Indonesia.

Sunawang. 1999. "Public Awareness and Participation in IDD Elimination Program in Indonesia." UNICEF, Jakarta.

UNICEF (United Nations Children's Fund). 1997. "Report on Iodine Deficiency Disease Elimination Project." Antananarivo, Madagascar.

———. 1999. "Salt Iodization Programmes: Strengthening Monitoring for Success." Workshop Report 21, April 23, Tagatay City, Philippines.

WHO (World Health Organization). 1991. *Global Database on Iodine Deficiency Disorders (IDD).* Geneva.

———. 1999. *Progress Towards the Elimination of Iodine Deficiency Disorders.* Department for Nutrition for Health and Development, Geneva.

WHO and UNICEF. 1994. *World Summit for Children—Mid-decade Goal: Iodine Deficiency Disorders.* Geneva.

World Bank. 1993. *World Development Report: Investing in Health.* New York: Oxford University Press for the World Bank.

———. 1999a. "Development Effectiveness in Health, Nutrition, and Population: Lessons from World Bank Experience." Report 19266, Washington, D.C.

———. 1999b. "Implementation Completion Report on Bangladesh: Fourth Health and Population Project, Credit 2259, 1991–1998." Report 19003. Washington, D.C.

Wirjatmadi, Bambang. 1997. "Pandangan Masyarakat Terhadap Kejadian GAKY di Daerah Gondok Endemik: Studi Kasus di Desa Bancar, Jawa Timur." University Airlangga, Surabaya, Indonesia.

Annex

Annex table A1. Data Used for Regressions in the Text, China

Province	State	Year	Total goiter rate of school children 8–12 years old, by palpation	Coverage: percentage of iodized salt with 20–60 parts per million iodine	Coverage: percentage of iodized salt with ≥ 5 parts per million iodine	Quality: median iodine content among iodized salt samples
Beijing	1	95	0.8	44.1		20.9
Tianjin	2	95	32.6	.		.
Hebei	3	95	12	31.1		19.5
Shanxi	4	95	10.9	72.2		29.8
Neimenggu	5	95	22.6	55.6		25.1
Liaoning	6	95	15.2	47.8		21.8
Jilin	7	95	16.2	55.2		22.7
Heilongjiang	8	95	23.2	50.5		23.3
Shanghai	9	95	1.5	.		.
Jiansu	10	95	17.4	.		.
Zhejiang	11	95	13.9	.		.
Anhui	12	95	23.5	28.4		16.4
Fujian	13	95	29	39.9		31.4
Jiangxi	14	95	40.2	.		.
Shandong	15	95	22.3	.		.
Henan	16	95	11.4	46		25.4
Hubei	17	95	11.2	47.1		20.7
Hunan	18	95	17.9	37.4		20.8
Guangdong	19	95	11.4	55.8		21.8
Guangxi	20	95	20.7	42.7		22.2
Hainan	21	95	15.2	18.9		17.8
Sichuan	22	95	37.1	.		.
Chognqing	23	95	.	.		.
Guizhou	24	95	22.5	.		.
Yunnan	25	95	18.4	61.8		24.9
Tibet	26	95	.	.		.
Shaanxi	27	95	23.9	36		18.6
Gansu	28	95	38.7	55.5		24.5
Qinghai	29	95	5.1	61.7		32
Ningxia	30	95	19	22		19
Xinjiang	31	95	43.3	44		24.8
Beijing	1	97	8.6	89	96.1	33.8
Tianjin	2	97	18.3	60.1	95.7	51
Hebei	3	97	7.1	71.2	92.3	35
Shanxi	4	97	7.6	79.3	99.6	43
Neimenggu	5	97	9.1	80.4	95.4	42.3
Liaoning	6	97	12.8	74.1	75.9	42.3
Jilin	7	97	7.5	61.5	99.3	50.8
Heilongjiang	8	97	9.2	77	98.3	39.8
Shanghai	9	97	3.9	.	.	.
Jiansu	10	97	8.3	66	92.6	46.1
Zhejiang	11	97	14.8	69.8	87.3	37.7
Anhui	12	97	11.7	77.1	98.4	40
Fujian	13	97	9.4	58.2	70.1	44
Jiangxi	14	97	8	74.3	93.8	41.1
Shandong	15	97	7.6	63.2	84	25.4
Henan	16	97	7.6	78.4	95	44.4
Hubei	17	97	6.8	80	99.4	38.5
Hunan	18	97	13.2	90.2	99.6	37
Guangdong	19	97	9.4	59.1	73.1	38.6

continued ...

