RESEARCH PAPER

Double Fortified Salt in India: Coverage, Efficacy and Way Forward

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Abstract

Iron deficiency remains the world's most widespread nutritional disorder and India is one of the countries very worst afflicted. India has successfully reduced the burden of iodine-deficiency disorders through mandatory iodization of salt for more than 20 years. This has resulted in a significant decrease in the prevalence of iodine deficiency diseases. Building on the success with iodization, double fortification of salt with iodine and iron is gaining ground and can be integrated with established iodization processes. DFS contemplates the creation and distribution of a powerful innovative product with demonstrated health effects, building on existing distribution platforms for salt through public distribution channels targeted to some of the most impoverished populations in the country at minimal expense and without requiring changes in cultural habits and compliance. Two formulations have been approved by Food Safety and Standard Authority of India (FSSAI) with iron either in the form of encapsulated ferrous fumarate or ferrous sulphate. A meta-analysis showed that DFS increased hemoglobin concentrations significantly. This intervention as part of a broader anemia strategy has the potential to effect large-scale anemia reduction across populations in India on a permanent and economically self-sustaining basis.

Keywords

iron deficiency, anemia, salt, fortification, iodine, iodine deficiency, salt industry, efficacy, scale up, targeting, economics, impact

Introduction

Anemia in India – Prevalence and Causes

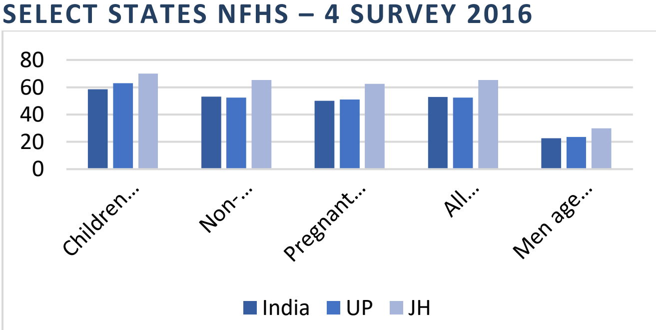
Iron deficiency remains the world's most widespread nutritional disorder, affecting approximately 1.6 billion people, (Benoist B, McLean E, Egli I, Cogswell M. 2008) worldwide disproportionately affecting women and young children. Its consequences, which include impairment of IQ and diminished energy levels, (Haas JD, Brownlie T. 2001) contribute to losses of up to 2-8% of GDP in the worst affected countries. (Horton S, Ross, J. 2003). Iron is the main driver (and causes roughly the majority of incidence) of anemia. (WHO 2014) Other causes of anemia include folic acid, vitamin B12 and vitamin A deficiencies, chronic inflammation, parasitic infections, and inherited disorders.

India is one of the countries very worst afflicted, even on a percentage basis, by anemia: a staggering approximately 52% of women of reproductive age and 59% of children under 5 are anemic. (Figure 1) One-third of the nearly 300 million anemic preschool children around the world live in India. The human costs are astronomical, in terms of lack of energy, illness, and damped cognition and IQ. In economic terms, it has been estimated that the Indian GDP is reduced by 6% every year due to iron deficiency anemia (Horton, S. and Ross J. 2003). Anemia prevalence in India has remained flat or rising, even with increased GDP. (L. Haddad and S. Zeitlyn eds. 2009). The problem cuts across income quintiles - a significant percentage of people even in the upper two income quintiles are anemic.

A recent study of children aged 6-30 months in low and middle-income families near Delhi (Kumar T., Taneja S., Yajnik C.S., Bhandari N. and Strand T.O. 2014) revealed an alarming anemia rate of 69.6%. The main predictor for anemia, was plasma serum Transferrin Receptor (sTfR) concentration, which is an indicator of iron stores in the body and its level in the blood increases when Hb concentration decreases. This confirms that iron is one of the most important determinants for anemia. In the study Folate and vitamin B12 status also predicted plasma Hb concentration but to a lesser extent. A review paper on prevention of iron deficiency recently published in India (Anand T., Rahi M., Sharma P. and Ingle G.K. 2014) highlighted the lack of progress in addressing iron deficiency in India and called for renewed efforts on a number of fronts including increased iron intake through fortification of foods.

Iodine deficiency is the world's leading preventable cause of mental disability, with 1.6 billion people at risk from iodine deficiency disorders (UNICEF 2004) which in turn is linked to approximately 18 million babies being born mentally impaired annually across the globe. While substantial progress has been made through iodization of salt to reach nearly 75% of iodine deficient populations, there is still a significant gap remaining to be covered. 71 million people in India suffer from either goiter or iodine deficiency disorders that adversely affect brain development, and a full 31% of Indian schoolchildren have insufficient iodine intake. Nearly 100% of Indian women and children are at risk of folic acid deficiency. (National Institute of Nutrition: Hyderabad, India, 2009)

FIG 1. ANEMIA PREVALENCE IN INDIA AND IN SELECT STATES NFHS – 4 SURVEY 2016



Enhancement of Micronutrient Intakes through Food Fortification

In industrialized countries micronutrient malnutrition has been largely controlled, at a very low cost. Investments made several decades back in fortification of staple foods have played an important role in improving intakes and have been proven safe and economical. The May 2012 Copenhagen Consensus of eminent world economists, including several Nobel laureates, ranked investing in a bundle of micronutrients as the most cost effective in a list of 40 potential development investments. (Copenhagen Consensus. 2012)

Within micronutrient programs, fortification is considered the most far-reaching and cost effective. It is complementary to other interventions such as distribution of micronutrient supplements and powders, or dietary promotion. After initial setup, the incremental cost is often wholly internalized and borne solely by consumers and industry, with minimal need for ongoing government subsidy/philanthropy to pay for direct product cost (governments will only continue to oversee implementation of policies and programs, setting of standards and regulation, communications, monitoring, and evaluation.). Governments may however choose to provide the product at a subsidized cost to very vulnerable populations.

Fortifiable food products and condiments are frequently consumed in high-income countries. In low income countries they are less widely consumed or available. An exception is salt, which is widely consumed daily even in hard to reach regions of very poor populations. Salt is an excellent vehicle for a multiple nutrient fortification program due to its universal consumption by adults and children in small and regular quantities, even by the very poor and food insecure, the relatively centralized production and processing of salt (as compared to other food commodities) and the infrastructure that has been created in recent years through national iodine fortification programs globally.

Over the past two decades a major multi-sectoral collaboration of national governments, salt companies and a range of partners (UNICEF, Kiwanis, MI) in universal salt iodization (USI) has led to significant advances in reducing iodine deficiency, making USI one of the most successful nutrition interventions of the past half-century. At this time, salt iodization facilities have been installed in more than 140 countries. A public investment of only $400M has leveraged private investment of nearly $3B over a 20-year period, resulting in access to iodized salt for more than 70% of the global population, or approximately 5 billion people.

In India, approximately 76% of the population now consumes iodized salt. (UNICEF 2016) India has successfully reduced the burden of iodine-deficiency disorders through mandatory iodization of salt for more than 20 years. This has resulted in a significant decrease in the prevalence of iodine deficiency diseases. It would therefore be prudent to use the iodization infrastructure to deliver iron along with iodine through salt to the deficient populations. Salt also holds the potential to carry additional micronutrients such as iron, vitamin B12, zinc to correct a range of mineral and vitamin deficiencies in the diet. A phased approach to introduce DFS first through targeted public and market-channel programs, and ultimately to extend it to the entire population and making it mandatory, is therefore warranted.