Annex table A1. Data Used for Regressions in the Text, China (continued)

Province	State	Year	Total goiter rate of school children 8–12 years old, by palpation	Coverage: percentage of iodized salt with 20–60 parts per million iodine	Coverage: percentage of iodized salt with ≥ 5 parts per million iodine	Quality: median iodine content among iodized salt samples
Guangxi	20	97	14.3	80.9	99.9	41.8
Hainan	21	97	12.8	55.5	77.5	34.9
Sichuan	22	97	18.6	74.9	99.6	40.6
Chognqing	23	97	18.3	74.3	.	40.2
Guizhou	24	97	14.6	63.6	97.8	30
Yunnan	25	97	9.2	86.1	98.9	44.1
Tibet	26	97	29	6.2	19	8.5
Shaanxi	27	97	10.2	72.2	99.3	40.2
Gansu	28	97	10.6	61	99.6	40.3
Qinghai	29	97	2.4	52.8	77.8	30
Ningxia	30	97	8.6	67.7	99.7	45.5
Xinjiang	31	97	22.1	73.6	87.7	38.6
Beijing	1	99	8.7	86	96.6	42.8
Tianjin	2	99	8.6	79.8	87.8	38.7
Hebei	3	99	5.4	83	98	44.3
Shanxi	4	99	6.4	58.4	97.5	49.7
Neimenggu	5	99	6	94.8	99.2	43.4
Liaoning	6	99	8.4	90.8	94.6	43.4
Jilin	7	99	6.2	80.3	99.4	46.6
Heilongjiang	8	99	6.1	90.4	98.6	45.5
Shanghai	9	99	0.8	73.7	94.6	47.6
Jiansu	10	99	4.2	65.7	89	51.7
Zhejiang	11	99	6.3	85	95.1	41.3
Anhui	12	99	7.5	82.8	98.2	46.4
Fujian	13	99	4.2	65.1	78.8	45.5
Jiangxi	14	99	6.8	90	97.4	39.1
Shandong	15	99	13.2	79	86.8	30.7
Henan	16	99	6.9	90.1	99.4	44.4
Hubei	17	99	8.7	90.2	98.9	38.7
Hunan	18	99	4.3	85.2	98.7	46.6
Guangdong	19	99	7.5	81.3	92.2	47.6
Guangxi	20	99	6.9	82	98.8	46.6
Hainan	21	99	10.3	37.5	60.1	33.4
Sichuan	22	99	15.8	76.1	85.5	38.8
Chognqing	23	99	24	71	91.1	47.6
Guizhou	24	99	19.4	,84.5	99.7	44.4
Yunnan	25	99	7.7	87.9	98.3	41.6
Tibet	26	99	22.8	27.5	51.7	20
Shaanxi	27	99	9.6	78.3	97.3	44.4
Gansu	28	99	11.3	69.5	93	44.8
Qinghai	29	99	4.9	55	71.7	41.3
Ningxia	30	99	4.1	79.8	93.3	45.5
Xinjiang	31	99	20.9	69.3	76.4	43.5

Annex table A2. Basic Loan and Credit Data

Loan or credit number	Project name	Expected total program costs	Estimated and actual Bank disbursement (millions of dollars)	Board approval	Credit closing
CR 2756 and LN 3914	China: IDD Control Project	152.3	20	June 1995	December 2000
LN 4125	Intensified IDD Control Project	45.3	28.5	December 1996	June 2002
CR 2474	IDD component of the Food Security and Nutrition Project	1.6	1.0	March 1993	December 1998

Notes

1. Thyroxine and triiodothyronine.

2. A condition that includes gross mental retardation, deaf-mutism, short stature, and various other defects.

3. A 1994 World Health Organization (WHO) and UNICEF study reported that consumer salt containing at least 20 parts per million of iodine would ensure the minimum requirement for many domestic animals. There is no apparent risk of toxicity for any class of animals even from salt with more than 200 parts per million of iodine.

4. Salt is one of the few commodities that is universally consumed daily, regardless of income, in a small and constant amount. Mixing an iodine compound with salt produces no adverse chemical reaction, so that iodized and noniodized salt are indistinguishable. The cost of iodination is low, normally .02–.07 cents per kilogram, less than 5 percent of the retail price of salt in most countries (Mannar and Dunn 1994).

5. In provinces where the coverage of iodized salt surpasses 95 percent, supplementary iodine capsules are sold only after pregnant women are tested and found iodine deficient. In provinces where the consumption of iodized salt is less prevalent (< 95 percent), pregnant women can purchase iodine capsules during prenatal checkups without being tested.

6. Nutrition issues were neglected in some countries but well supported in others. Reasons noted include lack of attention to nutrition across portfolios at the country level, relatively few nutrition staff, and the difficulty of integrating multisectoral aspects of nutrition programs into standard health investments.

7. The following projects continue to support mostly iodized oil capsule supplementation: Bangladesh: Fourth Health and Population Project, Credit 2259 (1991–98); Bangladesh: Integrated Nutrition Project (1995–2002); Benin: Health and Population Project (1995–2001); Burkina Faso: Health and Nutrition Project (1994–2000); and Mauritania: Nutrition, Food Security and Social Mobilization Project (1999–2001).

8. Values between 50 and 99 micrograms per liter suggest mild iodine deficiency, values of 20–49 micrograms per liter indicate moderate iodine deficiency, and values below 20 micrograms per liter indicate severe deficiency.