Double Fortified Salt

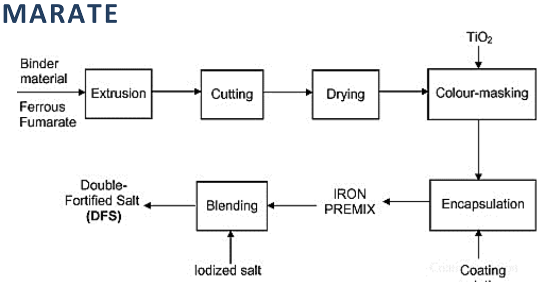
The promise of salt to carry multiple nutrients was first proposed in 1969 (Levinson and Berg 1969). The second micronutrient that has been considered most extensively for addition is iron. Salt can be an effective carrier for iodine and iron and effectively complement current nutrition programs and reach larger populations in a cost-effective manner and at-scale to quickly reduce anemia in a population. Salt is the chosen vehicle because it constitutes an unmatched distribution platform with a uniform uptake amongst all income groups including the poorest. It is perhaps the only food consumed daily worldwide ingested in small and regular quantities. It is centrally processed and thus amenable to fortification. Further salt, is universally consumed by all segments including the poor among whom anemia is much more prevalent.

The main challenge here is the interaction between iron and iodine which leads to loss of iodine. The use of stabilizers, and encapsulation of iron and/or iodine have been investigated as the feasible way of solving this problem. Other research on adding iron and iodine to salt includes a formulation using ferrous sulphate by the Indian National Institute of Nutrition (Nair KM, Brahmam GN, Ranganathan S, Vijayaraghavan K, Sivakumar B, Krishnaswamy K. 1998) and a study in Morocco using micronized ferric pyrophosphate (Zimmermann MB, Wegmueller R, Zeder C, Chaouki N, Rohner F, Saïssi M, Torresani T and Hurrell RF. 2004).

Two formulations have been approved by Food Safety and Standard Authority of India (FSSAI): DFS is prepared with adequately iodised salt further fortified with iron either in the form of encapsulated ferrous fumarate or Ferrous Sulphate. The production process of DFS with Ferrous Sulphate is developed by National Institute of Nutrition (NIN), Hyderabad, the process of production of DFS with encapsulated ferrous fumarate is developed by University of Toronto Canada.

The technology developed by the University of Toronto uses an encapsulated ferrous fumarate (EFF) DFS formulation, which uses cold extrusion, colour masking, and microencapsulation of the iron particles to provide greater stability and create a barrier that prevents iron-iodine interaction. (Y. O. Li, D. Yadava, K. L. Lo, L. L. Diosady, and A. S. Wesley. 2011). The process starts with raw ferrous fumarate and processes it through a series of steps to agglomerate and coat the iron particles until a uniform white particle comparable in size with salt particles is obtained. It is then mixed with binding agent, and extruded. The extrudates are cut into shape and the required size, dried and colour masked. The coloured masked extrudates are subsequently coated with Hydroxy Propyl Methyl Cellulose (HPMC). Encapsulated iron premix contains 18-20% iron. The encapsulated iron is then transported to the salt refinery for blending with iodized salt.

FIGURE: PRODUCTION OF DOUBLE FORTIFIED SALT USING ENCAPSULATED FERROUS FUMARATE



The process of double fortification of salt requires just one additional step to current salt refineries producing refined/crushed dried iodized salt. This step involves the preparation of a rich mix of the encapsulated iron premix with a small quantity of salt followed by mixing this rich mix with the bulk of the salt in the required proportion in a ribbon blender. The proportion of encapsulated iron premix to salt is approximately 5.5 kg/Ton of salt. DFS is essentially organoleptically indistinguishable from iodized salt in appearance, taste or smell. This formulation can only work well with salt of the same particle size, 300-700µm, without the problem of segregation. Iron premix with relatively smaller size would adhere to the surface of salt particles. The layer has an optimal thickness (of only a few microns) that protects the iron until it is ingested, and passes through the stomach, and reaches an optimal point in the gastrointestinal tract where the encapsulant disintegrates, enabling the absorption of iron.

An efficacy study conducted by ETH Zurich and St. Johns' Research Institute in Bangalore on DFS - EFF in 2008 showed a 66% reduction in anemia prevalence, and improvement in other iron indicators, over 10 months. (Andersson M, Thankachan P, Muthayya S, Goud RB, Kurpad AV, Hurrell RF, Zimmermann MB. 2008). Consumer acceptance studies were conducted in Bangladesh and Sri Lanka in 2012 and found good acceptance (Lanka Market Research Bureau, Ltd., Unitrend, Ltd. 2012.) A randomized controlled trial (conducted in 2014 found significant improvements in all biomarkers of iron status in women tea pickers in Darjeeling, India.) (Jere D. Haas, Maike Rahn, Sudha Venkatramanan, Grace S. Marquis, Michael J. Wenge. 2014. In addition, the Darjeeling study has demonstrated significant improvement in cognitive skills and energy efficiency among recipients of DFS. (Murray-Kolb L. 2014). These improvements depended on the extent of the anemia and on the concurrent causes of anemia. DFS provides approximately 30-40% of the Recommended Daily Intake (RDI) of iron for women of reproductive age. The importance of the new formulation of DFS lies essentially in the fact that it is indistinguishable in taste, colour and smell from regular salt (speck like particles of encapsulated ferrous fumarate may be faintly visible but do not deteriorate with time) and in addition, unlike micronized ferric pyrophosphate ,which has a similar bioavailability to the encapsulated ferrous fumarate, it causes no additional loss of iodine in moist salt during storage.

The Food Standards and Safety Authority of India (FSSAI) issued a Gazette Notification approving the revision of the standards for DFS that will encompass the current team's EFF DFS formulation to effect immediately (The Gazette of India. 2014). Double Fortified Salt is now being produced in India on a commercial scale and has the potential to be distributed through commercial channels and public programs to reach economically weaker sections of the population in many countries. A phased approach to introduce DFS first through targeted public and market-channel programs, and ultimately to extend it to the entire population and making it mandatory, is considered the most optimal strategy.

TABLE: FSSAI DFS PRODUCT SPECIFICATIONS

Sl. No.	Characteristic	Requirement	
		Ferrous Sulphate	Encapsulated Ferrous Fumarate*
i)	NaCl content of the salt used for the production of DFS, percent on dry weight basis	99	98
ii)	Moisture, percent by mass, Max	1.5	1.5
iii)	Water insoluble matter, percent by mass, on dry basis, Max	1.0	1.0
iv)	Chloride content (as NaCl), percent by mass, on dry basis, Min	97.0	97.0
v)	Matter insoluble in dilute HCL, percent by mass on dry basis, Max	0.30	0.30
vi)	Matter soluble in water other than sodium chloride, percent by mass, on dry basis, Max	2.5	2.5
vii)	Iron content (as Fe), ppm	850-1100	850-1100
viii)	Iodine content, ppm, Min a) Manufacturer's level b) Distribution channel including retail level	 30 15	 30 15
ix)	pH value in 5% aqueous solution	3.5-5.5	3.5-7.5
x)	Sulphate (as SO4), percent by mass, Max	1.1	1.1
xi)	Magnesium (as Mg), water soluble, percent by mass, Max	0.10	0.10
xii)	Phosphorous (as P2O5), ppm	2,800-3,100	Not more than 3,100
Xiii)	Sodium hexametaphosphate (SHMP), percent by mass on dry basis, Max	1.0	1.0

* Provided that DFS may contain food additives permitted in appendix A and Hydroxy Propyl Methyl Cellulose, Titanium Dioxide, fully Hydrogenated Soyabean Oil, Sodium Hexametaphosphate (all food grades) at concentration of not more than GMP and

anti-caking agent not more than 2.0 per cent on dry basis and the water insoluble matter wherein anti-caking agent is used shall not exceed 2.2 percent.

Dosage

DFS is designed for use as a regular salt for cooking and as table salt. Saltiness of the food will limit excess use of DFS by accident. Based on an estimated average salt consumption of 10 g per person/day, the DFS is designed to provide 100% daily requirement of iodine and 30 – 40% for iron. FSSAI specifications are set out in Table 1.