9. Ultrasonography is more precise and objective, especially for small goiters. Goiters are graded, with grade 0 not palpable or visible, grade 1 a mass in the neck that is invisible when the neck is in normal position, and grade 2 a visible swelling in the neck.

10. All amounts are in U.S. dollars unless otherwise indicated.

11. United Nations partners involved were the World Health Organization, the United Nations Development Programme, the United Nations Children's Fund, and the United Nations Industrial Development Organization.

12. The project was implemented by the China National Salt Industry Corporation, provincial salt authorities, and individual salt enterprises.

13. Activities included health education, mobilization of community and leadership support, and development of effective monitoring and surveillance. Progress was assessed by three national surveys, in 1995, 1997, and 1999.

14. About 33 percent had 100–200 micrograms per liter of ordinary iodine, and 44 percent had over 200 micrograms per liter. This information is taken from the ThyroMobil Surveys of 29 countries. The survey in Indonesia was conducted by Djokomoeljanto. Part of the summary findings from the ThyroMobil Surveys were reported in ICCIDD (2000).

15. The most recent survey (1998) indicates that oil capsule coverage of pregnant women in 76 percent of districts was less than 20 percent, and over 50 percent in only 3 percent of districts (Indonesia, Ministry of Health 1998, p. 30).

16. Betroka (Toliary), Belazao and Ambohidratrimo (Antananarivo), Fandriana (Finanrantsoa), Ranomafana-Est (Toamasina), Bealanana (Mahajanga), and Maroabihy-Est (Antsiranana). These sites collect samples of salt and urine from primary school children and send them to be tested in the capital once a year. Four of the six provinces (Toliary, Antananarivo, Toamasina, and Finanrantsoa) also have Ministry of Health laboratories to test salt samples from production sites; by the end of 2000 laboratories will be set up in the other two.

17. Similarly, government commitment and the use of radio, television, traditional drama, teachers, and village health volunteers were effective in reducing the prevalence of IDD in Ecuador and Bolivia.

18. Sunawang (1999) also finds no correlation between the population's knowledge of IDD and coverage of qualified iodized salt (30–60 parts per million) in provinces with > 85 percent coverage.

19. The Ecuadorian government tries to maintain a good relationship with producers through annual information and motivation meetings. Cooperation from small salt manufacturers in Bolivia and the compliance of Cameroon's sole refiner are the main reasons for those countries' successful iodination (Mannar and Dunn 1994).

20. In Indonesia about 25,000 salt farmers supply 80 percent of total raw salt (90,000 tons a year) to about 300 salt processing plants to process and iodize, with the state-owned PT Garam producing and processing the other 20 percent.

21. National Indonesian Standard (SNI) licenses are given to producers who have fulfilled certain criteria of salt quality and internal quality control. Only 40 percent of its 182 salt processing plants had obtained the SNI licenses by May 2000. The

Ministry of Industry and Trade began in 2000 to work with salt producers to help them secure SNI licenses.

22. The remaining 10 percent buy from other sources such as door-to-door salesmen or raw salt sellers in the area. There is no significant difference between urban and rural inhabitants (Indonesia Statistics Bureau 1999).

23. Ecuador and Brazil sampled salt weekly at production plants during early phases of the fortification program. Bhutan has developed a systematic monitoring and reporting system for iodine content at production, distribution, and consumption, with reports reviewed centrally every month. Ecuador uses legal sanctions in the form of fines and newspaper publication of noncompliant brand names (Mannar and Dunn 1994).

24. The Bank has funded an extremely costly comprehensive IDD mapping for the entire country—the benefits may not be large enough to justify such an exercise. More cost-effective is the Statistics Bureau's inclusion of questions on iodized salt in its yearly household surveys, with the project's funding. Such a supplementary survey is very helpful in providing information on coverage and consumption rates of iodized salt, the effectiveness of information, education, and communication campaigns, demand factors, and regional lapses in supply. Sampling of urine among primary school children can be done during the surveys. It is unclear whether the Statistics Bureau will continue the survey on consumption of iodized salt during the yearly household surveys after the Bank project is completed.

25. Pemeriksaan Obat dan Makanan, 2000.

26. Bangladesh's experience has shown that poor quality control can undermine efforts in IDD control. The Bank's Fourth Bangladesh Health and Population Project found that 78 percent of households consumed iodized salt in 1997, although iodine status was not evaluated at that time (World Bank 1999b, p. 38). Based on a 1997 survey, Khorasani (1999, p. 205) found that of 379 salt samples collected from 138 factories in Bangladesh, only 5 percent contained a satisfactory amount of iodine. Of the 1,104 samples collected from retail outlets, 44 percent contained too little iodine, and the rest contained too much. In the 379 samples 49 percent contained too much iodine and 46 percent contained too little. Moreover, only 57 percent of the salt factories with iodination facilities were in regular production, while 36 percent were closed. About 17 percent of the factories produced salt containing more than 20 times the recommended amount of iodine.

27. Indonesia Statistics Bureau 1999, table 1, p. 14.

28. Latief 1999, table 6, p. 6.