Efficacy

A meta-analysis conducted recently (Maria J Ramirez-Luzuriaga, Leila Margaret Larson, Venkatesh Mannar, Reynaldo Martorell. 2018) to examine the effect of DFS on hemoglobin concentrations and assess differential effects of DFS on hemoglobin concentrations by population subgroups showed that DFS increased hemoglobin concentrations. Significant heterogeneity was observed, and random effects models were used. Stratified analyses by population subgroups indicated significant effects among school-age children and women of childbearing age. Ferrous sulfate and ferrous fumarate showed similar effects. The analysis concluded that DFS is efficacious in increasing hemoglobin concentrations in LMIC populations.

Stability and Consumer Acceptability

Stability tests conducted in the laboratory settings as well as in field distribution and storage conditions have shown that the DFS-EFF is stable even in humid tropical climates with high temperatures and are acceptable for human consumption as an alternative to iodised salt. The suggested shelf-life is 12 months from the date of opening the package containing DFS. DFS has been designed for use in cooking and as table salt in a similar daily usage of iodised salt. Consumer acceptability tests indicated that most consumers find DFS to be acceptable in terms of taste and color. Most consumers considered DFS more acceptable when considering its enhanced nutritional value compared to iodised salt. Sensory acceptability tests under typical household use, preservation and cooking practices in refugee camps and community feeding programs showed that DFS is well consumed as a replacement for iodised salt.

Scale Up

All prerequisites for scale up analyses that have been completed for DFS include: efficacy, organoleptic (taste/color/smell) properties, design and fabrication of process equipment and other technical support. What still needed to be done was to evaluate the effectiveness of the intervention at scale through a targeted public distribution program, to lay the groundwork for launch through commercial channels, and to facilitate state and nationwide scale up.

Two distribution arms hold promise

1. A mid-tier market-based channel, targeting income quintiles C and D, where salt is currently unbranded or locally branded, but is relatively moisture-free and thus suitable for fortification, and
2. Public distribution channels, to reach those in the bottom income quintile. Also, mandating the use of fortification is widely-deployed (over 100 countries require iodization of salt, and at least 50 require iron fortification). A phased approach to introduce DFS first through targeted public and market-channel programs, and ultimately to extend it to the entire population and making it mandatory, is therefore recommended.

Salient features of the two approaches are summarized in Table 2

TABLE 2: EXPANDING ACCESS TO DFS IN INDIA

Public Sector Approaches	Open Market Approaches
PDS, ICDS and MDM can reach significant vulnerable populations **Targeted beneficiaries using existing supply chains: FPS shops, Anganwadi centres and schools** **Needs strong BCC and monitoring** **State subsidies to act as incentives**	Business case for salt producers Initial entry through higher grades gradually percolating to less expensive grades Government policy and regulation would help Demand creation through active campaigns by private sector

The use of DFS has been not only encouraged but made mandatory in the Mid-Day Meal program in Government run schools as well as the Integrated Child Development Services (ICDS) systems to support pre-school children and pregnant/lactating mothers, as per a formal circular by the GOI ministry in charge of those systems, (GOI, MWCD. 2009) although that use has not yet been implemented, largely because of the previous unavailability of an effective formulation. The Mid Day Meals scheme (MDM), reaches approximately 100 million school children across India every day. In Tamil Nadu, MDM has already distributed EFF DFF, to over 5 million school children in 33,000 schools, each school day for approximately 7 years.

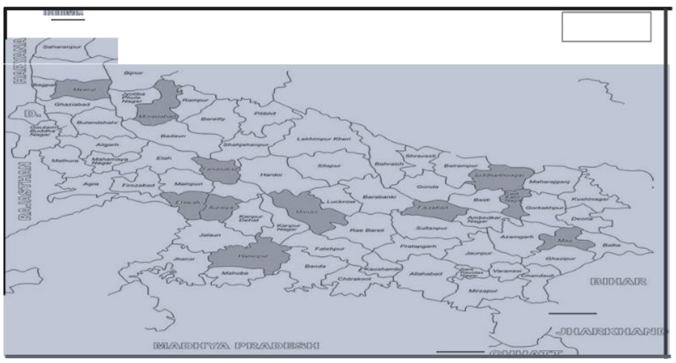
Even larger than these two systems (in terms of reach) is the Public Distribution System (PDS) in India, which targets the poor, and reaches over 200 million people with its network of 500,000 Fair Price Shops. PDS also reaches entire families, for potentially all meals, and operationally builds on the distribution of packages of commodities to the home. PDS was established by the Government of India under the Ministry of Consumer Affairs, Food, and Public Distribution and is managed jointly with state governments. A majority (an estimated nearly 80%) of the people in India who are currently covered under PDS suffer from significant micronutrient deficiencies. However less than 5% of foods provided through PDS, are fortified with micronutrients. This is both a problem and an immense opportunity to help hundreds of millions of undernourished people. The PDS in many states already distributes iodized salt, which will pave the way for the introduction of DFS using the same procurement and distribution infrastructure. While the PDS has significant flaws, due to leakages, inefficiencies, and lack of supply, and while DFS is not yet mandatory in the PDS, its scale and nature, coupled with the widespread prevalence of anemia across the country and all age groups, makes it a powerful option.

The Government of Uttar Pradesh was the first State to launch the scale up of DFS for distribution utilizing the public distribution system with the objective of enabling a major health impact, namely, to reduce iron deficiency anemia, iodine deficiency and their functional consequences across the population of Uttar Pradesh, with particular impact on children under five and women of child bearing age. The State has proposed that the DFS be distributed in 10 districts in phase 1 of the project. In this phase, various aspects of the project are being measured – uptake and consumption of the DFS, quality in terms of purity, iron and iodine content, consumer acceptance of the salt as well as movement in the outcome indicators i.e. anemia levels. The parameter used for prioritizing 10 districts in the State is anemia prevalence in children under 5 years of age (Source: NFHS 3: District Level Household and Facility Survey) in the high burden districts as defined by Ministry of Women and Child development (No.11-2/2012-ND, 11th December 2013). This is a good proxy for the overall anemia prevalence in the district. These 10 districts cover 10% of the total number of card holders in the state and 12% of the total BPL and Antyodaya card holders in the state. The total population in the 10 districts who are being be targeted under this program is approx. 23 million.

Currently the State of Uttar Pradesh primarily distributes only wheat, rice, sugar and kerosene through the PDS, and salt needs to be added to this in collaboration with the State Department of Food and Civil Supplies. The initiative would be well served by the extensive coverage of the network of fair price shops – around 77000 across the state, each with up to a 1000 cards (i.e. 5000 people). Distribution through the PDS vis-à-vis open market will also help self-select the target population, namely the impoverished and help achieve better health status at scale.

The sources of DFS will be in one of the primary salt production states (Gujarat, Rajasthan, Tamil Nadu) in India. Each of the states produces a significant proportion of India's edible salt and there is high level interest in these States in the twin objectives of modernizing the salt industry in the state, enhancing product quality and value, and simultaneously applying modern technologies to enable salt to provide public health benefits. While the initial rollout of DFS through PDS will be limited to 10 districts, the State Government of U.P is interested to expand through public channels, and an analysis of its effectiveness is one appropriate next step for several reasons. Public distribution systems are a principal way to reach those in lower income quintiles. The national branded salts are principally sold to those in upper income quintiles. Further, despite the recent DFS tender offers, many governments (in India and globally) will not take a decision to scale up without a real evidence base, and based on only an efficacy study of a few hundred subjects. And even for those that are planning scale-up, the time to set a baseline is now. With such a baseline and an examination of effectiveness, the intervention (which may reach hundreds of millions of people) can be evaluated in an evidence-based manner. And it can proceed based on substantiated and not speculative health claims. To encourage consumer acceptance and market adoption requires building a solid business case, including production templates and consumer acceptance feedback, as well as solid health claims, which are being monitored as a part of the project.

FIGURE 2. MAP OF UTTAR PRADESH SHOWING THE 10 DISTRICTS SELECTED FOR THE FIRST PHASE OF THE DFS – PDS PROGRAM



Following the launch of DFS in UP other States have followed. Table 2 sets out the list of States that have commenced rollout of the intervention at scale to date. Several other States are considering introducing the intervention and DFS could potentially reach 200 million beneficiaries through public programmes (Table 3)

TABLE 3: ESTIMATED COVERAGE IN PROJECT STATES

State	No of Districts covered by DFS Programme	No of beneficiaries	Subsidized sale price
Uttar Pradesh	10 (92 blocks)	24 million	Rs 3/kg for AAY Rs 6/Kg for all other cardholders
Madhya Pradesh	89 blocks	10 million	Rs 1/kg for all card holders
Jharkhand	Entire State (24 Districts)	32 million	Rs 1/kg for all card holders
Total		66 million	

DFS Programme Objectives and Impact Assessment

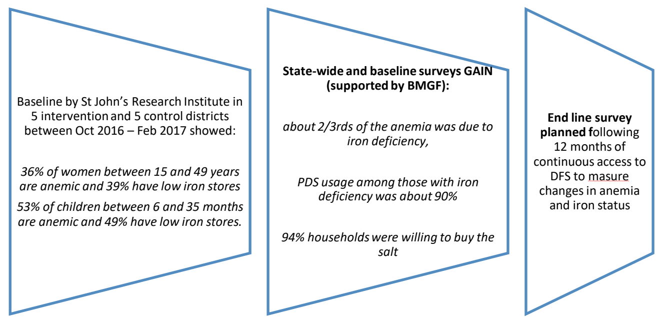
The ultimate objective of the program is to improve the iodine & iron status of population and protection of new-borns against mental impairment due to iodine & iron deficiency disorders though increased utilization of DFS at household level.

The short-term objectives include:

1. Indigenously produce adequate quantity & quantity of DFS.
2. Availability of DFS for supply through PDS programs.
3. Regular availability of DFS at fair price shops (FPS).
4. Improve knowledge of importance of DFS & willingness to pay.

The effectiveness of the DFS strategy is being assessed for the UP DFS project by GAIN along with research partners – SJRI, Bangalore and SGPGI, Lucknow. A baseline has been conducted by GAIN in 5 interventions and 5 control blocks. An End-line survey would be planned after one year of continuous distribution and consumption of DFS by the beneficiaries to assess the program impact. The evidence generation pathway is set out in Figure 3.

FIGURE 3. EVIDENCE GENERATION FOR DFS IMPACT – BASELINE & ENDLINE SURVEYS



Economics

The pricing scenario for salt currently sold in Indian markets and projected price for DFS is reviewed below:

• Uttar Pradesh depends upon salt sources in Gujarat and Rajasthan for its salt needs; both edible and industrial. It is understood from trade sources in Lucknow that refined iodised salt (not free-flow) is retailed in Uttar Pradesh at Rs.6.50 to Rs.8 per kilo, in pouches. On the other hand, free-flow refined salt is retailed at Rs.13-18 per kilo depending upon quality of salt and packaging and the brand.

Table 4 summarizes incremental costs for salt iodization and double fortification.

• In public channels, DFS prices would likely be quite low. Several states offer a reasonable quality/packed iodized salt through PDS anywhere between Rs 5 - Rs 8/kg. In Tamil Nadu Chief Minister announced the sale of Amma DFS at Rs 14 through PDS and Amma Iodized salt at Rs 10/kg. These prices may include a subsidy component (that is initially borne by the State Governments) but could be phased out over a period.

- In market channels, if or when the producer or the retailer chooses to capitalize on this for additional profit margin (beyond the actual cost of production), they would consider what the market would be willing to pay. One should note that while the percentage is large, the absolute increase in expenditure is not high. It is about Rs 10 per person per year, when considering production costs only (Rs 4 per family of 5 per month = Rs 0.8 per person month=Rs 10 per person per year). Also, perhaps some price inelasticity may be present, particularly if a health benefit is communicated, and particularly in the upper income quintiles, where anemia is still a large problem. Further, we hope to reduce the price increase through technology optimization undertaken in this project. Vertical integration may offer cost reduction opportunities, as may other line items (e.g. sales and marketing) in the product cost. Lastly, we have seen strong interest from the salt industry in offering DFS as a value-added product, so the consumer demand may well be there.

TABLE 4. INCREMENTAL COSTS OF IODIZATION AND DOUBLE FORTIFICATION OF SALT

Component	Incremental Cost (Rs/kg)
Iodization (@50ppm) cost per person per year	3
Additional cost of iron via DFS per person per year	12

Expansion of DFS across India: Key Considerations

- Mapping the roles of key stakeholders/actors in the salt processing and distribution system. Deducing the potential, reach and impact of the DFS programme
- Supply Chain Related Aspects: Material & Information Flow: Capture salt supply chain flows (material & information)
- Economic considerations (Cost and subsidy issues/Consumer willingness to pay for additional value/Reaching low income groups
- Establishing the commercial viability for producing and marketing DFS
- Programme Implementation Strategy, Plan & Budgets:
- Needs assessment for capacity building (sensitization & training) of different departments and key actors who are involved in DFS supply chain.
- Promotion & Communication: Identify promotion and communication strategic elements for effective implementation of the DFS programme.
- Drafting and approval of standards
- Premix Procurement/Production Plan
- Monitoring & Evaluation: Monitoring & evaluation tools to capture the impact indicators and measure effectiveness

The Way Forward

The DFS project will be implemented against a backdrop of other food and pharmaceutical interventions. The Government of India has placed a high priority on combatting anemia.

DFS plays a complementary role to supplementation programs, which are targeted to specific groups, and which need to continue. Supplementation (targeted to pregnant and lactating women) is mandatory and needs to improve in terms of coverage and compliance. But in order to improve reach the iron status of huge swaths of the population across the life cycle (e.g. 56% of women of reproductive age, 70+% of children under 5, and large portions of men) that are iron deficient, a fortification approach is essential.

Further, supplementation does not help those who are outside the reach of the health systems, or who do not or cannot comply with the supplementation regimes. A program of fortification can reach adolescent girls, supplying them each day with approximately 10 mcg of iron, or 70 mcg per week, which is roughly what is ingested in the usual one iron supplement pill per week in supplementation programs. Further, fortification provides iron and folic acid tablets to women after they know they are pregnant, by which point it is too late to correct the risk of neural tube defects in their offspring. This was the rationale behind mandatory folic acid fortification, which was shown to significantly cut neural tube defects in Canada by nearly 70% and could also offer a potential extension for DFS to include folic acid and other nutrients as well in the future.

In the past there has been some apprehension that a perception of the health benefits of fortified salt could lead to an overconsumption of salt, contributing to chronic disease. The iodized salt experience over the past two decades, however has generally not borne out this result. Levels of fortification of salt could be easily adjusted to reflect reduced levels of salt intake.

In sum, DFS contemplates the creation and distribution of a powerful innovative product with demonstrated health effects, building on vast distribution platforms: a) the immense salt iodization structure that reaches approximately 70% of households in India, b) the reach of the public distribution channels targeted to some of the most impoverished populations in the country, and c) salt production and distribution networks in India. The elegance lies in the novel and path-breaking and simple product, designed specifically to avail itself of these massive systems for minimal expense and without requiring changes in cultural habits and compliance. As a result, this venture has the potential to effect large-scale anemia reduction across populations on a permanent and economically self-sustaining basis. On a value for money basis, we might venture to say it is an order of magnitude more cost-effective than most other nutrition or health interventions. Indeed, as per the Copenhagen Consensus of eminent economists, it may be ranked the single most cost-effective development intervention

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